

**Islamic Republic of Iran
Ministry of Petroleum
Health, Safety and Environmental Department**

**The Project for
Strengthening Environmental Management
in Petroleum Industry
in Persian Gulf and its Coastal Area**

Final Report

February 2014

Japan International Cooperation Agency

**Japan Oil Engineering Co., Ltd
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14-020

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List of Abbreviations

ACGIH	American Conference of Industrial Hygienists
ADNOC	Abu Dhabi National Oil Company
ADIOS	Automated Data Inquiry for Oil Spills
ALARP	As Low As Reasonably Practicable
ALOS	Advanced Land Observing Satellite
API	American Petroleum Institute
BAT	Best Available Technology
BDO	Butane diol
BIPC	Bandar Imam Petrochemical Company
Bcfd	Billion Cubic Feet per Day
BOD	Biochemical Oxygen Demand
BPD	Barrel per Day
BTX	Benzene, Toluene, and Xylene
CCS	Carbon Capture & Storage
CD	Capacity Development
CEO	Chief Executive Officer
CFU	Compact Floatation Unit
CISADA	Comprehensive Iran Sanctions, Accountability, and Divestment Act of 2010:
CLC	Civil Liability Convention
CNOOC	China National Offshore Oil Company
COD	Chemical Oxygen Demand
COP	Codes of Practice
CoPBPN	Codes of Practice Best Practice Notes
COW	Crude Oil Washing
CP	Cleaner Production
C/P	Counter Part
CSA	Canadian Space Agency
CSR	Corporate Social Responsibility
cSt	Centistokes
CTA	Crude Terephthalic Acid
dB	Decibel
DOE	Department of Environment
DLR	German Aerospace Research Establishment (Deutsche Forschungstall fur

	Luft and R)
DSO	De-sulfide oil
DWT	Dead Weight Tonnage
EDC	Ethylene dichloride
EGR	Exhaust Gas Recirculation
EHC	Environmental High Council
EHS	Environmental , Health and Safety
EIA	Environmental Impact Assessment
ENVI	Environment for Visualizing Images
EOP	End of Pipe
EOR	Enhanced Oil Recovery
EPC	Engineering Procurement and Construction
ERSDAC	Earth Remote Sensing Data Analysis Center
FS	Feasibility Study
FSU	Floating Storage Unit
FUND 92	Fund Convention 1992
GHSEC	ADNOC Group HSE Committee
GIS	Geographic Information System
GNOME	GNU Network Object Model Environment
GPS	Global Positioning System
GTL	Gas to Liquid
ha	hectare
HAZID	Hazard Identification Analysis
HAZOP	Hazard Operability Study Analysis
HF	High Frequency
HNS	Hazardous Noxious Substances
HSE	Health Safety and Environment
HSE-MOP	HSE Department of MOP
HSE-MS	HSE Management System
HYCOM	Hybrid Coordinate Ocean Model
ICETT	International Centre for Environmental Technology Transfer
IC/R	Inception Report
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IGF	Induced Gas Floation
ILO	International Labour Organization

IMO	International Maritime Organization
IMS	Integrated Management System
IOMOU	Indian Ocean Memorandum of Understanding
IOOC	Iranian offshore oil company
IOR	Improved Oil Recovery
IOTC	Iranian Oil Terminals Company
ITOPF	International Tanker Owners Protection Federation
IPIECA	International Petroleum Industry Environmental Conservation Association
IPS	Iranian Petroleum Standard
ISO	International Standard Organization
IUCN	International Union for Conservation of Nature
JAXA	Japan Aerospace Exploration Agency
JCCP	Japan Cooperation Center, Petroleum
JICA	Japan International Cooperation Agency
JOE	Japan Oil Engineering Co., Ltd
JOGMEC	Japan Oil, Gas and Metals National Corporation
KPC	Khark Petrochemical Company
LANDSAT	Land Remote Sensing Satellite System
LEL	Lower Explosive Limit
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MAH	Maleic anhydride
MARPOL	International Convention for the Prevention of Pollution from Ships
MBBR	Moving Bed Biofilm Reactor
MBR	Membrane Bio Reactor
MDA	MacDonald , Dettweiller and Associates Ltd
MDEA	Methyl diethanol amine
MDI	Methylene diphenyl diisocyanate
MEG	Mono Ethylene Glycol
MEMAC	Marine Emergency Mutual Aid Centre
MLSS	Mixed Liquor Suspended Solid
MMBTU	Million British Thermal Unit
MMSCFD	Million metric standard cubic feet per day
MMSCMD	Million metric standard cubic meter per day
M/M	Minutes of Meeting

MMUSD	Million metric United State Dollar
MODIS	Moderate resolution Imaging Spectroradiometer
MOFA	Ministry of Foreign Affairs
MOI	Ministry of Interior
MOP	Ministry of Petroleum
MOT	Ministry of Transport
MOU	Memorandum of Understanding
MTBE	Methyl Tertiary Butyl Ether
MW	Megawatt (1000 KW)
NCEP GFS	National Centres for Environmental Prediction Global Forecast System
NCOM	The Global Navy Coastal Ocean Model
NDC	North Drilling Company
Net CDF	Network Common Data Form
NGL	Natural Gas Liquid
NGO	Non-Governmental Organization
NICO	Naftiran Intertrade Company
NIGC	National Iranian Gas Company
NIGEC	National Iranian Gas Export Company
NIOC	National Iranian Oil Company
NIOEC	National Iranian Oil Engineering Company
NIOPMC	National Iranian Oil Products Distribution Company
NIOPTC	National Iranian Oil Pipeline and Telecommunication Company
NIORDC	National Iranian Oil Refining and Distribution Company
NOAA	National Oceanic and atmospheric Administration
NOSCP	National Oil Spill Contingency Plan
NORM	Naturally Occurring Radioactive Material
NPC	National Petrochemical Company
OBM	Oil Based Mud
ODS	Ozone Depleting Substances
OGP	International Association of Oil & Gas Producers
OHSAS	Occupational Health and Safety Assessment Series
OPEC	Organization of Petroleum Exporting Countries
OPRC	International Convention on Oil Pollution Preparedness, Response and Cooperation
OSR	Oil Spill Response
OSRP	Oil Spill Response Plan

OSSM	On-Scene Spill Model
PAJ	Petroleum Association Japan
PBT	Polybutylene Terephthalate
PDCA	Plan-Do-Check-Act
PDH	Propane Dehydrogenation
PET	Polyethylene terephthalate
PETZONE	Petrochemical Special Economic Zone
PM	Particulate Matter
PM10	Particles between 2.5 and 10 micrometres in diameter
PM2.5	Particles less than 2.5 micrometres in diameter
PMO	The Ports and Maritime Organization
PNOSC	Pazargad Non Industrial Operation Services Company
POGC	Pars Oil and Gas Company
ppb	Parts per Billion
PPE	Personal protective equipment
ppm	Parts per Million
PR/R	Progress Report
PS	Performance Standard
PSC	Port State Control
PSEEZ	Pars Special Economic Energy Zone
PSEZ	Petrochemical Special Economic Zone
PSO	Port & Shipping Organization
PTA	Purified Terephthalic acid
PVC	Poly Vinyl Chloride
QRA	Quantitative Risk Analysis
3R	Reduce, Reuse, Recycle
Razi	Razi Petrochemical Company
R&D	Research and Development
RESTEC	Remote Sensing Technology Center
RIIS	ROPME Integrated Information System
RIPI	Research Institute of Petroleum Industry
RO	Reverse Osmosis
ROPME	Regional Organization for the Protection of the Marine Environment
RSIS	Remote Sensing Images Information Systems
SAR	Synthetic Aperture Radar
SBM	Synthetic Oil Based Mud

SCF	Standard Cubic Feet
SEA	Strategic Environmental Assessment
SOLAS	International Convention for Safety of Life at Sea
SPAC	Strategic Planning and Control
SPC	Supreme Petroleum Council
SPGC	South Pars Gas Complex
SPM	Suspended Particles
SPM	Single Point Mooring
SRT	Sludge Retention Time
SRU	Sulphur Recovery Unit
SS	Suspended Solid
SUR	Sulphur Recovery Unit
SVOC	Semi-Volatile Organic Compound
S/W	Scope of Work
TAP	Trajectory Analysis Planner
TDS	Total Dissolved Substance
TGTU	Tail-Gas Treatment Unit
TLV-STEL	Threshold Limit Value-Short Term Exposure Limit
TLV-TWA	Threshold Limit Value-Time Weighted Average
TSS	Total Suspended Substance
TTPC	Terminals and Tanks Petrochemical Company
UAE	United Arab Emirates
UN	United Nations
UNCLOS	United Nations Convention on the law of the sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USD	United State Dollar
UTC	Coordinated Universal Time
VOC	Volatile Organic Compound
WB	World Bank
WBM	Water Based Mud
WHO	World Health Organization
WMP	Waste Management Plan
WWT	Wastewater Treatment
YEC	Yachiyo Engineering Co., Ltd

1. Introduction

1.1. Background of the Study

The Islamic Republic of Iran (Iran) has abundant proven oil reserves and natural gas reserves. The reserves being developed currently are confined to the southwest inland and offshore Persian Gulf, and further development of such reserves are planned by the government in this decade.

Accompanying the long time development at the coastal and offshore fields of the Persian Gulf, the environment in the region has been degraded significantly due to emission and discharge of various wastes such as gases, waste water and solid wastes associated with the past development and production activities despite the efforts of environmental protection by the developers.

In addition, with aging of the existing production facilities and future development of the fields in the region, it is expected that some potential risks of accidental oil spill from the offshore installations and the related vessels will be increased. The spilled oil from the facility or vessel, if occurred unexpectedly, is possible to impact significantly on marine and coastal environment and on the social/ economical activities in the surrounding sea area. In case of a large oil spill, it is expected easily that oil slicks may be diffused widely and impact on the marine environment in the whole of the Gulf, if no proper and timely response actions are taken.

Accordingly, in response to the official request of the Government of Iran for technical cooperation, the Japan International Cooperation Agency (JICA) had implemented the “Study for Strengthening Environmental Management in Petroleum Industry in Persian Gulf and its Coastal Area” (the Study) in close cooperation with Ministry of Petroleum (MOP) and the authorities concerned under the MOP.

1.2. Objectives of the Study and Scope of Works

(1) Objectives

The goal of the study is to strengthen the management capabilities for marine and coastal environment in the petroleum industry in Iran. For achieving the goal, the Study aims:

- (1) To review and analyze the current marine and coastal environmental management and emergency response preparedness on potential oil spill event, and
- (2) To formulate draft Master Plans for improvement of the marine and coastal environmental management system and oil spill emergency response system.
- (3) The study also aims to transfer the advanced technologies for the environmental management and effective response to the possible accidental oil spill to the Iranian side through

implementation of the study.

(2) Scope of Work

For achieving the objectives, the study shall be implemented progressively in two (2) phases as the Scope of Work.

- Phase 1: Review and analysis of the current marine and coastal environmental management and emergency response preparedness on potential oil spill event
- Phase 2: Formulation of draft Master Plans for strengthening the marine and coastal environmental management and oil spill emergency response system for petroleum industry

The following themes and works to be implemented in the respective phases of the Study had been performed in March 2012-November 2013.

Phase 1

1) Collection of basic information and analysis of current situation

- a. Position of petroleum industry related environmental management and disaster prevention/ response in the Fifth National Development Plan
- b. Offshore/ coastal oil and gas development plans and the associated potential marine and coastal environmental risks
- c. Current environmental situation (general environmental baseline) in the Persian Gulf and the pilot areas
- d. Assessment of potential marine and coastal environmental impacts of the development plans
- e. Current relevant legal and institutional frameworks for marine and coastal environmental protection/ management
- f. Current marine and coastal environmental management system of MOP/ petroleum industry

2) Review of current situation of marine and coastal environmental management in the pilot areas

- a. Current institutional framework on environmental management
- b. Current environmental status/ pollutions and environmental protective measures
 - Review on application of remote sensing technology
- c. Environmental performance of the responsible organization
- d. Applicable international guidelines and practices
- e. Capacity assessment of responsible organization for environmental management

3) Review of current situation of emergency oil spill response in the pilot areas

- a. Current emergency oil spill response scheme
- b. Potential oil spill risks and probable environmental impacts of the event
 - Modelling of oil spill trajectory and fate on water
- c. International/ regional oil spill response framework and requirements
- d. Status and trends of the Gulf countries
- e. Capacity assessment of responsible organization for oil spill response

Phase 2

- 1) Educational Activities of personal capacity building for environmental issues based on the current state
 - a. Identification of environmental issues
 - b. Preparation of training programs for personal capacity building on above a
 - c. Implementation of training programs as workshop style
 - d. Execution of Technical seminars for environmental measures and advanced HSE Management system
 - e. Execution of Training Program for Advanced HSE management system and Oil spill response measures in Japan
- 2) Development of draft Master Plans for strengthening marine and coastal environment management for petroleum industry
 - a. Identification of future development plans in the pilot areas and potential environmental impacts arising from the oil and gas development
 - b. Draft Master Plan for offshore environmental management of MOP
 - c. Draft Master Plans for environmental management of marine and coastal area in the pilot areas
- 3) Development of draft Master Plans for strengthening oil spill emergency response system for petroleum industry
 - a. Assessment of oil spill risks associated with the development and operational activities
 - b. Draft Master Plan for oil spill response plan of MOP
 - c. Draft Master Plans for oil spill response plan of the pilot areas

1.3. Study Area

The target areas to be covered in the Study are the marine and coastal areas of the Persian Gulf affected by the offshore oil exploration/operation and the petroleum industrial areas designated as pilot areas as follows.

- Mahshahr
- Khark Island
- Assaluyeh

Figure 1.3-1 shows the location of the pilot areas.



Source: World Maps Zone- Maps of Iran (<http://www.worldmapszone.com/iran/>)

Figure 1.3-1 Location Map of the Pilot Areas

1.4. Participating Organizations

The implementing agency of the Iranian side for the Study is Health, Safety, and Environment Department, Ministry of Petroleum (HSE-MOP). The Iranian side nominated the following personnel for the management of the study.

- Study Director: General Director, HSE-MOP
- Study Coordinator: Senior Environment Expert, HSE-MOP
- Deputy Study Coordinator: Director General, HSE Department, National Petrochemical Company (NPC)

A steering committee is established to supervise progress of the study and make decision on contents of the master plans based on outcomes of the study. Appointed committee members are as follows.

- HSE Headquarters, MOP
- National Petrochemical Company (NPC)
- HSE, Iranian offshore oil company (IOOC), representing Khark Island
- HSE, Petrochemical Special Economic Zone (PSEZ), representing Mahshahr
- HSE, Pars Special Economic Energy Zone (PSEEZ), representing Assaluyeh
- Port and Marine Organization (PMO)
- Department of Environment (DOE)
- Research Institute of Petroleum Industry (RIPI)
- Ministry of Foreign Affairs (MOFA)
- Strategic Planning and Control (SPAC)
- JICA Iran Office
- Other parties nominated by Chairman

1.5. Overall Schedule

The following study schedule and workflow including capacity development activities are as during March 2012 to December 2013.

- Phase 1 and 2 Schedule and workflow (See Table 1.5-1)
- Workshop program and schedule (See Table 1.5-2)

1.6. Reporting Documents for Master Plan and its Action Plan

The reporting documents are consisted of Ten (10) chapters for the master plan of environmental management. The content on chapters is as followings:

- Chapter 1 Introduction
- Chapter 2 Outline of Petroleum Development in Persian Gulf
- Chapter 3 Institutional Framework of HSE Management Systems
- Chapter 4 Current Situation of Pilot Sites
- Chapter 5 Oil Spill Emergency Response System
- Chapter 6 Strategy for the Draft Master Plans
- Chapter 7 Master Plan on Environmental Management for Oil Industry
- Chapter 8 Master Plan for Emergency Response for Oil-Related Disasters
- Chapter 9 Action Plans in the Pilot Sites
- Chapter 10 Conclusion and Recommendation

The framework of reporting is shown in Figure 1.6-1 'Main frame structure of reporting'.

Table 1.5-1 Phase 1 and 2 Schedule and Workflow

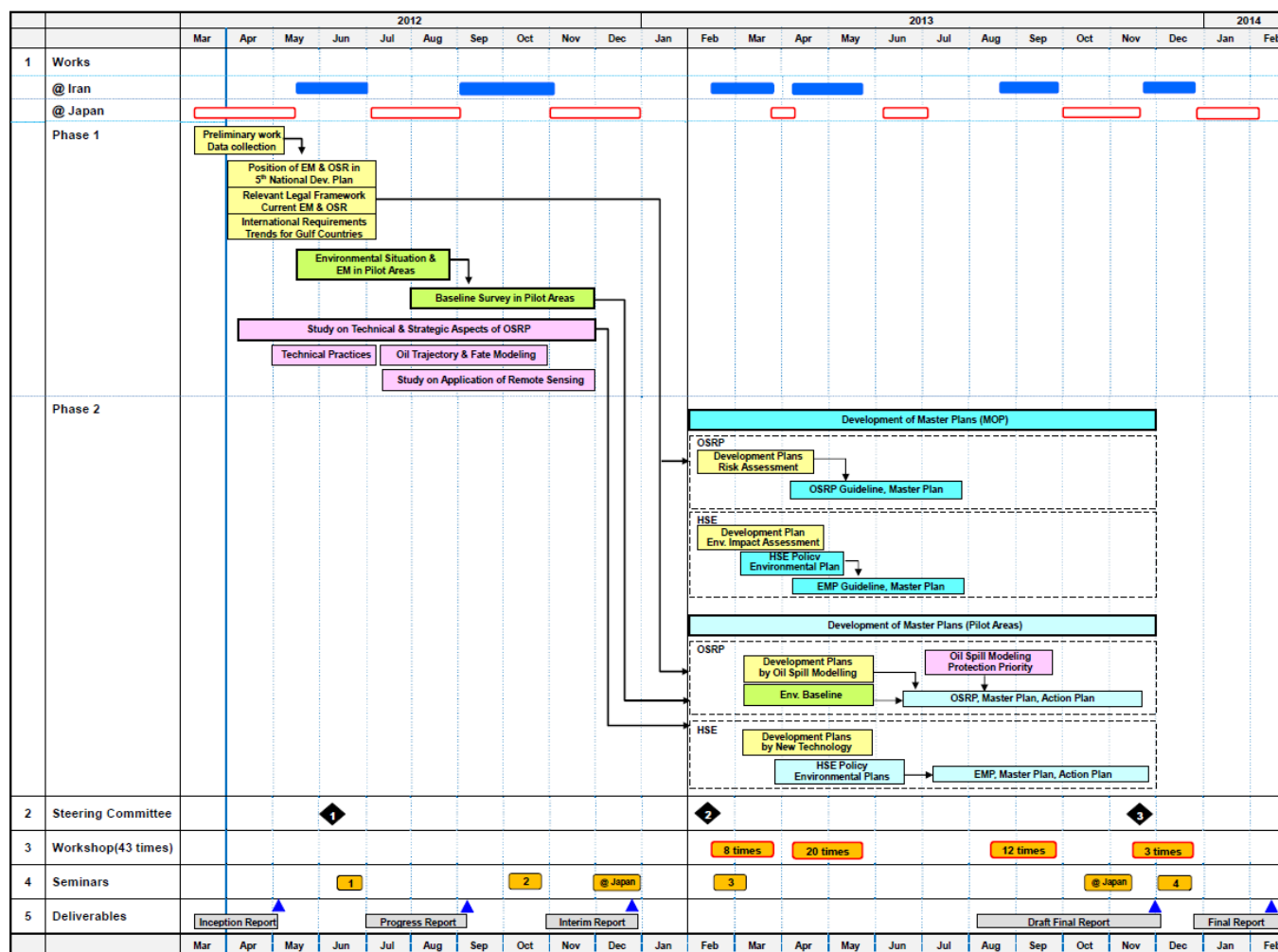


Table 1.5-2 Capacity Development Training (Workshop Program and Schedule)

			Phase 2													
			2013												2014	
No.	Components	Main target groups	2	3	4	5	6	7	8	9	10	11	12	1	2	
1	Introduction of Specific EIA to Oil and Gas Development	MOP, NIOC, NPC, NIGC, NIORDC, and IOOC		3	6	7	8			25	26					
2	Strengthening HSE System/Organizat ion	MOP, NIOC, NPC, NIGC, NIORDC and IOOC		5	9	10				27	28	29				
3	Oil Sill Modeling	MOP, NIOC, IOOC, and IOTC		2	11	12	13									
4	OSRP Training	MOP, NIOC, IOOC, and IOTC				14				30	31					
5	Flaring Reduction (CO2 reduction)	MOP, NIOC, NIGC,NIORDC, NPC, IOOC/PSED/PSEED			15	16				32	33					
6	Air Pollution Control System	MOP, NIOC, NIGC,NPC, NIORDC,IOOC,PSEZ, and PSEED		4	17	18										
7	Improvement of Wastewater Management	MOP, NPC, PSEZ, and PSEEZ			19	20				34						
8	Improvement of Oil Pollution in Khark Island	MOP, NIOC, IOOC, and IOTC			21	22				35						
9	Waste Management for Offshore Oil & Gas Field Development	MOP, NIOC, and IOOC			23	24				36						
10	HSE System on FOC company	MOP,NPC,NIOC,NIGC ,NIORDC and PSED/PSEEZ		1												
11	CSR and SEA System	MOP,NPC,NIOC,NIGC ,NIORDC and PSED/PSEEZ										37	38			
			3rd Survey		4th Survey				5th Survey		6th Survey					

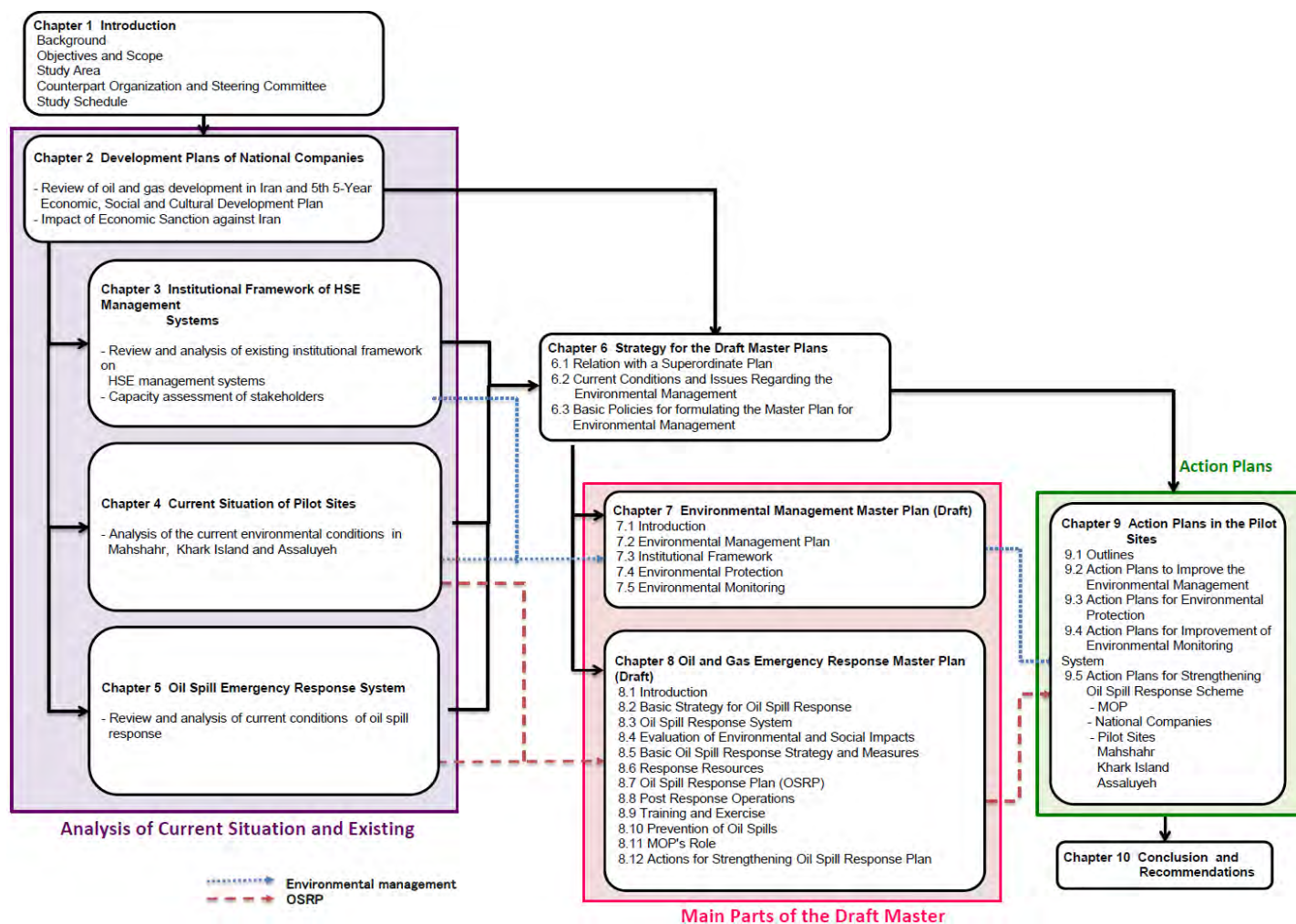


Figure 1.6-1 Structure of the Report

2. Outline of Petroleum Development in Persian Gulf

2.1. Oil and Gas Development in Iran

According to Annual Statistical Bulletin 2012 by OPEC, the confirmed crude oil reserve in Iran is 154,580 million barrel in 2011. Iran has the third largest confirmed crude oil reserve in the world, behind Venezuela and Russia. Crude oil production in Iran is 3,576 thousand barrel per day in 2011, which is the fifth largest behind Russia, Saudi Arabia, the United States, and China. Similarly, Iran has the second largest natural gas reserve, behind Russia. Marketed production of natural gas in Iran is 188,753 million standard m³, which is the third largest behind the United States and Russia. On the other hand, output of petroleum products in Iran is 1,770 thousand barrel per day, which is the eleventh largest in the world (second largest in the Middle East behind Saudi Arabia).

The organization in charge of oil and gas development and production in Iran is National Iranian Oil Company (NIOC) under the supervision of the MOP. Operations in oil and gas fields are implemented by the subsidiary companies of NIOC. Figure 2.1-1 shows the distribution of the producing fields, pipelines, oil refineries, gas processing plants and tanker terminals in the country.



Source: NIOC

Figure 2.1-1 Oil and Gas Fields and Pipelines in Iran

Operations in the target areas of the Project are implemented by Iranian Offshore Oil Company (IOOC) under the supervision of the NIOC. Khark Island, one of the pilot areas of the Project, is the biggest oil export terminal in Iran and oil export from the island accounts for 93 percent of the national crude oil export. Crude oil tanks and shipment in the island are managed by Iranian Oil Terminals Company (IOTC) which belongs to NIOC. National Iranian Oil Refinery and Distribution Company (NIORDC) and the subsidiary companies are responsible for oil refining and pipeline distribution in the country. Crude oil refined in Abadan Refinery is sent to Khark Island through Mahshahr Terminal, which is located in Mahshahr, one of the pilot areas of the Project. National Iranian Gas Company and the subsidiary companies have the authority of gas refining and trading in the country. Assaluyeh, one of the pilot areas of the Project, is the largest gas refining zone. National Iranian Petrochemical Company and the subsidiary companies are responsible for producing and trading the petrochemical products. Mahshahr and Assaluyeh are the main petrochemical industry zones in the country.

2.2. Fifth Five-Year Economic, Social and Cultural Development Plan

The Fifth Five-Year Economic, Social, and Cultural Development Plan was formulated for five (5) years from 1390 to 1394 in the Iranian Calendar (March 2011 to March 2015). The plan consists of the following chapters and annex:

- Chapter 1 Islamic – Iranian Culture
- Chapter 2 Science and Technology
- Chapter 3 Social
- Chapter 4 Administrative and Management System
- Chapter 5 Economy
- Chapter 6 Regional Development
- Chapter 7 Defensive, Political and Security
- Chapter 8 Legal – Judicial
- Chapter 9 Budget and Oversight
- Annex

The oil and gas development strategy is stated in Article 125 – 132, Section of “Petroleum (Oil) and Gas”, Chapter 5 Economy. Key findings from the development plan are as follows:

- It is planned to increase the maximum capacities for development of oil and gas fields and to maintain the production capacity of the year 1389 (2010) by priority, with one million barrels of petroleum and two hundred fifty million cubic meters of natural gas of the maximum capacity of extra production (Article 125).

- The plan emphasizes the development of the South Pars gas field (Article 125).
- Authorization is given to the MOP to take measure for making reciprocal sale contracts for both exploration and development of new fields to identify and explore the oil and gas reserve throughout the country as much as possible, and to transfer and apply the new technologies in the exploration operations in all regions of the country (except provinces of Khuzestan, Bushehr , Kohkiluye and Boyer Ahmad) with emphasis on the joint maritime and in land regions with the neighboring countries (Article 126).
- The MOP is also authorized to take measure for completing two liquid gas refineries “Setareh-e Khalij-e Fars” (Persian Gulf Star) and “Fars” with 360 thousand barrels and 120 thousand barrels of capacity respectively (Article 127).
- In order to increase and enhance scientific, technological and innovative capability in the oil industry, equivalent with one percent (1%) of resources of the annual developmental plans to be appropriated for the purpose of creating potential for attraction, development of prioritized oil, gas and petrochemical technologies and their application in the related industries, enhancing the existing technologies and their localization, and reducing the intensity of energy (Article 129).
- In order to increase the recovery coefficient of the country's reserves, the MOP is charged to prepare the comprehensive plan for preserving and increasing output from the hydrocarbon reserves (Article 130).

Formulation of the strategic environmental evaluation system is stated in Article 184, Chapter 6 Regional Development. Core activities for the strategic environmental evaluation system are as follows:

- General strategies for development of regions and taking into account the combined impacts of these strategies
- Indicators of environmental impact of development and indicators of bio-capacity
- Enforcing indicators of regional and national sustainability
- Monitoring regional and national development plans and schemes
- Enabling program and determining the execution mechanism of environmental strategic evaluation

The oil and gas industry is also required to follow the implementation of the strategic environmental evaluation system, however, national regulations of the system have not been formulated.

Plans related to the environment are stated in Article 187 to 193, Chapter 6 Regional Development. Article 192 includes plans for reduction of environmental pollution from all the large industries and development projects. According to the article, the following measures are required:

- Self-disclosure of monitoring results of environmental measures undertaken in the large scale of project to DOE
- Installing and operating the simple and feasible monitoring system

Violators are subject to the article (30) of the Air Pollution Abatement Act.

The Annex states the goals of environmentally sustainable development and formulation of practicable plans for conservation of natural environment including marine and coastal areas as well as mitigation of climate change by reduction of Ozone Destructive Substances (ODS) emissions. In order to promote the plans, the Annex also states to establish functional framework comprising the relevant ministries and organizations, industrial sectors and local and regional communities.

2.3. Development Plans of National Companies

Iran is one of the world's top four holders of both confirmed oil and natural gas reserves, and Iran ranked as the third-largest exporter of crude oil in the world next to Saudi Arabia and Russia in 2010.

Furthermore, Iran holds the second largest natural gas reserves globally, but the gas produced is used mostly to meet domestic demand. Natural gas accounts for 54 percent of Iran's total domestic energy consumption. Most of the remainder of energy consumption is attributable to oil with marginal contributions from coal and hydropower. Iran is expected to increase natural gas production from offshore South Pars natural gas field in the Persian Gulf.

Under such situation, the petroleum sector led by four national companies, National Iranian Oil Company (NIOC), National Petroleum Company (NPC), National Iranian Gas Company (NIGC) and National Iranian Oil Refining and Distribution Company (NIORDC), under the management of the Ministry of Petroleum (MOP), is implementing various development projects in accordance with the long term development plan of the country.

Figure 2.3-1 shows the oil and gas development sites in Iran.



Source: NIOC website

Figure 2.3-1 Oil and Gas Development in Iran

The current development activities and the on-going projects as well as future development plans of each national company are summarized hereinafter.

2.3.1. National Iranian oil Company (NIOC)

The NIOC is exclusively responsible for the exploration, extraction, transportation and exportation of crude oil, as well as sales of natural gas and liquefied natural gas (LNG). Having provided the domestic refineries and manufacturing plants with crude oil required for the petroleum products, the NIOC exports its surplus production according to commercial considerations in the framework of the quotas determined by the Organization of Petroleum Exporting Countries (OPEC) and at the prices prevalent in the international markets. The NIOC also signs some long term contracts on "buy-back" basis with foreign companies in order to exploit national oil fields and export its products.

Current NIOC production capability is over 4 million barrels of crude oil and in excess of 500 million cubic meters of natural gas per day. The vast majority of Iran's crude oil reserves are located in giant onshore fields in the south-western Khuzestan region near the Iraqi border. Overall, Iran has 40 producing fields, which consist of 27 onshore and 13 offshore fields. Iran's crude oil is generally medium in sulfur and in the 28°-35 °API range.

(1) Offshore Oil Field Development

Iranian Offshore Oil Company (IOOC), a subsidiary company of NIOC, is in charge of development of offshore oil and gas fields in the Persian Gulf except South Pars gas fields.

The development fields are separated in four (4) operational districts, which are Bahregan District and Khark District in the northern Gulf, Sirri District and Lavan District in the southern Gulf. The locations of respective oil fields are shown in Figure 2.3.1-1.



Source: IOOC presentation material

Figure 2.3.1-1 IOOC Offshore Oil and Gas Development

1) Bahregan District

There are four oil fields in this district, which are Bahregansar, Hendijan, Nowruz and Soroosh field.

The oil produced from Hendijan field is transferred to Bahregansar complex. The oil is then transferred to onshore together with the oil produced in Bahregansar field via subsea pipeline for treatment and storage.

Nowruz and Soroosh field were re-commissioned by Shell in the form of buy-back contract. Initial production capacities of the fields were 90,000 BPD at Nowruz and 100,000 BPD at Soroosh. The oil produced from Nowruz is transferred to Soroosh offshore complex. The oil from the both fields is treated on the complex, and then, stored on the floating-storage unit (FSU) which is moored at

the vicinity of the complex. The oil is directly loaded from the FSU to oil tankers.

Associated gases separated from the crude oil on the platforms in the fields, which are flared as surplus gas at present, will be recovered and transferred to the NGL units on Khark Island in near future.

2) Khark District

Oil Fields in Khark District include Aboozar, Dorood and Foroozan field, which produce approximately 320,000 BPD of crude oil (see Figure 2.3.1-2). The crude oil from these fields is transferred to treatment facilities on Khark Island. The treated crude oil is stored in the storage tanks and exported from the loading terminals of the island.

It is remarkable that an EOR/IOR project for improvement of declined recovery rate was implemented recently to study the possibility for pressure maintenance of the reservoir by reinjection of gas and seawater in Dorood field.

Comprehensive gas gathering projects are on-going at Khark Island. The associated gases of Bahregan District are transferred to Khark Island together with the gases from Aboozar, Dorood and Foroozan fields. The gases gathered are processed in two units of the NGL plants with about 45,000 BPD of capacity. The surplus gas of the processing is used to gas injection system for EOR/IOR in Dorood field.



Source: IOOC brochure

Figure 2.3.1-2 Khark Island (left) and Aboozar AB Platform (right)

3) Lavan District

Salman field with water injection system has a production capacity of 200,000 BPD of crude oil. The oil from the field is transferred to Lavan Island. Production facilities of Resalat field have been destroyed severely during the war with Iraq. Reconstruction project to produce 46,000 BPD of oil by water injection is in progress (see Figure 2.3.1-3).

Reshadat field was also destroyed during the war; however, 8,000 BPD production is maintained

currently. Field development and reconstruction project is underway to achieve 75,000 BPD of production.

Balal field was developed in the form of buy-back contract in 2002 and 40,000 BPD of crude oil is transferred from the field to Lavan Island.



Source: IOOC brochure

Figure 2.3.1-3 Reshadat Oilfield (left) and Balal Oil Field (right)

4) Sirri District

Crude oil produced in Alvand, Sivand, Dena and Nosrat field is gathered at Nasr platform of Dana field and transferred to Sirri Island for processing and storage. Esfand field produces about 60,000 BPD of oil by water injection. The oil is also transferred to the island.

Development project of Sivand and Dena fields which is aimed for the reconstruction and increasing the water injection capacities as well as optimization of onshore processing facility is underway.

On the other hand, a new gas gathering project which is aimed to produce about 12,000 BPD of NGL from the associated gas from the fields was recently completed, and the dry gas is transferred to Kish and Qeshm Islands for power plant fuel.

(2) Export Terminals

Khark Island, the site of the vast majority of Iran's exports, has a crude storage capacity of 16 million barrels of oil. Four new storage tanks are being built on the island with the overall capacity of 4 million barrels of crude. After completion of the project, the total crude storage capacity will be some 20 million barrels.

The island has two loading installations. The eastern platform is located 1,100 meters from the coast and it is about 1,840 m long and 40 m wide; while the western platform is located 1,450 m from the coast and allows three vessels weighing between 200,000 and 500,000 tons to berth. These loading facilities have a total loading capacity of 5 million BPD (see Figure 2.3.1-4).



Source: Mehr News 10/2/2011

Figure 2.3.1-4 Crude Storage Tanks and Loading Berths of Khark Island

Lavan Island is the second-largest terminal with capacity to store 5 million barrels and loading capacity of 200,000 BPD. Other important terminals include Kish Island, Abadan, and Bandar Imam Khomeini in Mahshahr.

(3) South Pars Gas Development

The most significant energy development project in Iran is the offshore South Pars field (see Figure 2.3.1-5), which produces about 35 percent of the total gas produced in Iran. The field was discovered in 1990, and it is located about 100 km offshore in the Persian Gulf. South Pars Project has a 24-phase development scheme spanning 20 years. The entire project is managed by Pars Oil & Gas Company (POGC), a subsidiary of the National Iranian Oil Company. Each phase has a combination of natural gas with condensate and/or natural gas liquids production. Phases 1-10 are on-stream. The majority of South Pars natural gas development will be allocated to the domestic market for consumption and gas re-injection. The remainder will either be exported as liquefied natural gas (LNG) and/or used for gas to liquids (GTL) projects.



Source: PSEEZ brochure

Figure 2.3.1-5 South Pars Gas Production Platform

(4) Other Field Developments

Kish gas field which has significant reserves is expected to produce 3 Billion cubic feet per day (Bcfd) of natural gas. Phase 1 of the project is expected to come on-stream in 2016. Phase 1 is expected to produce approximately 1 Bcfd and Phase 2 will produce an additional 2 Bcfd.

In addition to Kish gas field, there are other promising gas fields that could further boost Iran's production. These additional fields include the Golshan, Ferdowsi, and North Pars gas fields, which are expected to be completed in the next decade.

(5) Liquefied Natural Gas (LNG)

POGC is responsible for LNG development, although various companies including the National Iranian Gas Export Company (NIGEC) are also involved. A number of LNG projects have been proposed in the past, however only one South Pars LNG project still remains an option, Iran LNG. This planned project includes two liquefaction trains with an expected capacity of 10.8 million tons of LNG.

(6) Pars Special Economic Energy Zone (PSEEZ)

The Pars Special Economic Energy Zone Organization (PSEEZ) is an authority in charge of administration and management of Assaluyeh region on behalf of the National Oil Company (NIOC) and the Ministry of Petroleum (MOP). The main activities include: approval of facility designing, execution of the projects, operation and maintenance, creation and installation of the general infrastructures such as road, railway, harbor, airport, electricity and water supply, and the

overall management and operation of the zone. The organization was established in 1998 aiming at supporting the largest gas field development projects consisting of the development of the offshore gas fields and three smaller onshore zones totaling 46,000 hectares. The development projects are summarized below.

1) South Pars Gas Field Development

South Pars gas field is one of the largest independent gas reservoirs in the world lying on the territorial border between Iran and Qatar in the Persian Gulf. This gas field covers an area of 9,700 km², of which 3,700 km² belongs to Iran. The Iranian portion is estimated to contain some 14 thousand billion m³ of gas reserves and some 18 billion barrels of gas condensates. This amount corresponds to roughly 8% of the world's total gas reserves and approximately 47% of Iran's gas reserves.

Presently, some precise and sophisticated projects have been designed for development of 24 phases to produce 820 million cubic meters of gas per day (see Figure 2.3.1-6). South Pars gas field development shall meet the growing demands of natural gas such as injection into oil fields, and gas and condensate export as feedstock for petrochemical industries in the zone. The entire project is managed by Pars Oil and Gas Company (POGC), a subsidiary company of NIOC.



Source: PSEEZ brochure

Figure 2.3.1-6 South Pars Development Project

2) Pars 1 (South Pars)

The Pars 1 projects consist of a total of 16 phases of gas refineries and 15 phases of petrochemical complexes, as well as downstream petrochemical and various relevant industries, semi-heavy industries and marine industries (see Figure 2.3.1-7). Phases 1 to 10 have been completed and currently operational; while phases 15, 16, 17, 18, 20 and 21 are under construction.



Source: NPC Project, Petrochemical Industry

Figure 2.3.1-7 PSEEZ Petrochemical Plants

3) Part 2 (Pars Kangan)

The Pars 2 projects plan to construct 8 gas refinery plants and 3 LNG plants. It is worth mentioning that the refineries of phases 11 to 14, 19, 22 to 24 and Iran LNG, Pars LNG, and Persian LNG are to be constructed in Pars 2 zone.

4) North Pars Gas Field

The contract for the development of the North Pars gas field was signed in October 2007 between the NIOC and the Chinese developer CNOOC and the reservoir development planning is currently carried out by the company.

5) Pars 3 (North Pars)

Part 3 project is the supporting activities towards the development plan for the North Pars gas field. The activities include the development of the Mond heavy oil field situated on the northern onshore of the North Pars gas field.

6) Golshan Gas Field

This gas field is located in the Gulf, 180 km south east of Bushehr and 65 km off the coast. The gas production capacity is estimated at 42 to 56 trillion cubic feet and an agreement for the field's development has been signed with the Malaysian company.

7) Ferdowsi Gas Field

The Ferdowsi gas field is 190 km southeast of Bushehr and 85 km off the coast in the Gulf. The estimated gas production is 13 trillion cubic feet in maximum. The contract for development is contracted with the Malaysian company, too.

2.3.2. National Petrochemical Company (NPC)

The National Iranian Petrochemical Company (NPC) is responsible for the development and operation in the country's petrochemical sector. Today, NPC is the second largest producer and exporter of petrochemicals in the Middle East, following Saudi Arabia. Currently allied with 56 subsidiaries, including 9 production complexes and 18 project implementing companies, NPC operates as a mother company handling policy-making, planning, directing and overseeing the activities of its subsidiaries and affiliates.

Over these years, NPC has not only expanded the range and volume of its products, but it has also taken steps in areas such as Research and Development (R&D) to achieve more self-sufficiency.

The focus over the past few years has been on products which use natural gas as feedstock; in particular, methanol, ethylene, propane and butane.

NPC launched massive investment programs under the country's first five-year development plan in a bid to build new petrochemical facilities. It continues its investment programs following the subsequent five-year development plan. Under the current situation, NPC has adopted its new strategy of privatization. For implementation of the plans, NPC developed two special economic zones on the northern and central coasts of the Persian Gulf.

(1) Petrochemical Special Economic Zone (PETZONE)

The Petrochemical Special Economic Zone (PETZONE) is located in the southwest of Mahshahr city, Khuzestan province near the northern coast of Persian Gulf. The zone covers an area of 2,600

hectares. The zone is linked to international waterways via Bandar Imam Port. The main reason to select the zone was to bring industrial development, especially in the petrochemical sector, and its downstream industries in the region.

As the managing organization of the PETZONE, a subsidiary of NPC, PSEZ is responsible for promoting and development of the zone, which began its activities in 1997. Among its major activities, developing the infrastructural facilities to attract domestic and foreign investors is also included.

The zone is divided into five sites according to the purposes as shown in Figure 2.3.2-1.

- Site 1** Private sector petrochemical downstream plants and light industries
- Chemical plants, electrical and instrument factories, construction material yards, metal works and tool factories, laboratories, etc.
 - Administrative and civil services, commercial and temporary residential quarters
- Site 2** Light and heavy industries
- Site 3** Heavy petrochemical and other plants
- Site 4** Upstream petrochemical plants and central utility plant
- Site 5** Petrochemical plants and auxiliary facilities (warehouses, storage tanks, etc.)



Source: NPC Project, Petrochemical Industry

Figure 2.3.2-1 PETZONE Master Plan

NPC has adopted its new strategy of privatization. Under the new strategy at the present, 18 petrochemical plants and over 150 light industry units has been in operational and 11 plants are under construction as the expansion projects in the zone.

2.3.3. National Iranian Gas Company (NIGC)

National Iranian Gas Company (NIGC) is responsible for the treatment (refining), transmission, and delivery of natural gas to the domestic industrial and commercial sectors and power plants.

The NIGC is responsible for new natural gas projects including gas pipeline network in Iran, however, NIGC does not play a role in upstream gas projects, which NIOC manages.

The South Pars Gas Company (SPGC), a subsidiary company of NIGC, is the sole operator of the gas refinery plants in PSEEZ (see Figure 2.3.3-1).



Source: NIGC Annual Report 2011

Figure 2.3.3-1 Gas Refinery Plant in PSEEZ

Most of Iran's gas is consumed domestically and is increasing at 12% of average annual rate in the past 15 years. In 2010, Iran exported 0.4, 0.25, and 7.77 billion cubic meters of gas to Armenia, Azerbaijan and Turkey respectively. In terms of imports, Iran has received 6.5 billion cubic meters from Turkmenistan.

In 2011, Iran signed a contract with Iraqi and Syrian governments in order to export Iran's gas to Iraq, Syria, Lebanon, the Mediterranean region and eventually Europe. It is estimated that in the next three to four years, there will be an excess production of 200-250 million cubic meters of gas in the South Pars gas field, the largest worldwide gas field located in Persian Gulf.

In addition to the gas treatment and transmission activities, NIGC launched two underground gas storage projects at two fields in 2010. The projects aim to maintain balance between the natural gas production and consumption of the domestic distribution networks.

Iran is now the third country in the world to have developed Gas to liquids (GTL) technology. Iran is seeking to reach a capacity of one million bpd of GTL-derived gasoline within the next decade.

The NIGC's remarkable strategic objectives include enhancing production capacities, especially South Pars, maximization of the added value through GTL and others.

2.3.4. National Iranian Oil Refinery Development Company (NIORDC)

National Iranian Oil Refinery Development Company (NIORDC) has 9 oil refineries including major refineries such as Abadan, Isfahan, Bandar Abbas, Tehran and Arak. The products of these refineries are mainly gasoline, gas oil (diesel), kerosene, jet fuel, fuel oil, LPG, etc.

NIORDC is implementing the projects to increase the total refining capacity from some 1,600,000 BPD to 3,300,000 BPD between 2007 and 2012.

At year of 2008, Iran has been importing nearly 40% of gasoline-domestic-market needs, because of lack of refining capacity. With the completion of the projects consisting of 8 new refineries construction and improvement of the existing refineries, Iran aims to change over the country from a gasoline importer to a exporter for the neighbor countries by 2013-2015.

The planned new refineries are listed in Table 2.3.4-1.

Table 2.3.4-1 New Refineries

Refinery	Location	Capacity (BPD)	Completion year
Khuzestan Refinery	Arvand	180,000	2012
Persian Gulf Star Refinery	Assaluyeh	360,000 (Condensate)	2010
Shahriar Refinery	Tabriz	150,000	2012
Anahita Refinery	Kermanshah	150,000	2012
Hormoz Refinery	Bandar Abbas	300,000	2012
Caspian Refinery	Gorgan	300,000	2013
Pars Refinery	Shiraz	120,000	2012
Yasouj Refinery	Yasouji	150,000	2014

Source: NIORDC website/ "Iran: Construction of 7 refineries moving ahead" (payvand.com/news)

2.4. Impact of Economic Sanctions against Iran

The United Nations Security Council adopted Resolution 1929 (2010) on 9 June 2010 and reaffirmed the need for all states party to comply fully with all their obligations. In July 2010, Comprehensive Iran Sanctions, Accountability, and Divestment Act of 2010 (CISADA) was enacted in the United States. Both the United Nations and bilateral sanctions, by the United States as an example, is overviewed and the impact of economic sanctions focused on the petroleum sector is examined below.

(1) Resolution 1929 (2010) of the United Nations Security Council

The preamble of the Resolution 1929 (2010) describes that the need of vigilance over transactions involving Iranian banks, including the Central Bank of Iran, so as to prevent such transactions contributing to proliferation of nuclear activities, or to the development of nuclear weapon delivery systems. In the Resolution 1929 (2010), in order to prevent Iran's proliferation of nuclear activities and the development of nuclear weapon delivery systems, Paragraph 21 calls upon all states to prevent provision of all financial transactions. Paragraph 23 calls upon states to take appropriate measures that prohibit the opening of new branches, subsidiaries, or representative offices of Iranian banks in their territories. Paragraph 24 calls upon states to take appropriate measures that prohibit financial institutions within their territories or under their jurisdiction from opening representative offices or subsidiaries or banking accounts in Iran. The Resolution 1929 (2010) could complete a basic legislative framework to enact bilateral sanctions in States party. In addition, it is said that strengthening sanctions suggested by the United States was realized with the adoption of the Resolution. Prior to the other countries, the United States enacted the sanctions such as CISADA.

(2) Sanctions of the United States

CISADA is consisted of two parts: sanctions against energy sector and financial sector. Section 102 defines the sanction against to an investment that directly and significantly contributes to the enhancement of Iran's ability to develop petroleum resources with USD 20 million or more, or a combination of investments of at least USD 5 million and such investments equal or exceed USD 20 million in total in a 12-month period. The section also states the sanction against to selling, leasing, or providing goods, services, technology, information, or support that could directly and significantly facilitate the maintenance or expansion of Iran's domestic production of refined petroleum products with USD 1 million of a fair market value or more, or USD 5 million of the accumulated fair market value or more during a 12-month period.

Section 104 provides the sanctions against foreign financial institutions that facilitates Iran's development of nuclear weapons, activities of foreign terrorist organizations and Iran's Revolutionary Guard Corps

In 30 July, 2012, the President of the United States has ordered that a foreign financial institution is prohibited to open or maintain a correspondent account if the foreign financial institution has knowingly conducted or facilitated any significant financial transaction with NIOC or NICO (Naftiran Intertrade Company) in Executive Order 13622.

(3) Impact of the Economic Sanctions

As mentioned above, the United Nations Security Council Resolution 1929 (2010) calls upon all

states to prevent the provision of all financial transactions. The Section 104 of CISADA has specifically targeted foreign financial institutions. US dollar settlement related to Iran become practically unable, because such transactions access the U.S. financial system through the corresponding account in the United States. In addition, the Executive Order 13622 includes transaction for the purchase or acquisition of petroleum or petroleum products or petrochemical products from Iran and transactions with NIOC and NICO. Those sanctions cause decrease the export of oil products from Iran and are assumed to affect the following matters:

- Aging/degrading of existing production/refining facilities and equipment
- Access to the latest technologies for development, production and environmental protection in the petroleum industry
- Access to the license of simulation software
- Access to the information about the latest international trend of HSE management

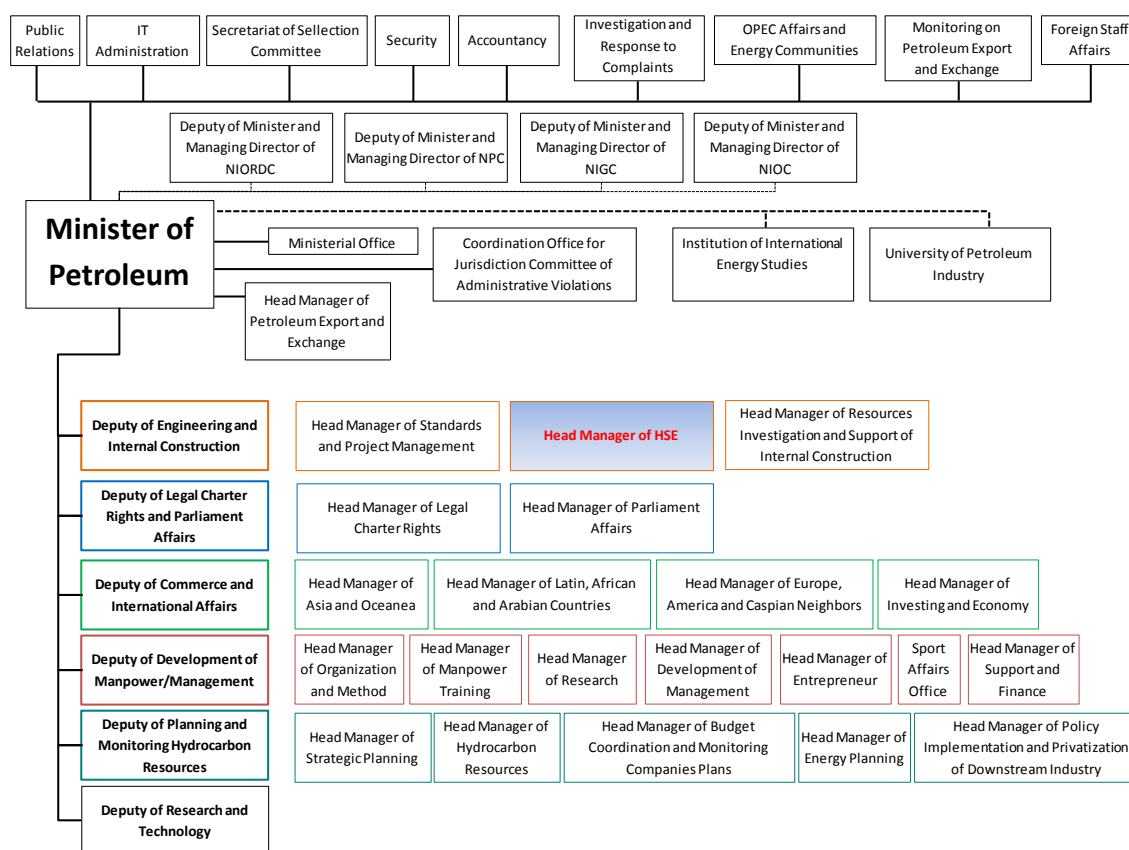
The study team will consider the impacts of the economic sanctions for preparation of the draft master plans on environmental management and oil spill response.

3. Institutional Framework of HSE Management Systems

3.1. Organizational Structure

3.1.1. Ministry of Petroleum (MOP)

Figure 3.1.1-1 shows the organizational structure of the MOP. The counterpart, HSE Department, belongs to the Division of Engineering and Internal Construction.

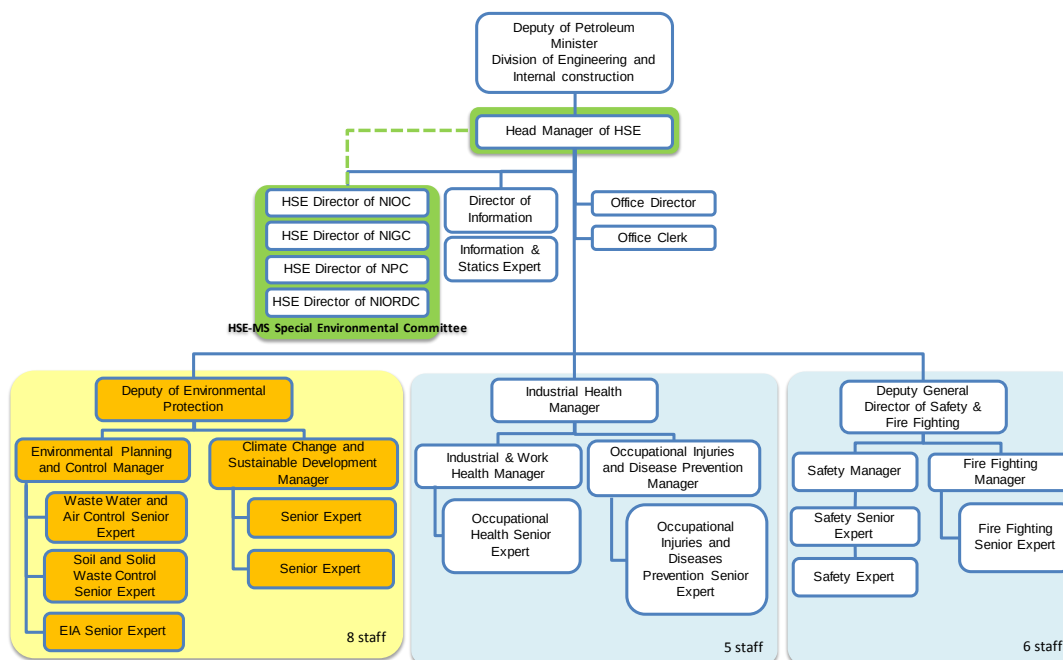


Source: MOP

Figure 3.1.1-1 Organizational Structure of the MOP

The organizational structure of the HSE-MOP was changed to improve and strengthen the capacity in November 2012. The prescribed number of staff was increased from four to eight for the Environment Protection Section, from three to five for the Industrial and Work Health Section, and from five to six for the Safety and Firefighting Section. The new organizational structure of the HSE-MOP is shown in Figure 3.1.1-2. The Environmental Impact Assessment (hereinafter referred to as EIA) Senior Expert has already retired, therefore, the Environmental Planning and Control Manager currently has the duties in EIA. All the staff members working in the Environmental Planning and Control Section transferred from the petroleum companies that fall under the MOP.

Those who have been engaged in environmental protection in the past positions have been deployed at the manager level, while no one has work experience of environmental protection in the past positions at the expert level.



Note: The part highlighted by yellow is the focal section of the Project.

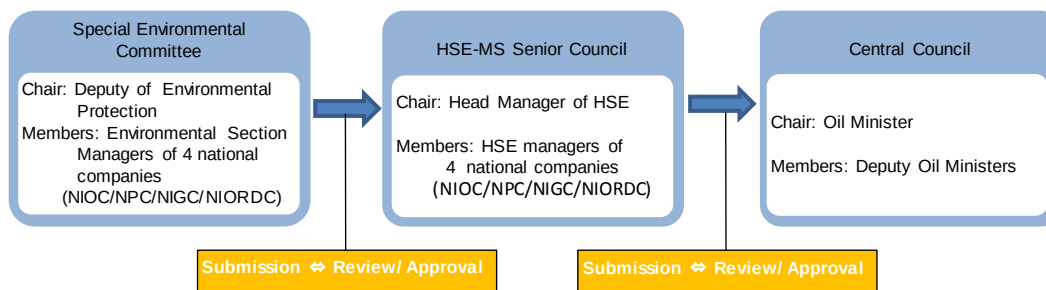
Source: MOP

Figure 3.1.1-2 Organizational Structure of the HSE-MOP (as of November 2012)

The major responsibility of the Environmental Planning and Control Section is enhancement and supervision of environmental management activities in the petroleum industry, fulfillment of national laws and international environmental conventions, and public awareness raising about the environmental issues.

Figure 3.1.1-3 shows the decision-making procedure of the MOP on environmental management. There is the Special Environmental Committee chaired by the Deputy of Environment Protection in the HSE-MOP. Agendas at the Special Environmental Committee are usually general issues common to all four national companies, such as the progress of the Project. The Special Environmental Committee prepares draft regulations and then the committee submits it to the HSE-Management System (hereinafter referred to as HSE-MS) Senior Council chaired by the Head Manager of the HSE-MOP. The members of the HSE-MS Senior Council are four HSE managers of NIOC, NIGC, NPC and NIORDC. The HSE-MS Senior Council has a responsibility to discuss and approve the agendas submitted by the Special Environmental Committee. The agendas approved by the HSE-MS Senior Council are submitted to the Central Council of Oil Minister

Deputies. The Central Council gives a final approval and then Oil Minister imparts the final agendas to all companies related to the MOP.



Source: MOP (interviewed by the study team)

Figure 3.1.1-3 Approval Procedure of Decisions in the MOP

The Special Environmental Committee had not been active before this project started. However, a new senior environmental expert was deployed in the HSE-MOP after commencement of this project and the activity of the committee has been enhanced.

The Environmental Planning and Control Section is also responsible for checking formats and contents of EIA reports prepared by petroleum companies in case that any new construction conducted by a petroleum company should conduct the EIA after consultation with the Department of Environment (hereinafter referred to as DOE). The executing company will submit the EIA report to the Evaluation Committee of the DOE and participate in the committee to defend the construction plan.

In addition to the EIA Evaluation Committee of the DOE, the Environmental Planning and Control Section is a member of the National Committee on Sustainable Development that is established in the DOE. The national committee has four sub-committees: green industry, climate change, hazardous waste management and marine environment.

Moreover, a part of job descriptions have also been revised in proportion to the organizational change in the HSE-MOP. According to the revised job descriptions, the Environmental Planning and Control Section should supervise the training courses that will be carried out by the four companies. The four companies provided the training courses to their staff, following their own curriculum before the revision. However, the Environmental Planning and Control Section should request the four companies to submit the training plans and coordinate the training courses with them.

3.1.2. Structure of Oil and Gas Companies under the Supervision of the MOP

The MOP supervises four national companies: National Iranian Oil Company (NIOC), National

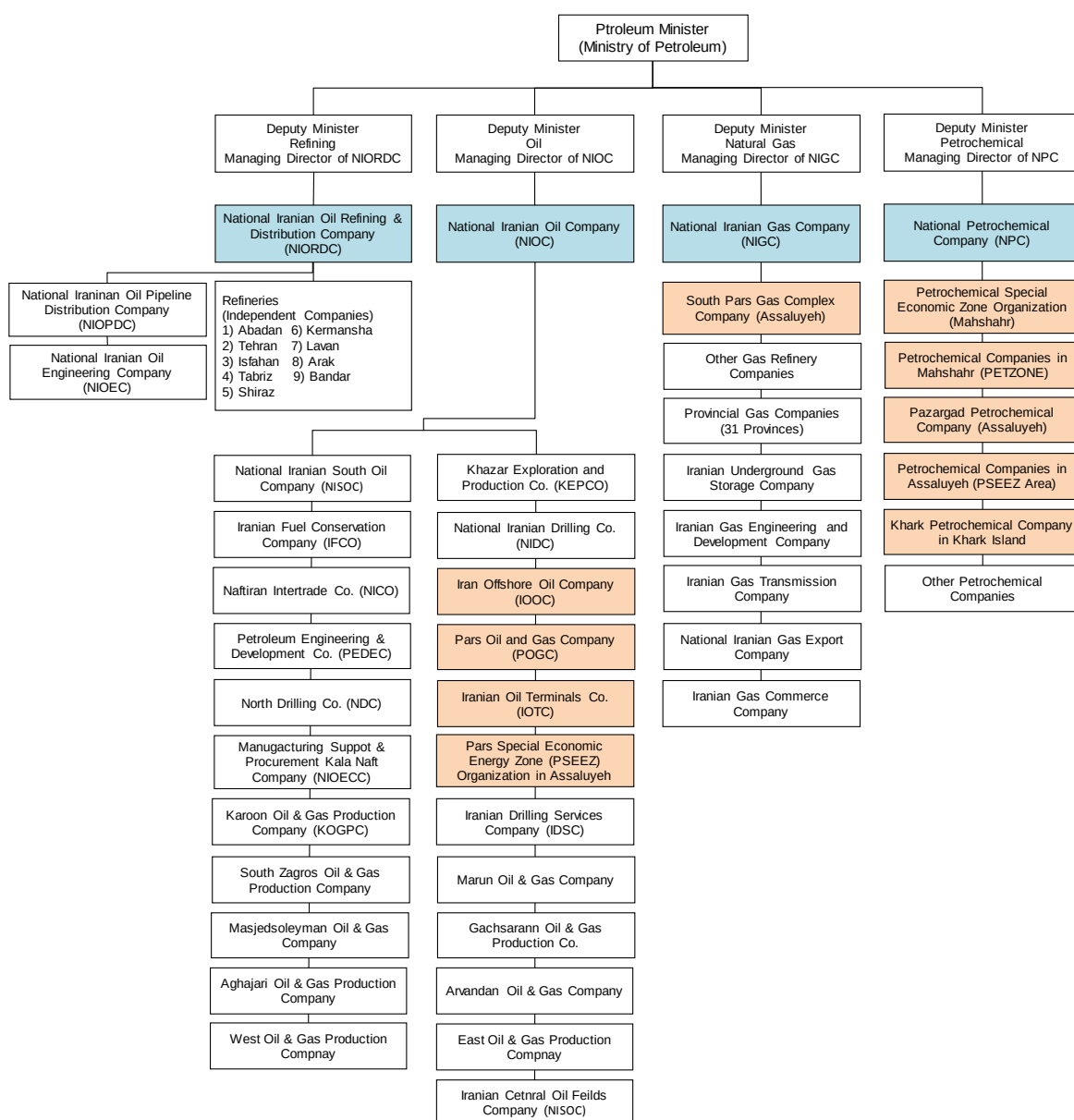
Petrochemical Company (NPC), National Iranian Gas Company (NIGC) and National Iranian Oil Refining and Distribution Company (NIORDC). There are four Deputy Ministers in the MOP and they are the presidents of the four national companies.

Deputy Minister for oil & gas development:	National Iranian Oil Company (NIOC)
Deputy Minister for petrochemical:	National Petrochemical Company (NPC)
Deputy Minister for natural gas:	National Iranian Gas Company (NIGC)
Deputy Minister for oil refining:	National Iranian Oil Refining and Distribution Company (NIORDC)

Each national company has its HSE department. The HSE-MOP communicates with each HSE department of the national companies. Each national company also supervises their subsidiaries and affiliated companies. Each subsidiary/affiliated company sets up its HSE department. Figure 3.1.2-1 shows the relation between the MOP and oil and gas companies. The companies representing pilot areas in the Project are Petrochemical Special Economic Zone Company (PSEZ) for Mahshahr, Iranian Offshore Oil Company (IOOC) and Iranian Oil Terminals Company (IOTC) for Khark Island, and Pars Special Economic Energy Zone Organization (PSEEZ) for Assaluyeh, respectively. The companies related to the Project by pilot area are as follows:

Mahshahr:	NPC, Petrochemical Special Economic Zone Company (PSEZ), Terminals and Tanks Petrochemical Company (TTPC), Petrochemical companies, NIORDC
Khark Island:	NIOC, NPC, Khark Petrochemical Company Iranian Offshore Oil Company (IOOC) Iranian Oil Terminals Company (IOTC)
Assaluyeh:	NIOC, NPC, Pars Special Economic Energy Zone Organization (PSEEZ) Pars Oil and Gas Company (POGC) Pazargad Non Industrial Operation Company, Petrochemical Companies NIGC, South Pars Gas Complex Company (SPGC)

The Iranian Government promotes privatization of state-owned companies to strengthen the non-governmental sectors in the development of Iran. Downstream companies are the target group of privatization process in the petroleum industry. Some of the petrochemical companies have been privatized. According to Article 7 of Chapter One in the Law of the Fourth Development Plan (2005-2009), the companies that less than 50 percent of their shares are held by the government and governmental companies, are considered as non-governmental and are not subject to rules and regulations governing the state companies. NPC is the leading company following the privatization process. Some petrochemical companies are handed over to the private sector and others are privatized as holding companies.



Note: National companies involved in the study Subsidiary companies involved in the study
Source: Prepared by the study team

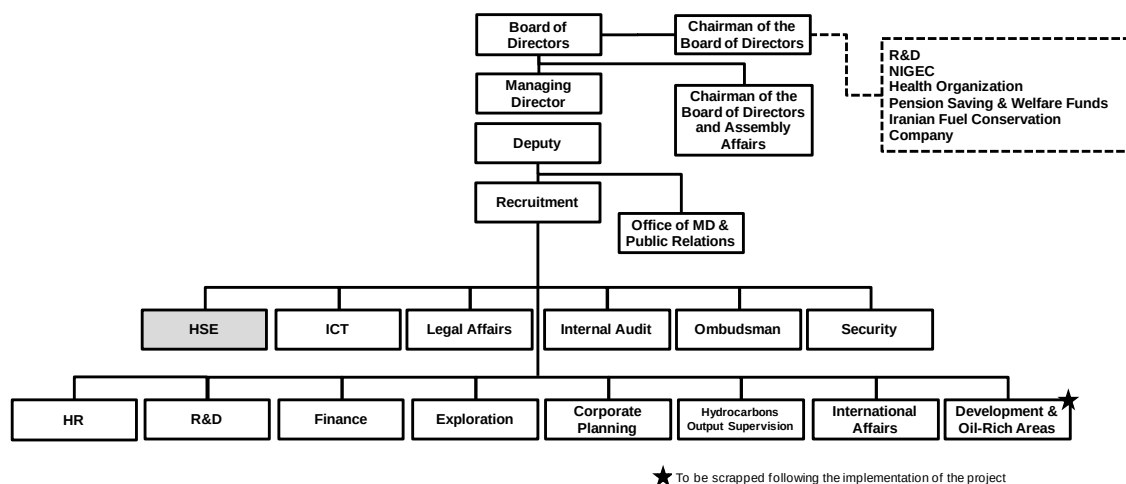
Figure 3.1.2-1 Relation of the MOP and Oil and Gas Companies

3.1.3. National Companies

(1) National Iranian Oil Company (NIOC)

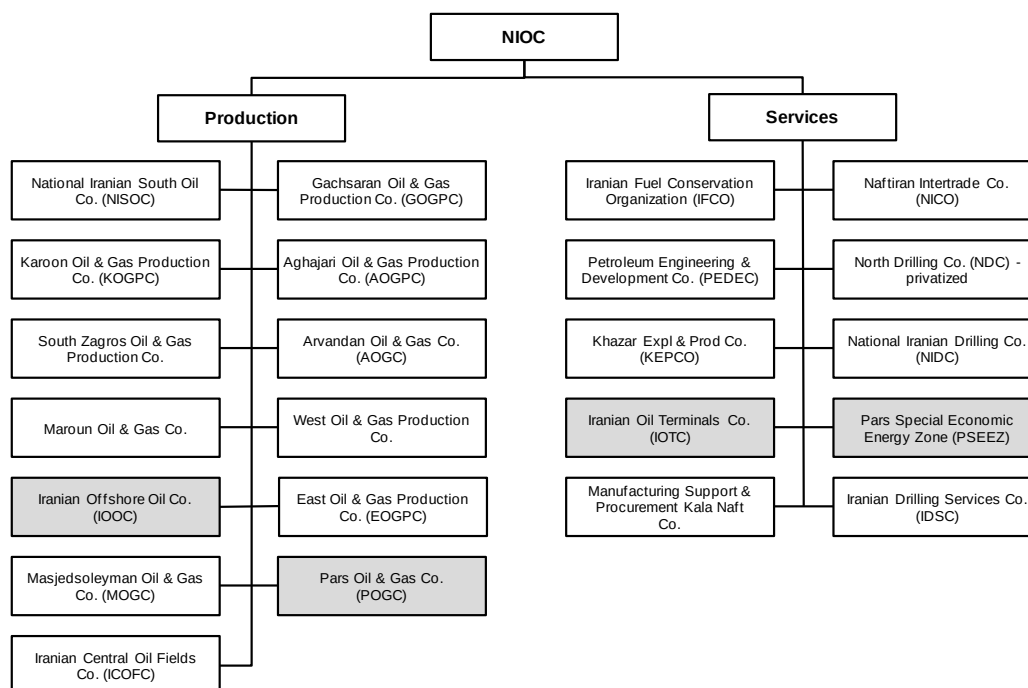
NIOC is responsible for directing and making policies for exploration, drilling, crude production, research and development, crude oil & gas export and hydrocarbon condensate products. Figure 3.1.3-1 shows the organizational structure of NIOC. According to the planned organizational structure of HSE Department, there are four posts for Environmental Protection Section in NIOC.

However, only two experts, one environmental manager and one environmental expert, have been deployed in Environmental Protection Section. As shown in Figure 3.1.3-2, NIOC has 13 subsidiaries for oil and gas production and 10 for oil field services. Out of them, only one company, North Drilling Company (NDC), will be privatized. The two experts in the Environmental Protection Section are in charge of monitoring and supervising all the environmental protection activities conducted by the subsidiaries.



Source: NIOC website

Figure 3.1.3-1 Organizational Structure of NIOC

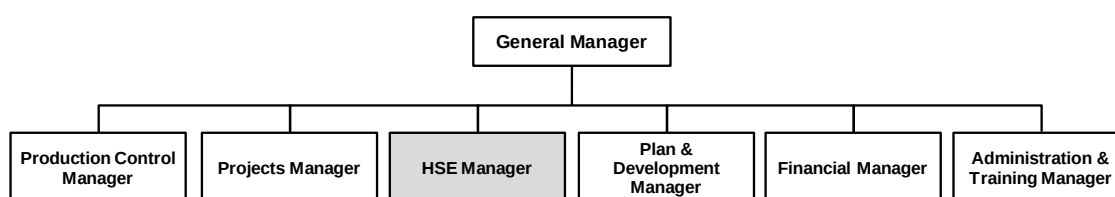


Source: Prepared by the study team based on the information on NIOC website

Figure 3.1.3-2 Subsidiaries that fall under NIOC

(2) National Petrochemical Company (NPC)

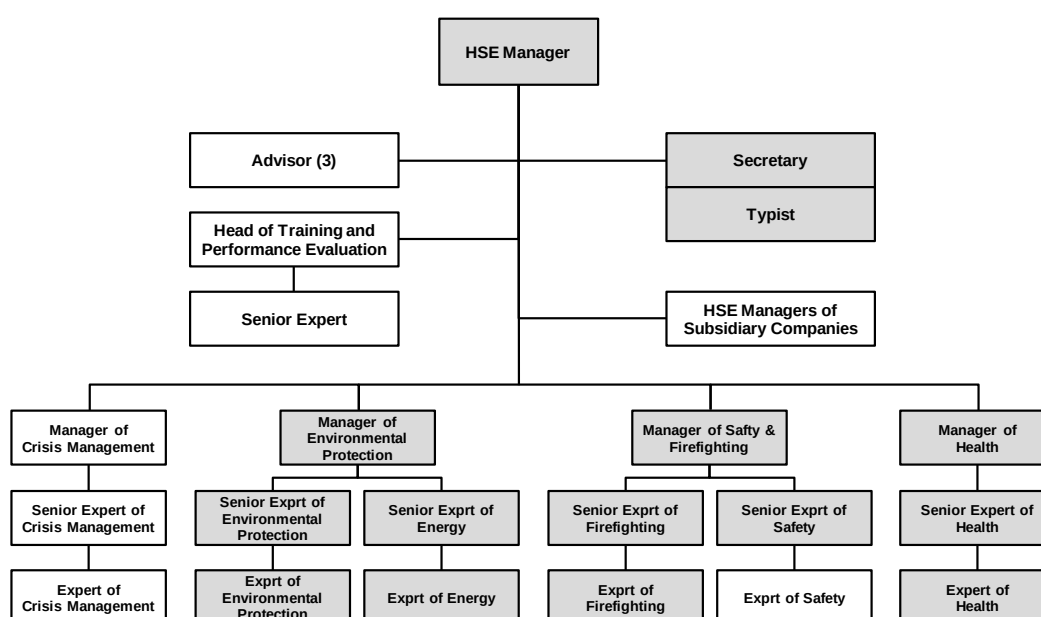
NPC is responsible for the development and operation of petrochemical facilities in the country. NPC's major activities are production, sale, distribution and export of chemicals and petrochemicals. In addition, NPC handles policy-making, planning, directing and supervising the activities of its subsidiaries and affiliates as a mother company. Major petrochemical complexes are located in PETZONE, Mahshahr, and in PSEEZ, Assaluyeh. In addition to those two areas, 12 petrochemical companies including Khark Petrochemical Company are in operation in the country. NPC has six departments including HSE. Figure 3.1.3-3 shows the organizational structure of NPC.



Source: NPC

Figure 3.1.3-3 Subsidiaries that fall under NPC

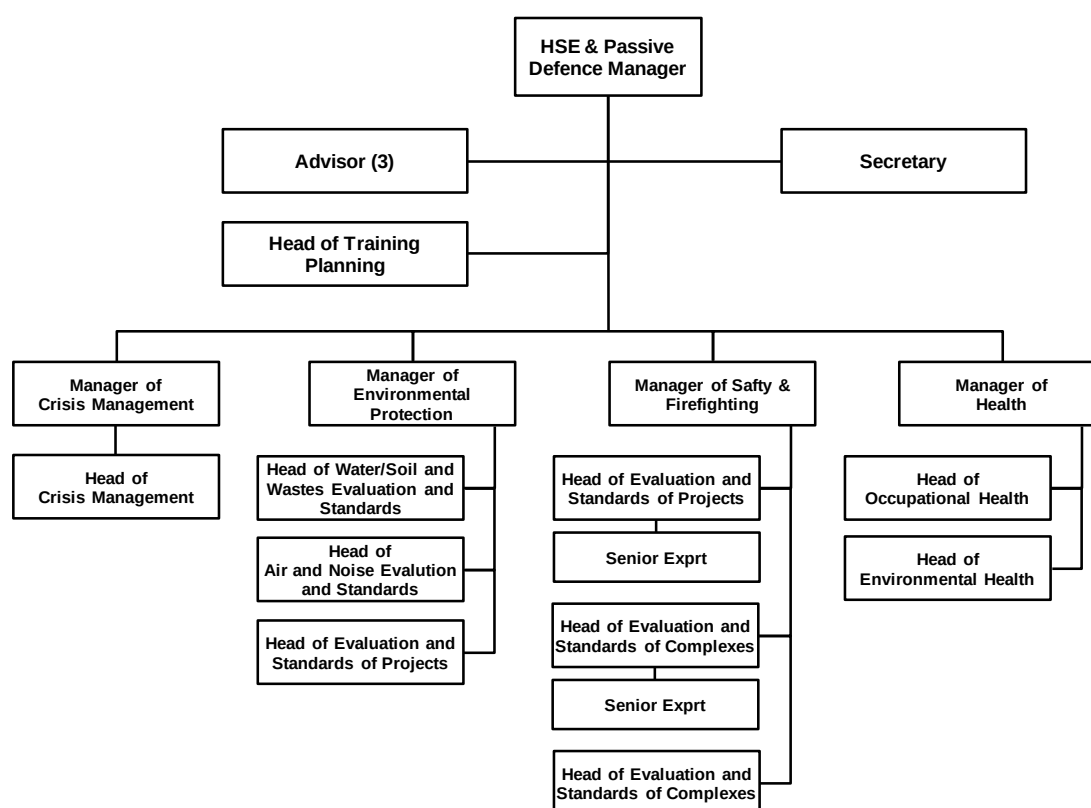
Figure 3.1.3-4 shows the planned organizational structure of HSE Department. NPC had a plan to deploy 25 staff members in the HSE Department, however, only 15 staff members are deployed (highlighted positions). Out of 15 staff members, five experts work for the environmental protection. NPC also has a plan to restructure the HSE Department in proportion to the progress of privatization as shown in Figure 3.1.3-5. The movement towards restructuring indicates that NPC aims to set its own evaluation standards in the fields of environment (air, noise, water, soil and project management) and safety and change into an organization that exercises control over the subsidiaries and private companies, in order to improve the vague structure of organizational responsibility. The restructuring seems to be in the right direction because this may contribute to clarification of NPC's responsibility as a supervising company to the petrochemical industry in the country.



Note: Highlighted parts show the posts deployed.

Source: NPC

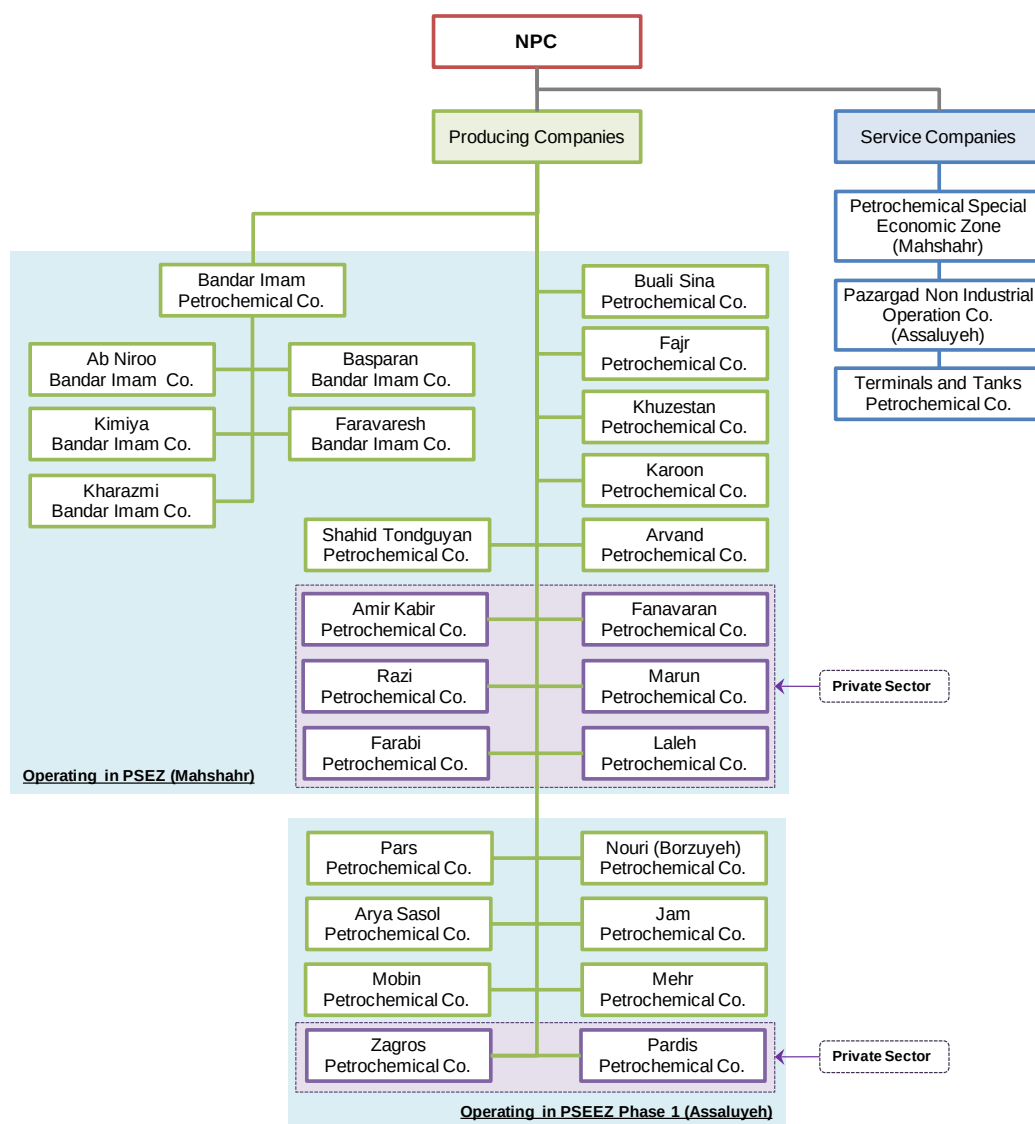
Figure 3.1.3-4 HSE Department of NPC (Current)



Source: NPC

Figure 3.1.3-5 HSE Department of NPC (After restructuring)

Based on the privatization policy of the state government, NPC handed over some petrochemical companies to the private sector. In PETZONE, Mahshahr, six companies are operated by the private sector: Amir Kabir Petrochemical Company, Fanavaran Petrochemical Company, Razi Petrochemical Company, Marun Petrochemical Company, Farabi Petrochemical Company and Laleh Petrochemical Company. In PSEEZ, Assaluyeh, two companies are operated by the private sector: Zagros Petrochemical Company and Pardis Petrochemical Company. Other petrochemical companies are privatized as holding companies. Figure 3.1.3-6 shows the subsidiaries and privatized companies operating in the pilot areas. The companies can be categorized into two types: producing companies such as Bandar Imam Petrochemical Company and Pars Petrochemical Company and service companies such as Petrochemical Special Economic Zone Company (PSEZ) and Terminals and Tanks Petrochemical Company (TTPC).



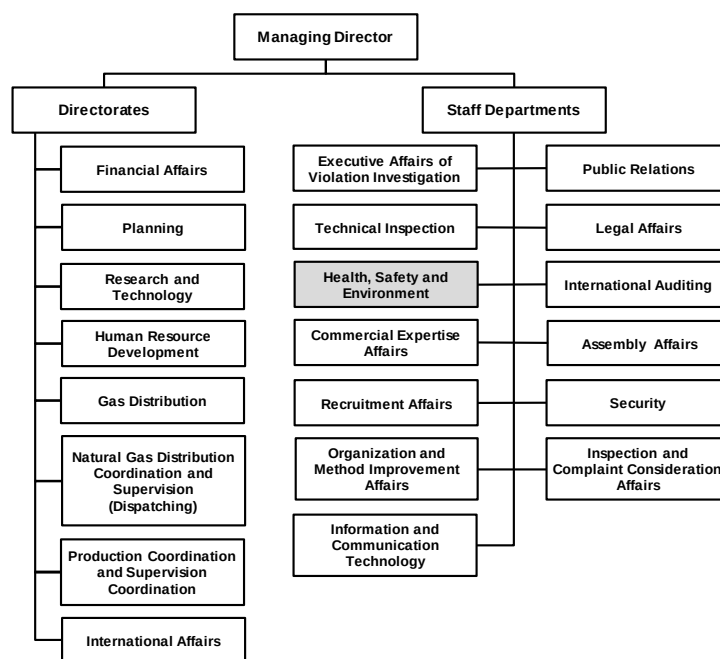
Source: prepared by the study team based on the NPC Annual Report 2009 and Petrochemical Industry 7th Edition

Figure 3.1.3-6 NPC's Subsidiaries and Privatized Companies

(3) National Iranian Gas Company (NIGC)

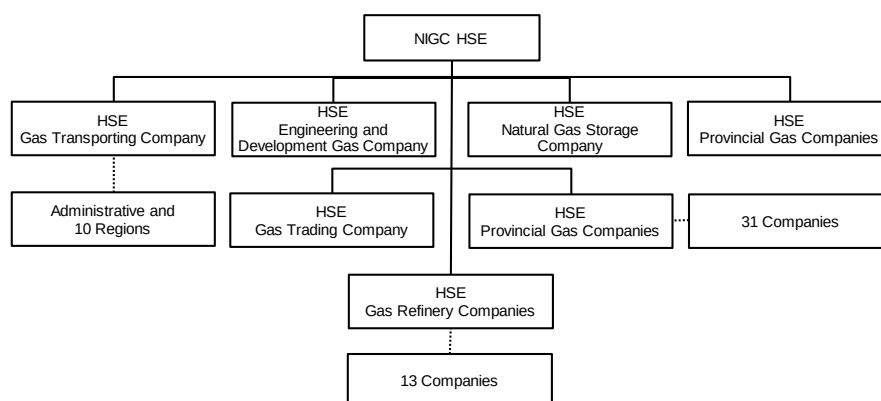
NIGC is responsible for treatment, transmission, and delivery of natural gas to domestic users, industrial and commercial sectors and power plants. NIGC does not work for upstream gas projects because the authority for gas production remains in NIOC. However, the NIGC's responsibility includes enhancing production capacity only if the target area is joint reservoirs such as South Pars. NIGC has 55 subsidiaries including provincial gas companies, gas refining companies, gas engineering and development company, gas transmission company, underground gas storage company, and so on. NIGC has the strategic objectives to realize the higher ranking in natural gas producers and gas technologies.

NIGC has eight directorates: financial affairs, planning, research and technology, human resources development, gas distribution, natural gas distribution coordination and supervision, production coordination and supervision coordination and international affairs. HSE is one of the staff departments that directly report to the managing director. The organizational structure of NIGC and HSE structure of NIGC group are shown in Figure 3.1.3-7 and Figure 3.1.3-8.



Source: Preparation by the study team based on the NIGC Annual Report 2012

Figure 3.1.3-7 Organizational Structure of NIGC

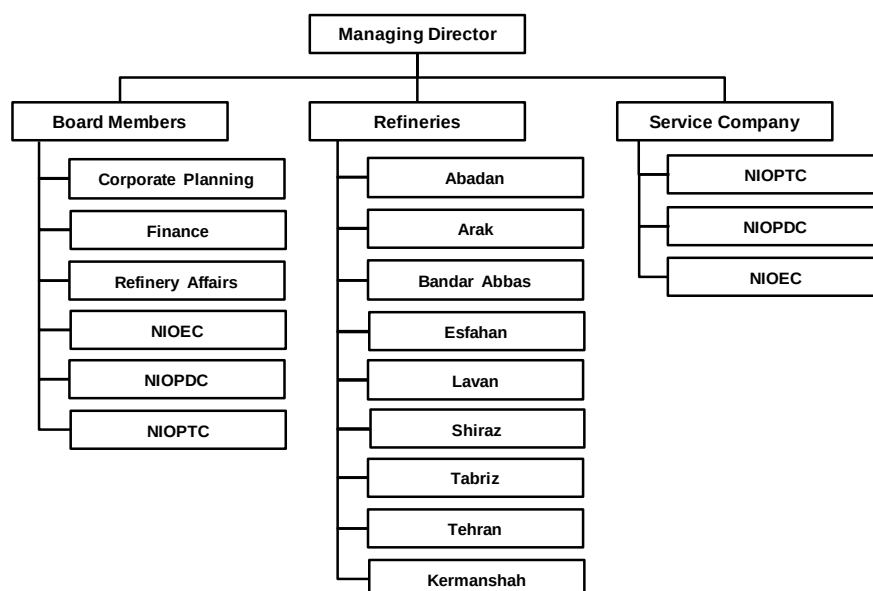


Source: NIGC

Figure 3.1.3-8 HSE Structure of NIGC Group

(4) National Iranian Oil Refinery and Distribution Company (NIORDC)

NIORDC performs expanding, upgrading and optimizing projects for the existing refineries, and constructing new refineries. In addition to the crude oil refining, NIORDC also works for engineering, construction and distribution that are entrusted to three major subsidiaries: National Iranian Oil Pipeline and Telecommunication Company (NIOPTC), National Iranian Oil Products Distribution Company (NIOPDC) and National Iranian Oil Engineering Company (NIOEC). The organizational structure of NIORDC is shown in Figure 3.1.3-9.



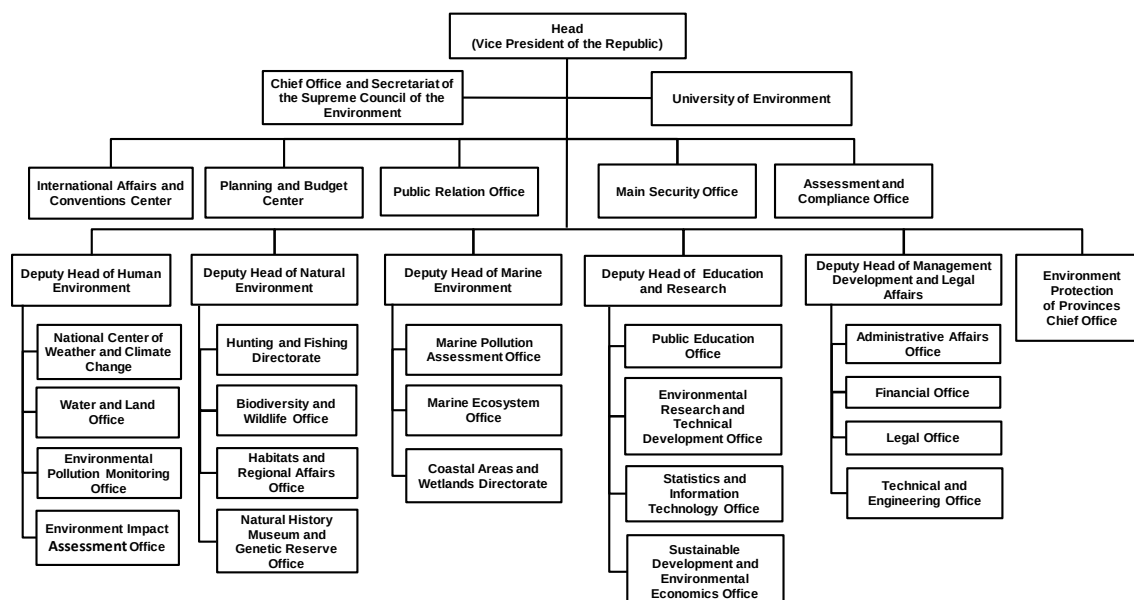
Source: NIORDC website

Figure 3.1.3-9 Organizational Structure of NIORDC

3.2. Other Relevant Organizations

3.2.1. Department of Environment (DOE)

The DOE is responsible for protecting and enhancing the environment, preventing and controlling of any form of pollution or degradation leading to the disturbance in the environmental balance, and conducting all matters related to wildlife and the aquatic biota of the territorial waters. The DOE has provincial directorates and monitor the environmental quality at the provincial level. Figure 3.2.1-1 shows the organizational structure of the DOE. Human Environment is the directorate related to the petroleum industry for pollution monitoring and EIA procedures. Marine Environment Directorate is also related to marine and coastal environmental management for the petroleum industry in aspects of marine pollution, marine ecosystem and management of coastal areas and wetlands.



Source: DOE

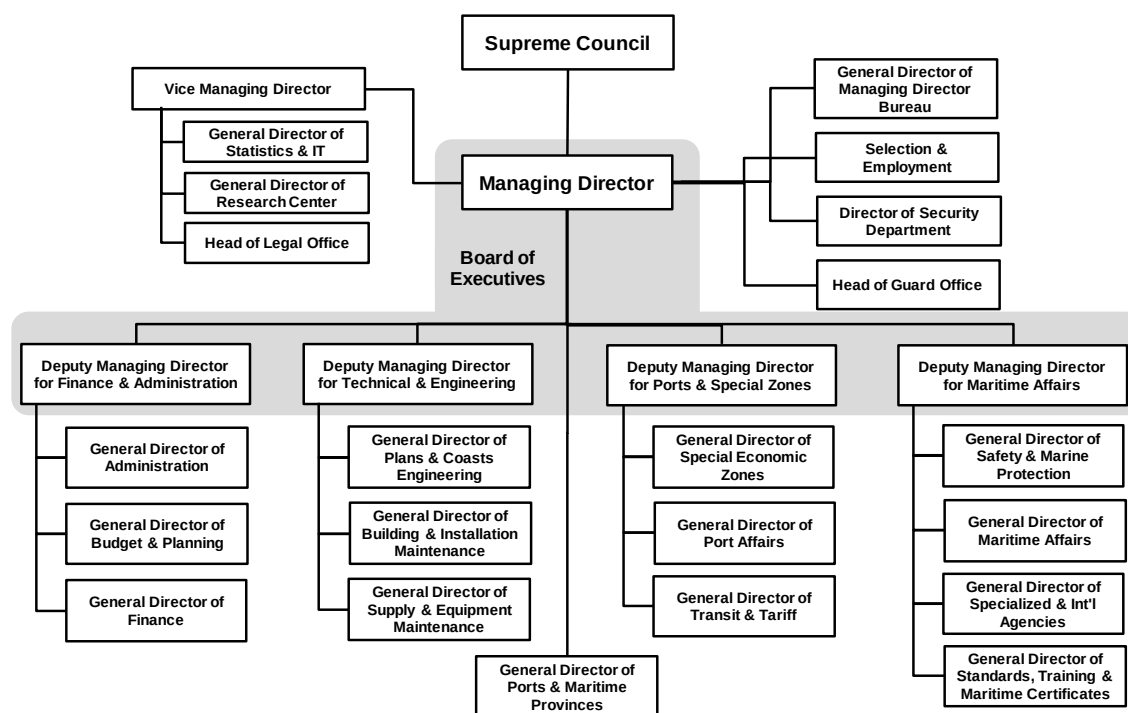
Figure 3.2.1-1 Organizational Structure of the DOE

3.2.2. Ports and Maritime Organization (PMO)

The PMO is an organization that falls under the Ministry of Road and Urban Development. The PMO puts into effect the Iranian Maritime Law and performs the functions laid down in the law. The PMO is a national focal point of emergency response and is responsible for administration of ports and commercial maritime affairs of the country. The functions include membership in international organizations related to port and maritime affairs. Figure 3.2.2-1 shows the

organization structure of the PMO. Safety and Maritime Protection is the section in charge of enforcing protection against oil pollution. The major activities of the section are as follows:

- Planning to prevent maritime pollution from ships and oil platforms in the waters
- Preparing and implementing the National Plan for Oil Pollution Preparedness, Response and Cooperation (OPRC)
- Supervising the preparation of local and provincial plans for oil spill response, and maritime search and rescue in the coastal provinces
- Establishing a national center for combating maritime pollution, and holding coordination meetings with relevant organizations
- Supervising the equipment of local provincial oil spill response centers
- Preparing the requisite standards for pollution combating equipment for oil terminals, wharves, oil platforms, etc.



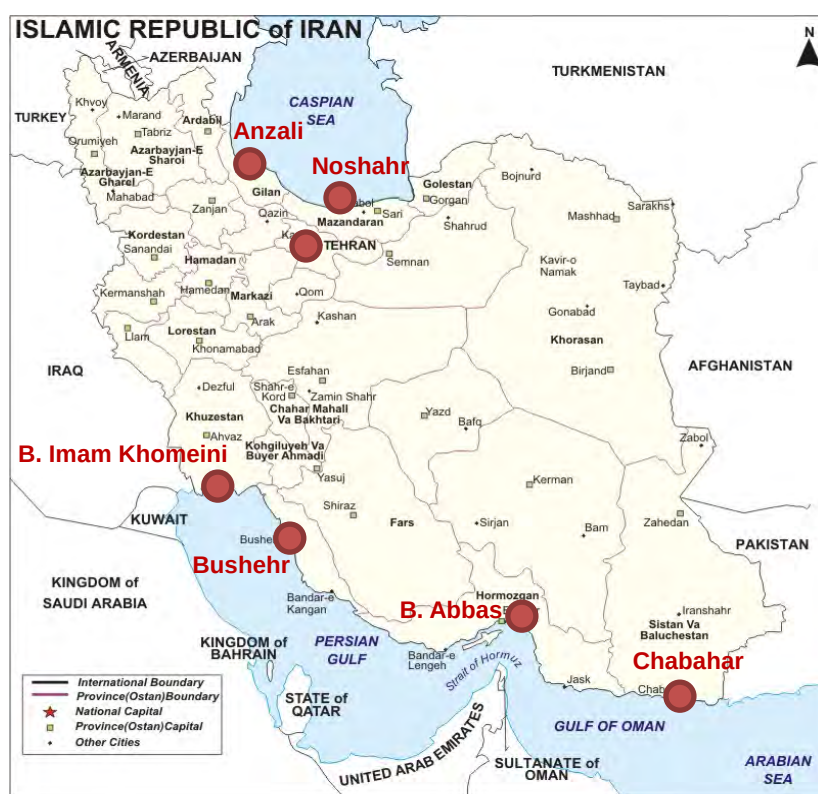
Source: PMO

Figure 3.2.2-1 Organizational Structure of the PMO

Based on the International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC), the PMO has prepared the “National System for Oil Pollution Preparedness, Response and Cooperation at Sea and Navigable Rivers” for implementing this Convention. The national system is composed of four chapters: Chapter 1 General Provisions, Chapter 2 Administrative Arrangements, Chapter 3 Executive Arrangement, and Chapter 4 Operational and Technical

Arrangements and Procedures. According to the national system, PMO is responsible for addressing oil spills that exceed 50 tons (Tier 1).

The PMO has provincial centers for oil pollution preparedness, response and cooperation. The locations of the centers are Tehran (National Center), Bandar Imam Khomeini (Khuzestan Province), Bandar Abbas (Hormozgan Province), Bushehr (Bushehr Province), Chabahar (Sistan and Baluchestan Province), Noshahr (Mazandaran Province) and Anzali (Gilan), as shown in Figure 3.2.2-2. The provincial centers have their local contingency plans for the ports and terminals they control, based on the national contingency plan. The local contingency plans for Bandar Imam Khomeini and Bushehr include PETZONE in Mahshahr and PSEEZ in Assaluyeh respectively. In addition to the provincial centers, there are five local centers for oil pollution preparedness, response and cooperation, which include Khark Island and Assaluyeh Port in Bushehr.



Source: World Maps Zone- Maps of Iran (<http://www.worldmapszone.com/iran/>)
PMO website (<http://maritimesafety.pmo.ir>)

Figure 3.2.2-2 Provincial Centers for Oil Pollution Preparedness, Response, and Cooperation

3.3. Environmental Management Policy and HSE Management System

3.3.1. MOP

The MOP does not have a written environmental management policy or strategy for environmental

protection from oil pollution. However, the MOP has the HSE policy. The objective stated in the HSE Policy of the MOP is to eliminate all the risks and effects on people, environment and facilities. In order to achieve the objective, the following commitments are stated in the policy:

- Stabilizing systematized attitude towards HSE management
- Prioritizing health, safety, and environment and preventing from accidents, damages and contaminations in the petroleum industry
- Recognizing and assessing the risks and risk management in different conditions
- Allocating financial, organizational and human resources required in order to develop environmental plans and activities
- Improving HSE's culture and creating open constructive relationship between managers, personnel and the public.
- Preparing a system to train personnel
- Following laws and regulations of HSE
- Controlling documents, reports' transparency and information's convenience
- Protecting and optimizing natural resources and energy, and decreasing wastes
- Making contractors follow the HSE management system in line with the MOP's policy
- Supporting the scientific and applicable studies, using new updated technologies and using experts' services and consultancies
- Assessing and revising the policies, agendas and plans in order to improve the HSE management system
- Monitoring personnel operations continuously

When the MOP established the HSE Department, the national HSE policy was introduced. The national policy has not been reviewed for nine years since the introduction. The methodology to monitor and evaluate the policy implementation also has not been examined.

The MOP has the Iranian Petroleum Standards (hereinafter referred to as IPS) which is developed and maintained by a technical committee. The objective of issuing the IPS is to set the standards for procurement, installation, construction, inspection and good design to be applied at every oil, gas and petrochemical industries. The IPS consists of 379 standards and 216 standard drawings. There are 13 technical fields including safety, firefighting and environmental pollution control in the IPS. The standards related to environmental management are as shown in Table 3.3.1-1.

The IPS was developed before introduction of the Iranian Environmental Regulations and Standards. Besides, the HSE-MOP has not participated in updating of the IPS. Therefore, the environmental part of IPS does not follow the latest Iranian regulations and standards. However, the MOP and all the petroleum companies should abide by the basic environmental laws, regulations and standards enforced by the DOE as a primary legal framework for the environmental management. Then the petroleum companies should consider the compliance with the requirements

of IPS.

Table 3.3.1-1 IPS related to Environmental Management

No.	Name of Standard	Description
IPS-G-SF-130 (0)	General Standard for Disposal of Solid Waste (issued in December 1997)	This standard gives general description and procedure of solid waste disposal and covers many aspects such as types, hazard, non-hazard, siting, sources, segregation, reduction, resource recovery, treatment sludge concentration and sampling equipment.
IPS-E-SF-860 (0)	Engineering Standard for Air Pollution Control (issued in July 1994)	This Standard represents the minimum requirements for air pollution control and covers the following main topics: pollution sources, types of emission, standard levels, measurement of air pollution, consideration in the selection of the pollution control equipment, process control and threshold limit values (TLV).
IPS-G-SF-860 (0)	General Standard for Air Pollution Control (issued in July 1997)	This standard specifies the minimum requirements for material, operation, tests, and inspections and covers site and process measurements, calibration and installation of instruments.
IPS-G-SF-870 (0)	General Standard for Soil Pollution Control (issued in December 1997)	In this Standard the following matter of soil pollution control is discussed: a) To provide authorities concerned on how to assess site conditions in the unsaturated zone and where a petroleum product release has occurred, information needed to localized where in the unsaturated zone petroleum product is located, and also the removal of petroleum products from the unsaturated zone at a given site. b) To assess on the technologies designed specifically for clean-up of the saturated zone. c) To provide a structural methodology for evaluation and potential consequences of a leak in a pipeline. The methodology that is intended to assist pipeline operators in assessing the need to install pipeline leak detection facilities, and an overview of available pipeline leak detection techniques.
IPS-E-SF-880 (0)	Engineering Standard for Water Pollution Control (issued in May 1997)	This Standard Specification is intended to cover the safety and environmental control aspects as the Company's minimum requirements for water pollution control in OGP production plants. The scope is accomplished under following titles: - Refinery Water Pollution Standard and Control - Petrochemical and Fertilizer Industry Water Pollution Sources, Standard and Control - Organic Chemical Manufacturing - The National Standard of Environmental Protection Agency - Monitoring
IPS-G-SF-880 (0)	General Standard for Water Pollution Control (issued in December 1997)	This standard specifies the minimum requirements for material, operation, tests, inspection and covers site, process and laboratory measurements and calibration of instruments.
IPS-G-SF-900 (0)	General Standard for Noise Control and Vibration (issued in December 1997)	This standard defines the procedures for noise control of plant and equipment. It specifies how to derive maximum allowable noise levels for equipment installed in oil refineries, chemical plants, gas plants and, where applicable, in exploration and production facilities and supply/marketing installations.

Source: MOP

In addition to the IPS, the HSE-MOP has guidelines and documents related to HSE management as shown in Table 3.3.1-2. Basically, the HSE-MOP follows the “Guidelines for the Development and Application of Health, Safety and Environmental Management Systems” prepared by the International Oil and Gas Producers Association (OGP) for developing, implementing and maintaining the HSE management systems in the petroleum industry. The guidelines and documents provided by the HSE-MOP include guidelines to be followed by the petroleum industry for waste management, environmental risk assessment, wastewater treatment and water quality analysis and so on.

Table 3.3.1-2 Guidelines and Documents related to HSE management

No.	Name of Document	Description
1	HSE codes of practice for contractors	This document provides HSE requirements and responsibilities for national companies and their contractors.
2	Guideline for health, safety and environmental management system auditing in oil industry	The guideline provides methodology for HSE auditing, such as required resources, preparation prior to on-site auditing, tools for auditing, and so on.
3	Guidelines for the development and application of health, safety and environment management systems	The guideline provides the main elements for developing, implementing and maintaining the HSE management systems. This document is same as the “Guidelines for the Development and Application of Health, Safety and Environmental Management Systems” prepared by OGP.
4	Guideline of special waste transportation	This guideline provides classification of the special wastes, instructions for signs to be used and transportation.
5	Guideline for storage of special waste	This guideline mainly provides characteristics of storage containers for special waste and attentions to be paid for storage of special waste.
6	Guideline for design of water and wastewater laboratories	This guideline provides how to design the laboratories, such as determination of needed space, and designing of facility, laboratory rooms and equipment.
7	Framework to identify and assess environmental risks	This document provides importance of environmental risk assessment, important factors of risk assessment, steps for the assessment, and explanation of risk matrix.
8	Regulations and methods of industrial waste management	This document defines industrial waste and provides responsibilities of HSE department of operating bodies, companies collecting special waste and dumping contractors, and procedures for industrial waste management.
9	Manual for chlorination and disinfection of wastewater in wastewater treatment plant	These documents provide methods for chlorination and disinfection in wastewater treatment plant.
10	Guidelines for sampling and preserving water and wastewater samples for chemical and bacteriological tests	The guideline provides sampling methods for water quality test, such as selection of sampling location, tools, storage, packing, and so on.

Source: HSE-MOP website

3.3.2. NIOC

NIOC has the HSE management system that follows the OGP's Guidelines for the Development and Application of Health, Safety and Environmental Management Systems. NIOC does not have guidelines or manuals for the subsidiaries to establish and execute the HSE management system. On the other hand, NIOC has a uniform format of monthly reports, and their subsidiaries report their activities to the HSE Department of NIOC with the uniform format. The HSE Department of NIOC compiles the monthly reports that are submitted by the subsidiaries quarterly and annually and submits the compiled report to the managing director (Deputy Minister). As discussed in Section 3.1.3, only two experts work for environmental protection in NIOC. They should monitor and supervise 13 oil and gas production companies and 10 oil field service companies. Therefore, they do not have sufficient capacity to audit the environmental management systems of the subsidiaries, while they can monitor the environmental records submitted by the subsidiaries. The following are the HSE objectives of NIOC:

- Environmental protection and reduction in environmental impacts
- Protection of human resources and decrease in disease caused by working
- Maintenance of machinery and equipment and protection of company's asset
- Strict adherence to the regulations, standards and HSE measures for all activities

The NIOC's HSE policy provides the following activities:

- To prepare the policies and guidelines in the HSE area of the company
- To develop a comprehensive annual program for health, safety and environment, passive defense of facilities and crisis management
- To explain the regulations and standards related to HSE
- To set the criteria and indices to evaluate effectiveness of the HSE management systems
- To establish the integrated management systems
- To perform periodical assessment and audit for investigation of the current status of effective factors on HSE elements
- To supervise the establishment of systems for effective technical inspection
- To implement the plan for management of waste, wastewater and air pollution, desulphurization from crude oil and cleaning of soil contaminated by oily substances

In 2007, NIOC prepared a guidebook that includes international conventions and domestic laws, which is composed of water, air and noise, waste, law violation and penalties and assessment. The guidebook is distributed to the departments of NIOC and its subsidiaries.

3.3.3. NPC

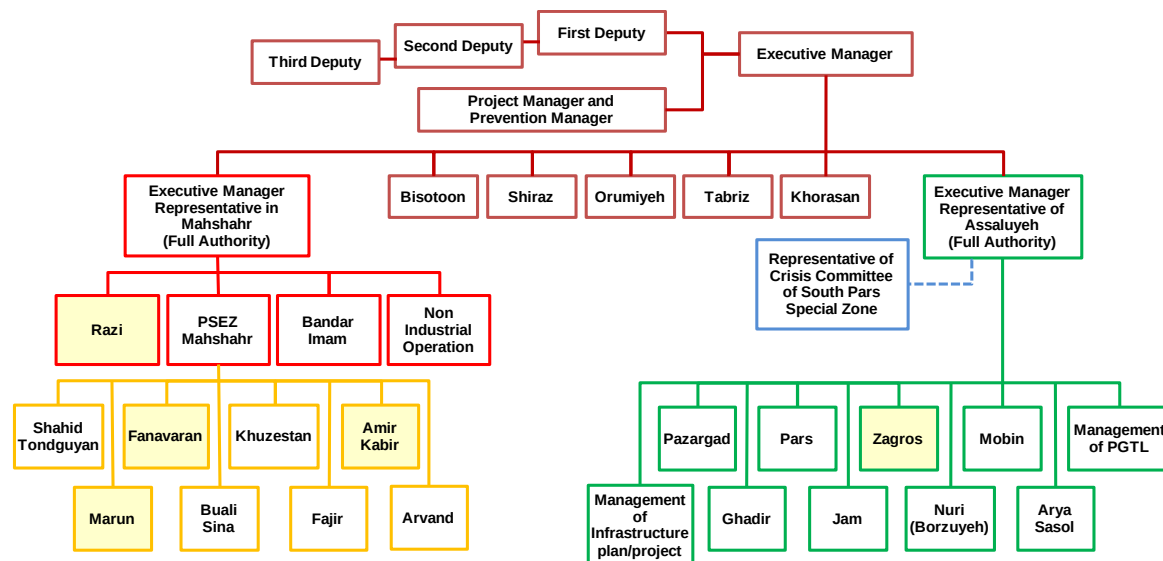
NPC also follows the OGP's guidelines and registers the integrated management system. NPC makes general policies, targets and internal regulations, audits implementation and progress of policies, analyzes trends and conditions, and carries out inspection on ISO implementation. According to the NPC's policy for the Health, Safety, Environment and Quality (HSEQ) Management System, NPC will put development for a better life as its agenda, with creating a safe environment and no contamination, eliminating all incidents and negative effects on people, environment and facilities, and guaranteeing the process of production with improving procedures. NPC has been preparing the "Petrochemical Industry Environmental Requirements" which consists of nine volumes as follows:

- Vol. 1: National laws & Regulations
- Vol. 2: International Conventions
- Vol. 3: Regulations & International Conventions related to Sea, Port & Ship
- Vol. 4: General Managing Requirements
- Vol. 5: Water Quality Management Requirements
- Vol. 6: Soil Quality Management Requirements (under Publishing)
- Vol. 7: Waste Management Requirements
- Vol. 8: Air Quality Management Requirements
- Vol. 9: Energy Management Requirements (under Publishing)

The general managing requirements include the practical guide for environmental guidelines, environmental pollutions identification, recording & reporting of environmental accidents and so on. The petrochemical companies are required to follow the environmental requirements and report the activities on monthly, quarterly and annual basis. NPC also has the guidelines for crisis management, which is applied to both petrochemical complex zones in Mahshahr and Assaluyeh. In the guidelines, accidents occurred in the zones are classified into three levels.

- Level 1: Controllable by equipment available for the company
- Level 2: Uncontrollable by their own equipment and necessity of extensive support through PSEZ and PSEEZ
- Level 3: Necessity of regional cooperation

Figure 3.3.3-1 shows the organizational structure of NPC's crisis management. The main members of the crisis management committee in Mahshahr are PSEZ, Non-industrial Operation Company, Bandar Imam Petrochemical Company (BIPC) and Razi Petrochemical Company. PSEZ is a representative for other petrochemical companies such as Amir Kabir Petrochemical Company and Shahid Tondguyan Petrochemical Company.



Note: Companies in Mahshahr and Assaluyeh that are handed over to the private sector

Source: NPC

Figure 3.3.3-1 Organizational Structure of NPC's Crisis Management

3.3.4. NIGC

The NIGC's HSE policy provides the following activities:

- To prioritize the issues of occupational health, safety and environment
- To provide the constructive communication systems open to the inside and outside of the company and easy access to information and statistics
- To allocate necessary resources for occupational safe and environment
- To comply with the MOP's, domestic and international regulations and standards
- To optimize the use of energy and resources and minimize the waste and pollutants
- To assess and review the methodology and programs of the HSE management systems
- To implement the necessary trainings
- To identify and assess the potential risks and implement the effective risk management
- To conduct studies
- To utilize the skilled and dedicated personnel
- To promote participation in the improvement of the HSE management systems

Based on the policy mentioned above, the Environmental Protection Unit in the HSE Department of NIGC is responsible for the following:

- To prepare and notify the rules, regulations, instructions and environmental guides and supervise the implementation
- To manage municipal, industrial and special wastes
- To manage domestic and industrial wastewaters

- To control air pollution
- To implement educational and cultural programs
- To correspond with environmental organizations and administrations and other relevant institutes and authorities

In addition, the HSE Department of NIGC has the following duties for crisis management:

- To develop the regulations, circulations, instructions and standards in passive defense
- To create a culture for employing passive defense in critical and sensitive plants of the country
- To institutionalize the manners in passive defense by planning and performing comprehensive training courses
- To present solutions against probable threats with passive defense approach by decreasing vulnerability for the purpose of continuing production and servicing
- To hold maneuvers for crisis management and passive defense in subsidiary companies for making preparedness against any threat and probable crisis
- To prepare a training booklet including complete training contents, target groups and details for training courses for all levels of general, professional and management
- To Prepare a financial plan for carrying out basic, detailed and conceptual research projects of passive defense in subsidiaries
- To appoint personnel to passive defense and crisis management positions in administrative level and subsidiary level

3.4. Relevant Legal Frameworks

3.4.1. International Conventions

Iran is a signatory country to the following international conventions on environmental protection, presented:

- UN Conference on the Man & Environment (Stockholm Declaration-1972)
- UN Conference on Environment & Development (Rio Declaration-1992)
- AGENDA 21-Character for Future (Rio-1992)
- Principal on the Conservation of the Forests (Rio-1992)
- United Nations Environment Program (UNEP-1972)
- International Union Conservation Nature & Natural Resources (1948)
- Convention on Wetlands (Ramsar-1971)
- Convention concerning to the Protection of the World Cultural and Natural Heritage (UNESCO- 1972)
- Convention for the Protection of the Ozone Layer (Vienna – 1987)

- Protocol on Substances that Deplete the Ozone Layer (Montreal – 1987)
- Convention on the Control of Trans-boundary Movement of Hazardous Wastes & Their Disposal (Basel – 1989)
- UN Framework Convention on Climate Change (New York – 1992)
- Kyoto Protocol to the UN Framework Convention on Climate Change (Kyoto – 1998)
- UN Convention to Combat Desertification (Paris – 1994)
- Convention on the Prevention of Marine Pollution by Dumping of Waste and other Matter (London – 1972)
- Convention on Oil Pollution Preparedness, Response and Co-operation (London – 1990)
- Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Brussels – 1969)
- Protocol Relating to Intervention on the High Seas in Cases of Pollution by Substances Other Than Oil (London – 1973)
- Berne Treaty on the Protection of Endangered Species in Their Habitats
- CITES Convention (Control of International Trade in Endangered Species)

3.4.2. Domestic Laws and Regulations

(1) The Constitution of the Islamic Republic of Iran

Iran is one of the few countries in the world where provisions for environmental protection are contained in the constitution. Article 50 of the Constitution stipulates that:

“In the Islamic Republic of Iran, preservation of the environment, in which the present and future generations shall have an ever developing social life, is considered as a public duty. Hence any economic activity or otherwise leading to the pollution of the environment or its irrecoverable degradation is prohibited”.

The ministries of energy, oil and industries have historically taken the position that economic growth should take priority over environmental issues. However, the recent Iranian governmental policy emphasizes on environmental protection and sustainable development. It is understood such prominence of the governmental policies have been gradually reflected especially since preparation of the third five years national development plan. It is also expected the next five years national development plan will further stress on the importance and value of environmental protection according to the DOE.

(2) Domestic Legal Frameworks related to Environmental Management

The domestic legal frameworks related to the marine and coastal environmental management that the petroleum industry should follow is shown in Table 3.4.2-1. The basic law on environmental management is the “Environmental Protection and Enhancement Act” issued in 1974 and amended in 1982. The DOE is the national agency responsible for application and enforcement of the laws and regulations related to environmental protection.

Table 3.4.2-1 Domestic Legal Framework related to the Environmental Protection

Title	Description	Issued Year
Petroleum Act	• This act provides rights, powers and responsibilities of the MOP.	1987
Act on Marine Areas of the Islamic Republic of Iran in the Persian Gulf and Gulf of Oman	• This law defines the harmless passing in the territorial waters and the sovereign right in the Exclusive Economic Zone (EEZ). • The vessels causing any kind of marine environmental pollution are not considered to be “harmless”. • Protection and preservation of the marine environment are the responsibility of the Iranian government.	1993
Act on Protection of Seas and Navigable Rivers against Oil Pollution	• This act provides responsibilities of DOE, PMO and other relevant governmental bodies to prevent oil pollution. • This act also provides the system of fine and compensation.	1975 (amended in 2010)
Environmental Protection and Enhancement Act	• This act provides the authority of Environmental Protection Higher Council (EPHC) and DOE. • This act also provides the system of penalty against violation of the rules.	1974 (amended in 1982)

Source: Study team

1) Petroleum Act

The “Petroleum Act” provides the exertion of rights and powers that are entrusted to the MOP and national companies, and supervision over petroleum operations and other duties and functions that should be undertaken by the MOP. According to the Act, the MOP can establish companies for execution of petroleum operations and exploitation throughout the country, continental shelf and marine areas. The MOP is also under the obligation to exert proper supervision and take due case, in the course of petroleum operations and through sound planning for conservation of the petroleum reserves, wealth and installations and prevention of environment pollution (air, water and soil) in coordination with the organizations concerned.

2) Act on Marine Areas of the Islamic Republic of Iran in the Persian Gulf and Gulf of Oman

The Act on Marine Areas of the Islamic Republic of Iran in the Persian Gulf and Gulf of Oman ratified in 1993 provides articles on internal water belonging to the Islamic Republic of Iran. Article 18 of the act defines the protection and preservation of the marine environment and proper exploitation of living and other resources of the exclusive economic zone and the continental shelf. The act also provides prosecution and punishment in connection with any crimes committed on board the ships passing through the territorial sea is within the jurisdiction of the judicial authorities of the Islamic Republic of Iran.

3) Act on Protection of Seas and Navigable Rivers against Oil Pollution

The Act on Protection of Seas and Navigable Rivers against Oil Pollution was issued in 1975 and amended in 2010. The amended Act provides:

- In case of pollution for any reason, the officials in charge of the ship, oil tanker, platform or oil facility shall inform the authorities of the nearest Iranian port, as well as the local authorities of the DOE and the Fisheries Organization as soon as possible;
- Violation of the requirement is fined. The officials that fail to fulfill the instructions of PMO, communicated to them for preventing the spread of pollution, are fined;
- In addition, the governmental officials that fail to fulfill their duties for preventing pollution, responding to it and dealing with the violators are also fined, as well as the regular executive punishment;
- Claims for compensation of damage to coastal or port areas, installations or equipment, as well as damage to the marine environment and reserves, aquatic fauna and other damage caused by pollution subject to the Act, is processed upon the request of the district attorney, or any of the PMO, the DOE and the Fisheries Organization, as appropriate.

The Act also provides that analysis of the climatic and marine ecological conditions as well as preventing pollution of waters shall be conducted by the DOE.

4) Environmental Protection and Enhancement Act

The basic law on environmental protection in Iran is the Environmental Protection and Enhancement Act first issued in June 1975 and last amended in November 1982. According to the act, the DOE has the authority to order owners of factories to remove pollution sources or stop the operations of sources/factors that cause environmental pollution. The DOE is a regulatory agency responsible for the application of the law and the various rules, regulations and guidelines issued on environmental protection.

(3) Legislation and Acts relating to Environmental Management

1) Air Pollution

The Air Pollution Control Rule of 1975 and its Act of 1994 elaborates on the provisions of the Environmental Protection and Enhancement Act of 1975 with respect to air pollution. It defines the responsibilities of the DOE regarding air pollution to include:

- Identification of sources of air pollution;
- Determination of acceptable levels of air pollution;
- Inspection and monitoring of operation of factories, businesses;
- Designation of vehicle emission monitoring centers;
- Provision of technical assistance any privately operated emission monitoring center;
- Development of programs to encourage and instruct industries to mitigate air pollution.

2) Water Pollution

The Sea and Border Rivers Protection Against Oil Pollution Act 1975 controls oil pollution from ships and fixed installation through a system of penalties for offenders. Fines of up to 10,000,000 Rials or prison sentence of 6 months may be imposed.

The Water Distribution Act of 1982 deals with sustainable management of water, focusing on both quantity and quality of water. In respect to water pollution, the law provides the responsibilities of owners of water wells and qanats (canals) for prevention of water pollution.

The Water Pollution Control Rule of 1984 provides the enforcement mechanism for water pollution control provisions of the Environmental Protection and Enhancement Act of 1975, focusing on monitoring, inspection, and relocation of polluting industries and other sources. The DOE is given the responsibility for enforcement, with the co-operation of other Government agencies.

The Act on Iranian Marine Areas of the Persian Gulf and Oman Sea of 1993 defines the basic requirements for preventing the pollution of marine waters in the Persian Gulf.

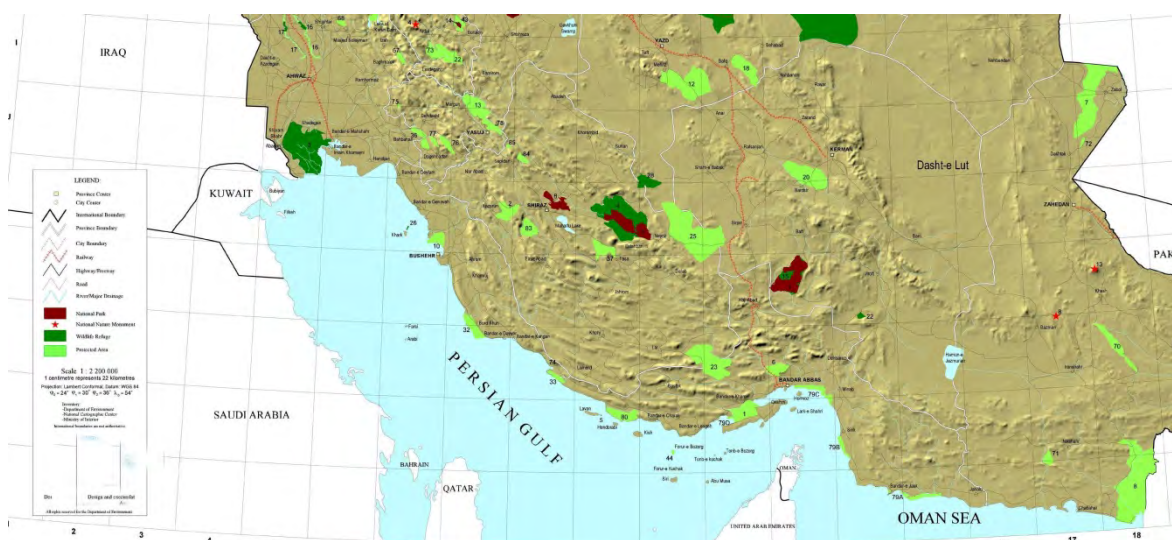
The Act on Sea and Border Rivers Protection against the Oil Pollution of 1996 issues comprehensive regulations on marine pollution aspects for regulating construction and exploitation of facilities in the continental shelf and Iranian special economic zones based on the Sea and Border Rivers Protection Against Oil Pollution Act 1975 and the Act on Iranian Marine Areas of the Persian Gulf and Oman Sea of 1993.

3) Solid Waste Management

The Municipality Act of 1955 empowers municipalities to become involved in waste management and reduction of industrial pollution. The Waste Management Act of 2004 provides legislative framework for waste management in Iran.

4) Natural Conservation Areas

The Environmental Protection and Enhancement Act of 1975, replacing and superseding all previous nature conservation legislation, provides for the enhancement of the role of the DOE and for increased attention to environmental issues. The act defines four categories of protected natural area as “Natural Park”, “National Nature Monument”, “Wildlife Refuge” and “Protected Area”. Atlas of Protected Areas of Iran published by the Department of Environment of Islamic Republic of Iran in 2006 outlines the definition of each natural conservation area. Figure 3.4.2-1 shows the locations of natural conservation areas. Besides these four categories in conformity with the IUCN classes, “No Hunt Area”, “Wetland”, “Sanctuary”, “Protected River” and “Biosphere Reserves” are under management of the DOE.



Source: DOE

Figure 3.4.2-1 Locations of Natural Conservation Areas

(a) National Park

Relatively vast natural areas having specific characteristics and national significance from the geological, ecological, biogeographical and scenic areas points of view are selected as national parks with the purpose of monitoring the biological and natural conditions, improvement of the population of animal species and vegetation sites and also recreational utilization. To fundamentally protect the biodiversity, genetic reserves, ecological integrity and scenic areas, consumer and residential utilizations are prohibited in these areas.

(b) National Natural Monument

Relatively small, interesting, unique, exceptional, unconventional and irreplaceable phenomena or plant and animal collections having protection, scientific, historic or natural significance are selected as national natural monument with the purpose of their protection. Protective measures in these areas shall guarantee their sustainable non-commercial utilization.

(c) Wildlife Refuge

Areas covering typical wildlife habitats selected with the purpose of preserving the population of animal species and improving their level of quality. The minimum area of a wild refuge must suffice to fulfill the animal species needs as well as the integrity and interactions among its units. These areas are appropriate places for educational and research activities especially those pertaining to wildlife. Compatible utilizations and controlled tourism are allowed in refuges.

(d) Protected Area

Relatively vast areas of high protection significance are selected with the purpose of preserving and restoring plants sites and animals habitats. Protected areas are appropriate places for the implementation of educational and research plans. Tourism and economic utilizations in proportion with each area under the comprehensive management plan of the area are allowed.

The Act on Protection and Exploitation of Forest and Range provides for the designation of Forest Parks primarily for recreation, although often including important representative or unique woodland types.

The Hunting and Fishing Act provides for the designation of Protected Rivers and Fishing Refuges. Protected Rivers are designated to protect natural habitats from fishing. As well as rivers, marshes, wetlands and bays along the Caspian Coast may also be designated with regards to fishing. A Fishing Refuge is an area set up to act as a non-fishing or restricted fishing area.

(4) Environmental Standards

The following section describes the environmental standards applicable for petroleum industries.

1) Airborne Noise Pollution Standards

In compliance with the Article 2 for the prevention of noise pollution as defined by an executive by-law approved in the cabinet meeting of the 5th April, 1999, the noise standards for ambient air in Iran are to become effective according to the following schedule as shown in Table 3.4.2-2. It is understood the standards for Industrial Areas are applicable.

Table 3.4.2-2 Airborne Noise Standards

Area	Day 7:00 am. – 10:00 pm Leq (30') dB(A)	Night 10:00 pm – 7:00 am. Leq (30') dB(A)
Residential Areas	55	45
Residential and Commercial Areas	60	50
Commercial Areas	65	55
Residential and Industrial Areas	70	60
Industrial Areas	75	65

Source: Department of Environment, Human Environmental Laws, Regulation Criteria and Standards, 2012

2) Ambient Air Standards

The ambient air standards in Iran are shown in Table 3.4.2-3.

Table 3.4.2-3 Ambient Air Quality Standards

Pollutant	1389 (2010-2011)		1390 (2011-2012)	
	$\mu\text{g}/\text{m}^3$	ppm	$\mu\text{g}/\text{m}^3$	ppm
Carbon Monoxide (CO)				
Max. 8 hours concentration	10,000	9	10,000	9
Max. 1 hours concentration	40,000	35	40,000	35
Sulfur Dioxide (SO ₂)				
Annual average	50	0.019	20	0.007
Max. 24 hours concentration	250	0.094	100	0.037
Nitrogen Dioxide (NO ₂)				
Annual average concentration	60	0.031	40	0.021
Floating Particles (PM10)				
Annual average	40	-	10	-
Max. 24 hours concentration	90	-	25	-
Floating Particles (PM2.5)				
Annual average	12	-	10	-
Max. 24 hours concentration	30	-	25	-
Ozone (O ₃)				
Max. 8 hours concentration	140	0.071	100	0.05
Max. 1 hour concentration	140	0.071	100	0.05
Lead				
Annual average	0.5	-	0.5	-
Benzene				
Annual average	5	-	5	-
Benzo-alpha-pyrene				
Annual average	1 (ng/m^3)	-	1 (ng/m^3)	-

Source: Department of Environment, Human Environmental Laws, Regulation Criteria and Standards, 2012

3) Emission Standards for Factories and Workshops

In accordance with the Article 15 of Air Pollution Prevention Act of 1995, the emission standards for factories and workshops relating to the petroleum industries are provided as shown in Table 3.4.2-4.

Table 3.4.2-4 Emission Standards

Plant Type	Pollutant Industries	Standard of Gases				Standard of Particles			% Darkness	
		Gas Type	1st Degree	2nd Degree	Unit	1st Degree	2nd Degree	Unit	1st Degree	2nd Degree
Refineries	Catalyst Reduction System	CO	0.1	0.1	ppm	150	350	µg/m ³	30	30
Sulfur Production	-	SO ₂	800	1000	ppm	-	-	-	-	-
		H ₂ S	20	30	ppm	-	-	-	-	-
Ammonia Production	Ammonia Unit	NH ₃	50	100	ppm	-	-	-	-	-
Sulfuric acid production	Oxidation of Sulfur, Hydrogen Sulfide, Alkylacid, Organic Sulfide	SO ₂	380	456	ppm	-	-	-	10	20
	Oxidation of Mercaptans and Acid Sludge	H ₂ SO ₄	-	-	-	40	75	µg/m ³	10	20
Asphalt Production	Drying heaters, elevators, sieves, asphalt storage, tanks, funnels, asphalt mixers, asphalt mineral tanks (and feed), equipment and dust conductors by controlling system	-	-	-	-	100	250	µg/m ³	20	25

Notes:

- * Standards of the first degree are implemented for new factories and workshops and also in existing factories and workshops where the locations are not in line with the Article 12 of the Air Pollution Prevention Law of 1995
- ** Standards of the second degree will be implemented for those factories and workshops whose location complies to the Article 12

Source: Department of Environment, Human Environmental Laws, Regulation Criteria and Standards, 2012

4) Effluent Standards

The Article 3 and 5 of the Regulating and Preventing Water Pollution Law provide effluent standards for (i) surface water consisting of seasonal or permanent water, natural or artificial lakes and marshes, (ii) absorbent well consisting of absorbing pits or ditches with a bed 3 meters higher than the underground water table and (iii) irrigation purposes. Table 3.4.2-5 shows the effluent standards in the country.

Table 3.4.2-5 Effluent Standards

(Unit: µg/m³ unless otherwise mentioned)

No.	Pollutant Material	Discharge to Surface Water	Discharge to Absorbent Well	Using for Agriculture and Irrigation
1	Silver (Ag)	1	0.1	0.1
2	Aluminum (Al)	5	5	5
3	Arsenic (As)	0.1	0.1	0.1
4	Boron (B)	2	1	1
5	Barium (Ba)	5	1	1
6	Beryllium (Be)	0.1	1	0.5
7	Calcium (Ca)	75	-	-
8	Cadmium (Cd)	0.1	0.1	0.05
9	Free Chloride (Cl)	1	1	0.2
10	Chlorine (Cl)	600 (Note 1)	600 (Note 2)	600
11	Formaldehyde (CH ₂ O)	1	1	1
12	Phenol (C ₆ H ₅ OH)	1	Trace	1

No.	Pollutant Material	Discharge to Surface Water	Discharge to Absorbent Well	Using for Agriculture and Irrigation
13	Cyanide (CN)	0.5	0.1	0.1
14	Cobalt (Co)	1	1	0.05
15	Chromium (Cr ⁶⁺)	0.5	1	1
16	Chromium (Cr ³⁺)	2	2	2
17	Copper (Cu)	1	1	0.2
18	Fluorine (F)	2.5	2	2
19	Iron (Fe)	3	3	3
20	Mercury (Hg)	Trace	Trace	Trace
21	Lithium (Li)	2.5	2.5	2.5
22	Magnesium (Mg)	100	100	100
23	Manganese (Mn)	1	1	1
24	Molybdenum (Mb)	0.01	0.01	0.01
25	Nickel (Ni)	2	2	2
26	Ammonium as NH ₄	2.5	1	
27	Nitrite as NO ₂	10	10	
28	Nitrate as NO ₃	50	10	
29	Phosphate as P	6	6	
30	Lead (Pb)	1	1	1
31	Selenium (Se)	1	0.1	0.1
32	Sulfide Hydrogen (H ₂ S)	3	3	3
33	Sulfite (SO ₃)	1	1	1
34	Sulfate (SO ₄)	400 (Note 1)	400 (Note 1)	500
35	Vanadium (V)	0.1	0.1	-
36	Zinc (Zn)	2	2	2
37	Fat Oil	10	10	10
38	Detergent ABS	1.5	1.5	0.5
39	BOD	30 (Instantly 50)	30 (Instantly 50)	100
40	COD	60 (Instantly 100)	60 (Instantly 100)	200
41	Dissolved Oxygen (DO)	2	-	2
42	Total Dissolved Substance (TDS)	(Note 1)	(Note 2)	-
43	Total Suspended Substance (TSS)	40 (Instantly 60)	-	100
44	Sedimented Substance (SS)	0	-	-
45	pH (Range)	6.5 – 8.5	5 - 9	6 – 8.5
46	Radioactive Material	0	0	0
47	Darkness (Unit of Darkness)	50	-	50
48	Dye (Unit of Dye)	75	75	75
49	Temperature (°C)	(Note 4)		
50	Digestion Coliform (MPN/100 ml)	400	400	400
51	Total Coliform (MPN/100 ml)	1000	1000	1000
52	Parasite Seed			(Note 5)

Notes:

- 1: Discharge of higher concentrations than shown in the above table will only be permitted if chloride, sulphate and the dissolved material of the receiving source does not increase more than 10% at a radius of 200 meters distance.
- 2: A higher concentration discharge than the above table is only allowed if chloride, sulphate and the dissolved substance of drainage are not more than 10% of consuming water
- 3: Existing industries are allowed to reduce BOD₅ and COD to 90% min of the BOD₅ and COD that they met before compilation of this standard.
- 4: Temperature should be kept in a range that does not increase the temperature of the receiving source to more than 3
- 5: The number of parasite seeds in treated urban drainage should not exceed more than one seed per liter, if it is being used for irrigation of agriculture products that are consumed raw.

Source: Department of Environment, Human Environment Laws, Regulation Criteria and Standards, 2012

3.4.3. Environmental Impact Assessment System

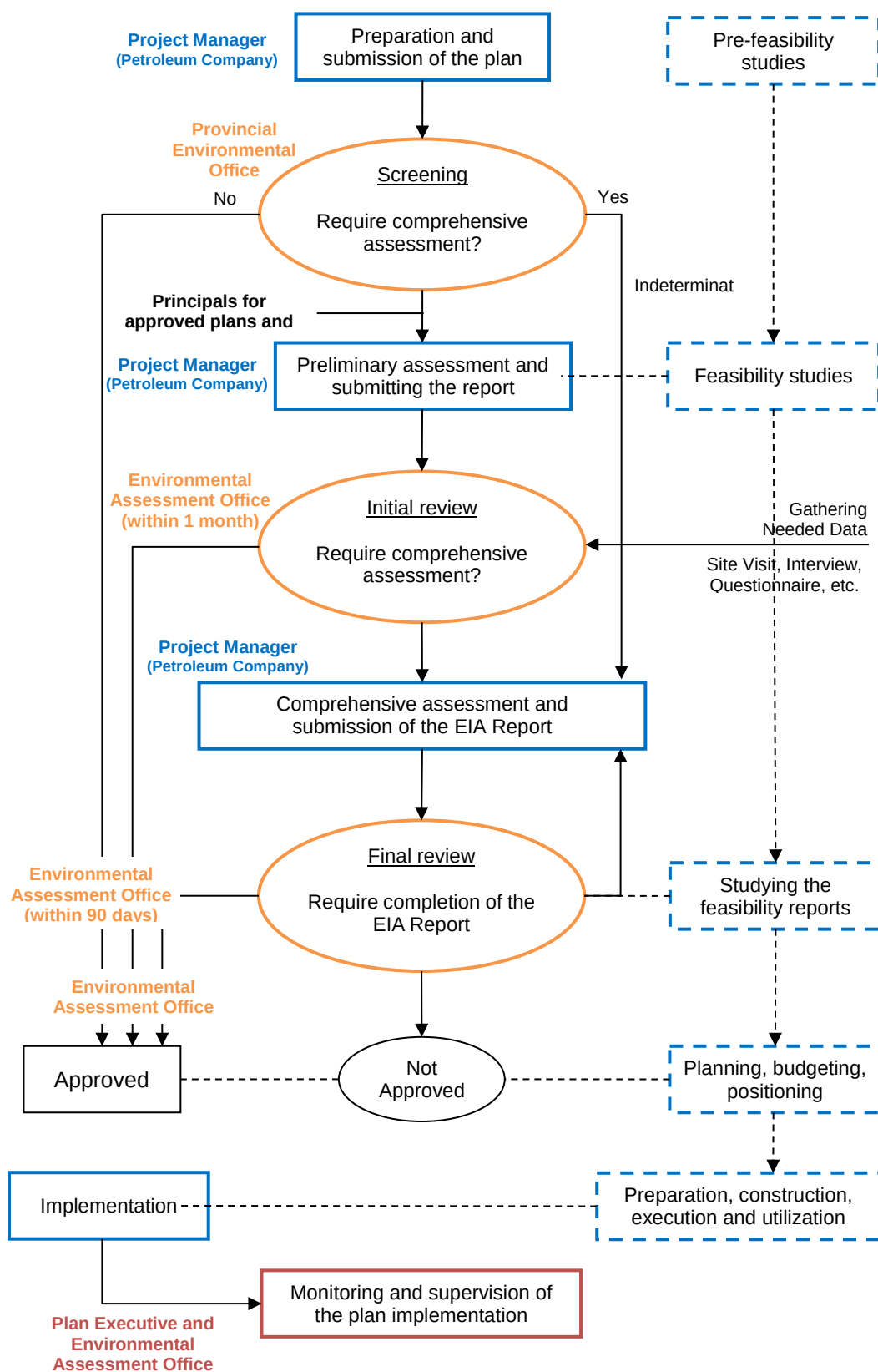
The Decision 138 of the Higher Council for the Environment requires implementation of Environmental Impact Assessment (EIA) for the following listed major development projects during feasibility study stage.

- Petrochemical factories of any size
- Refineries of any size;
- Power plant station with the capacity of larger than 100 Mega Watts (MW)
- Steel industries: (a) units producing raw material for steel mills with the annual capacity greater than 300,000 tons or (b) rolling and forming plants with the annual capacity greater than 100,000 tons
- Dam and other river structures: (a) dams with the height of greater than 15 m, having structure of greater than 40 ha or lake with the area greater than 400 ha; (b) inactive dams of any size; (c) man-made lakes with the area of greater than 400 ha; (d) aquafarms with the area of less than 400 ha at the discretion of the Ministry of Agriculture and DOE; or (e) irrigation and drainage plans and projects with the area of greater than 25,000 ha.
- Industrial estates (of any type) with the area of larger than 100 ha
- Airports with the runway length of longer than 2,000 m.

As mentioned above, the law designates only the petrochemical factories and refineries as the petroleum projects in which the implementation of EIA is required. Exploration, transport by pipelines and shipping are not included in the target projects of EIA. Besides, the HSE-MOP declared construction, development or extension works of the following sectors are subject to implementation of EIA regardless the scale of the project. Therefore, it is understood that EIA is required for most of the development or extension activities of the MOP and its subsidiaries.

- Oil and gas refineries
- Petrochemical plants
- Development and operation of oil and gas reservoirs (gas field and oil fields)
- Oil wharfs and berths
- Oil and gas pipelines
- Oil storages
- Oil and gas terminals

The attachment of minutes of meeting of the Environmental Protection Supreme Council dated 23rd December, 1997 provides for the DOE to establish an EIA submittal and approval procedure as described in Figure 3.4.3-1. The petroleum companies that will implement the projects abovementioned shall follow the EIA procedure controlled by the DOE.



Source: Data directly provided by the DOE in October 2012

Figure 3.4.3-1 Flow Chart of EIA Procedure by the DOE

The project proponent initially submits brief project information to the DOE. Once the report is submitted for approval, the DOE must inform proponent of any required alternations within one month. Based on the decision by the DOE, the proponent prepares EIA report. A committee, consisting of the head of the DOE as chairperson, five experts nominated by chairperson, a representative from the plan and budgetary organization, a representative from the forest and pasture organization, a representative from industrial research standards institute and a representative from relevant sector ministry, evaluates the EIA report within an additional 90 days period. The DOE prepared the EIA guidelines by industrial sector in cooperation with the UNDP. The EIA guidelines for the petroleum industry include petrochemical plants and petroleum refineries.

Since the publication of the fourth five years national development plan, a concept of Strategic Environmental Assessment (hereinafter referred as to SEA) has been introduced in Iran. Under the cooperation by the United Nations Development Programme (UNDP) in the project of Environmental Impact Assessment Enabling Activities and Capacity Building, IRA/97/017 in 1997, the DOE has developed required documentation and system relating to SEA. Yet, the DOE stated the comprehensive guidelines for SEA have still been under preparation. The study team also observed the concept and appropriate procedure of implementation of SEA have not been infiltrated among the members of the HSE-MOP and subsidiaries. Nevertheless, since the fifth five years national development plan also emphasizes the aspect of SEA in environmental management and the DOE asserts SEA could be still one of the priority items in the succeeding six five years national development plan, further importance on SEA will be weighted in the Iranian EIA system in the future.

The By-Laws on Article 183, 5th Economic, Social and Cultural Development Plan in respect of Strategic Environmental Assessment (1391/2/30) was enacted, based on the decision of the fifth five years national development plan. The by-law provides that the strategic environmental assessment consists of identifying the target area, conducting the study, preparing a report, making a decision and monitoring the activities at all stages. The SEA report should include the following:

- Survey on cumulative effects arising from implementation of the plan or scheme at the national, regional and sectional levels
- Survey on environmental effects, biodiversity and sustainability indices in the course of implementation of the plan or scheme
- Measures for monitoring environmental effects and suggesting environmental plans to be prioritized

The Higher Council for the Environment is the national institution in charge of strategic environment assessment of schemes and plans for national development, while a regional coordination council is responsible for regional development in each region. All the provinces are categorized into nine regions:

- Region 1: Gilan, Mazandaran and Golestan
- Region 2: East Azerbaijan, West Azerbaijan and Ardebil
- Region 3: Hamedan, Kermanshah, Kurdistan, Lorestan and Ilam
- Region 4: Khuzestan, Kohkiluyeh and Boyer-Ahmad
- Region 5: Fars and Bushehr
- Region 6: Tehran, Central, Zanjan, Semnan, Qazvin and Alborz
- Region 7: Esfahan, Yazd, Chaharmahal and Bakhtiari
- Region 8: Kerman, Sistan and Baluchistan and Hormozgan
- Region 9: South Khorasan, Razavi Khorasan and North Khorasan

The coordination councils have the duties: strategic environment assessment of the regional development schemes and plans based on the criteria set by the Higher Council for the Environment; supervision on implementation of the assessment at the regions level; regional coordination for formulation of the document for regional development; and formulation and monitoring of environmental indices in the region.

The By-laws on Article 185, 5th Economics, Social and Cultural Development Plan in respect of Sustainability Indices (1391/4/3) provides formulation of sustainability indices, based on the decision of the fifth five years national development plan. The DOE is the authority to develop the procedures. According to the DOE, however, the guidelines for SEA were still in progress in November, 2012 and the concept and measures of SEA were not well recognized by the MOP and the subsidiaries. On the other hand, the concept of SEA is mentioned in the fifth five years national development plan and the DOE indicates that SEA will be mentioned in the following five years national development plan again. It is assumed that SEA would be very important component for the EIA system in Iran in the future.

The DOE prepared the EIA guidelines by industrial sector in cooperation with the UNDP. The EIA guidelines for the petroleum industry include petrochemical plants and petroleum refineries.

3.5. International Requirements for HSE-MS

After a series of catastrophic accidents in 1980s, such as the Piper Alpha platform explosion incident in the North sea and the Exxon Valdez grounding incident in Alaska, HSE management system, which integrates the occupational health and safety management and the environmental management, has been introduced eagerly in the oil and gas sectors, in order to prevent accidents

and to implement oil exploration activities with suitable environmental considerations. Currently most of the major oil exploration companies and/or national oil companies in oil producing countries, including their subsidiaries, have established their HSEMS.

This section summarizes the general requirements for the HSEMS in Oil and Gas E&P projects and then highlights one example of a HSE legislative framework in the oil producing country, i.e. United Arab Emirates with the Abu-Dhabi National Oil Company (ADNOC), which aspire to achieve exemplary HSE performance in the Middle East.

3.5.1. General Guidelines in Oil and Gas Sectors

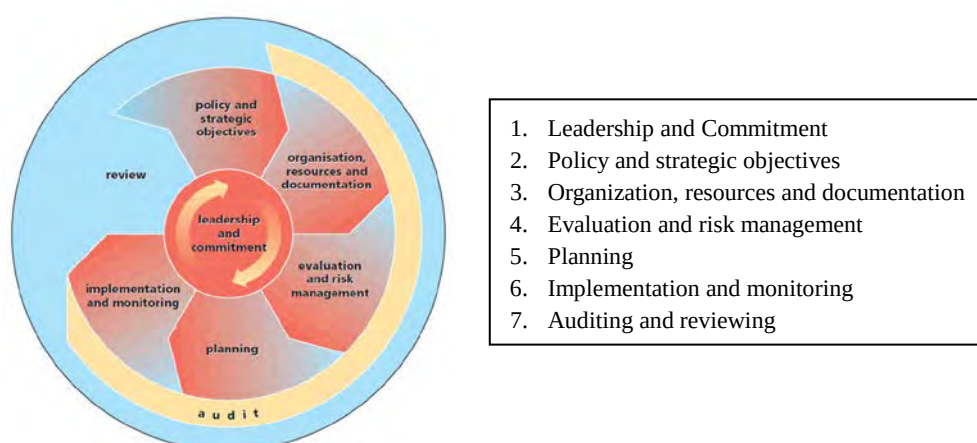
Many oil exploration companies refer to the guidelines and/or good practices which have been prescribed International Association of Oil and Gas Producers (OGP)¹ as follows:

(1) Guidelines for the Development and Application of Health, Safety and Environmental Management Systems 1994 (E&P Forum/OGP Report No. 6.36/210)

The OGP guideline of “Guidelines for the Development and Application of Health, Safety and Environmental Management Systems” (Report No. 6.36/210) has been referred as the guideline for establishment of HSEMS in many companies. The Guideline may be used as a template of a comprehensive management system for operating and/or contracting companies of the oil and gas exploration and production industry in compliance with the ISO 9000s (Quality management system), ISO 14001, (Environmental management system) and ISO 18001 (Occupational health and safety management system).

The Guideline describes the main elements necessary to develop, implement and maintain an HSEMS. They do not lay down specific performance requirements, but recommended that companies set policies and objectives taking into account information about the significant hazards and environmental effects of their operations. The model Health, Safety and Environmental Management System is shown schematically in Figure 3.5.1-1.

¹ E&P Forum was an association which was founded in 1974, to develop effective communications between the upstream industry and an network of international regulators, such as the United Nation, the International Maritime Organization, the World Bank, the International Standard Organization, etc. In 1999 it changed the name International Association of Oil & Gas Producers (OGP). OGP promotes to identify and share best practices to achieve improvements in every aspect of health, safety, the environment, security, social responsibility, engineering and operations. It encompasses most of the world's leading publicly-traded, private and state-owned oil & gas companies, industry associations and major upstream service companies (HP: <http://www.ogp.org.uk/>)



Source: Guidelines for the Development and Application of Health, Safety and Environmental Management Systems 1994, OGP

Figure 3.5.1-1 HSEMS Model

This HSEMS model aims to a continual improvement based on the PDCA cycle, i.e. P (Plan) - D (Do) - C (Check) and A (Action). Key elements of the HSEMS are shown in Table 3.5.1-1.

Table 3.5.1-1 Key Elements of the HSEMS Model

HSEMS Element	Addressing
Leadership and commitment	Top-down commitment and company culture, essential to the success to the system
Policy and strategic objectives	Corporate intentions, principles of action and aspirations with respect to health, safety and environment
Organization, resources and documentation	Organization of people, resources and documentation for sound HSE performance
Evaluation and risk management	Identification and evaluation of HSE risks, for activities, products and services, and development of risk reduction measures
Planning	Planning the conduct of work activities, including planning for changes and emergency response
Implementation and monitoring	Performance and monitoring of activities, and how corrective action is to be taken when necessary
Auditing and reviewing	Periodic assessments of system performance, effectiveness and fundamental suitability

Source: Guidelines for the Development and Application of Health, Safety and Environmental Management Systems 1994, OGP

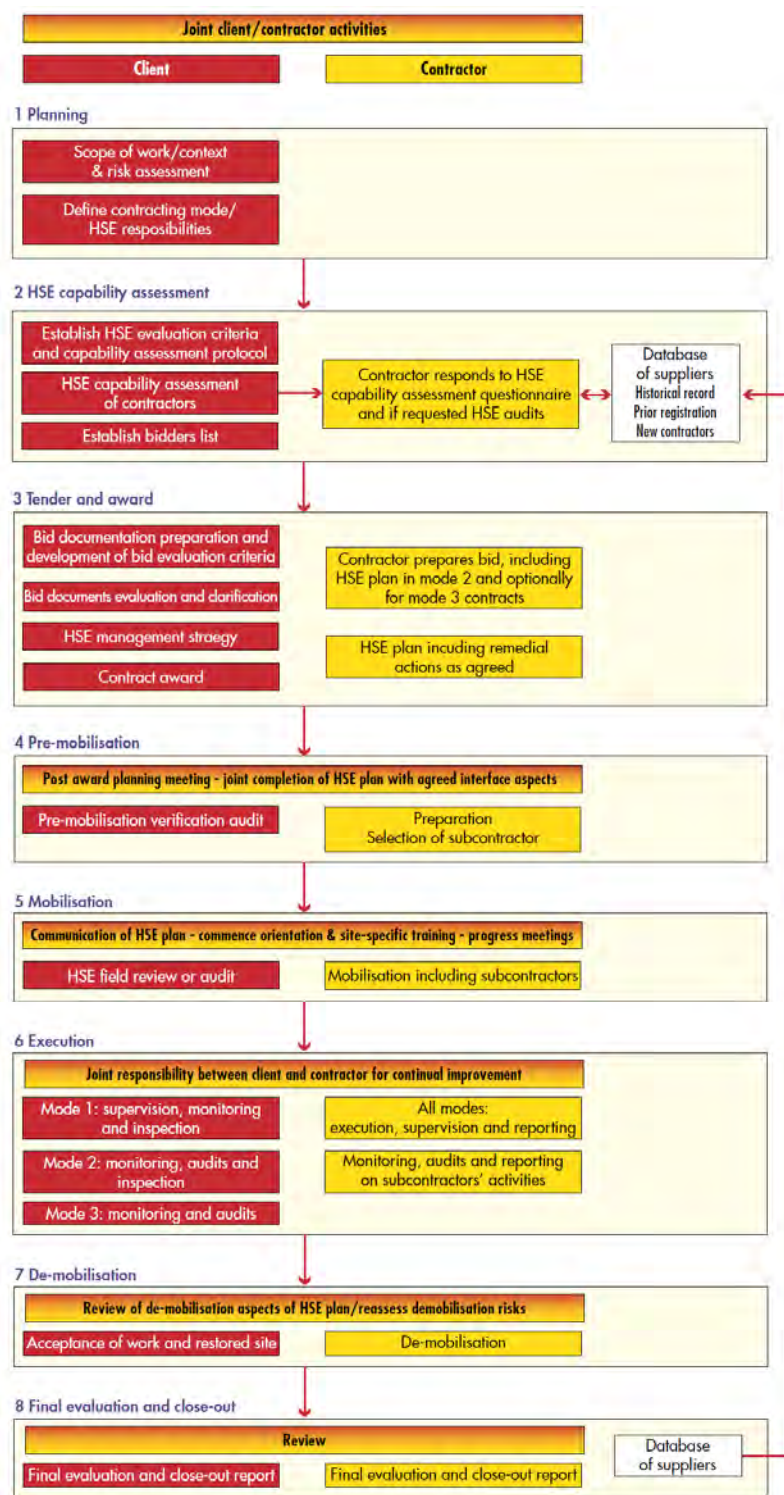
(2) HSE Management – Guidelines for Working Together in a Contract Environment, June 2010 (OGP Report No. 423)

In general, the oil & gas exploration & production projects are to be conducted by the oil & gas exploration company, which is usually called “Client”, and companies who carry out individual work under contract, which is called “Contractor(s)”. Since 2000 there has been a significant

increase in the ratio of contractor hours to client hours, which resulting shift in responsibility and risk from the client to the contractors². After the publication of the original guideline of HSEMS in 1994, which was described in the previous section, most of the oil & gas E&P companies have been established their HSEMS and incorporate them into the individual E&P projects. In order to achieve the further improvement in HSE performance, enhancement of the client/contractor relationship within a common HSE management process, clarifying their roles and responsibilities, has been recognized as an important issue.

OGP published a guideline, *HSE Management – Guidelines for working together in a contract environment*, to assist with the management of the client–contractor relationship in this changing environment in 2010. The guideline explain the roles and responsibilities of client and contractor in each contracting stage of; 1-Planning, 2-HES capability assessment, 3-Tender and award, 4-Pre-mobilization, 5-Mobilazation, 6-Execution, 7-De-miobilization and 8-Final evaluation and close-out. It also provides the questioner and evaluation scoring system for the contractors as appendixes.

² The ratio of contractor hours to client hours was 1:1 in 1990s, however, it reached 4:1 in 2009 according to the OGP statics.



Source: HSE Management – Guidelines for Working Together in a Contract Environment, June 2010

Figure 3.5.1-2 HSE Roles and Responsibilities of Client and Contractors in E&P Project

3.5.2. HSE Requirements in Financial Agencies

Many of the oil and gas E&P projects are financed and/or invested by the export credit agencies (ECAs) or banks. ECAs review the project's environment and social consideration practice in order to confirm their mitigation measures to reduce or minimize the effects toward the natural environment and/or regional society. The Performance Standards and Environmental, Health and Safety Guidelines (EHS Guidelines) of the International Finance Agency (IFC), which is one of the World Bank Group, assisting private sectors, are referred widely as the guiding principles for the confirmation of the environment and social considerations. The IFC standard requests the project owner to comply with the environment, health and safety laws and regulations in the relevant country including environmental impact assessment, but also to implement a suitable HSE management. Followings are the brief descriptions.

(1) IFC Performance Standards³

Together, the eight Performance Standards establish standards that the client is to meet throughout the life of an investment by IFC:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

Performance Standard 1 establishes the importance of (i) integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of environmental and social performance throughout the life of the project. Performance Standards 2 through 8 establish objectives and requirements to avoid, minimize, and where residual impacts remain, to compensate/offset for risks and impacts to workers, Affected Communities, and the environment. While all relevant environmental and social risks and potential impacts should be considered as part of the assessment, Performance Standards 2 through 8 describes potential

³ <http://www.ifc.org/ifcext/enviro.nsf/Content/PerformanceStandards>

environmental and social risks and impacts that require particular attention.

(2) IFC: Environmental, Health and Safety Guidelines (EHS Guidelines)⁴

The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in IFC's Performance Standard 3: Resource Efficiency and Pollution Prevention. IFC uses the EHS Guidelines as a technical source of information during project appraisal activities, as described in IFC's Environmental and Social Review Procedures Manual.

The EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC, and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. For IFC-financed projects, application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets with an appropriate timetable for achieving them. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to IFC, become project- or site-specific requirements.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be required to achieve whichever is more stringent. If less stringent levels or measures than those provided in the EHS Guidelines are appropriate in view of specific project circumstances, a full and detailed justification must be provided for any proposed alternatives through the environmental and social risks and impacts identification and assessment process. This justification must demonstrate that the choice for any alternate performance levels is consistent with the objectives of Performance Standard 3.

The General EHS Guidelines contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors, which contents are as summarized in Table 3.5.2-1. It should be used together with the relevant industry sector guideline(s): Table 3.5.2-2 lists the sector guidelines which are generally referred in the oil and gas sectors.

⁴ IFC Environmental, Health, and Safety Guidelines HP:
http://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/IFC+Sustainability/Sustainability+Framework/Environmental,+Health,+and+Safety+Guidelines/

Table 3.5.2-1 IFC General EHS Guidelines

<u>1. Environmental</u> 1.1 Air Emissions and Ambient Air Quality 1.2 Energy Conservation 1.3 Wastewater and Ambient Water Quality 1.4 Water Conservation 1.5 Hazardous Materials Management 1.6 Waste Management 1.7 Noise 1.8 Contaminated Land	<u>3. Community Health and Safety</u> 3.1 Water Quality and Availability 3.2 Structural Safety of Project Infrastructure 3.3 Life and Fire Safety (L&FS) 3.4 Traffic Safety 3.5 Transport of Hazardous Materials 3.6 Disease Prevention 3.7 Emergency Preparedness and Response
<u>2. Occupational Health and Safety</u> 2.1 General Facility Design and Operation 2.2 Communication and Training 2.3 Physical Hazards 2.4 Chemical Hazards 2.5 Biological Hazards 2.6 Radiological Hazards 2.7 Personal Protective Equipment (PPE) 2.8 Special Hazard Environments 2.9 Monitoring	<u>4. Construction and Decommissioning</u> 4.1 Environment 4.2 Occupational Health and Safety 4.3 Community Health and Safety

Table 3.5.2-2 IFC Industry Sector Guidelines

<u>Oil and Gas</u> ✓ Offshore Oil and Gas Development ✓ Onshore Oil and Gas Development ✓ Liquefied Natural Gas (LNG) Facilities
<u>Chemicals</u> ✓ Natural Gas Processing ✓ Petroleum Refining
<u>Infrastructure</u> ✓ Ports, Harbors and Terminals ✓ Shipping ✓ Gas Distribution Systems ✓ Crude Oil and Petroleum Product Terminals

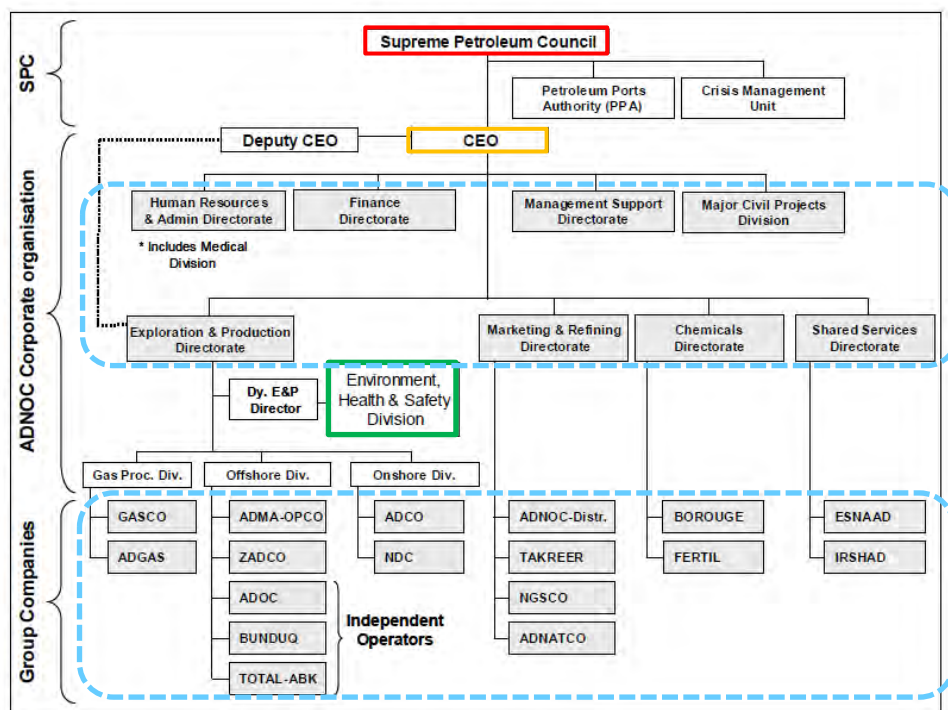
3.5.3. Regulatory Framework in Oil Producing Countries - Self-regulation System in ADNOC, UAE

In the Emirate of Abu Dhabi, which owes the majority of the UAE's hydrocarbon resources, Abu Dhabi National Oil Company (ADNOC) and its Group Companies aspire to achieve an HSE management system with high performance levels, which is exemplary in the Middle East countries. This section summarizes their outlines.

(1) Organaization, and Roles and Responsibilities for HSEMS

Abu Dhabi National Oil Company (ADNOC) was established in 1971 to operate in all areas of the oil and gas industry and since then has steadily broadened its activity in establishing companies and subsidiaries and creating an integrated oil and gas industry in the fields of exploration and production, support services, oil refining and gas processing, chemicals and petrochemicals, maritime transportation and refined products and distribution. The Supreme Petroleum Council (SPC), chaired by the UAE and Ruler of Abu Dhabi, was establishce in 1988 to formulate and oversee the implementation of Abu Dhabi prretroleum policies.

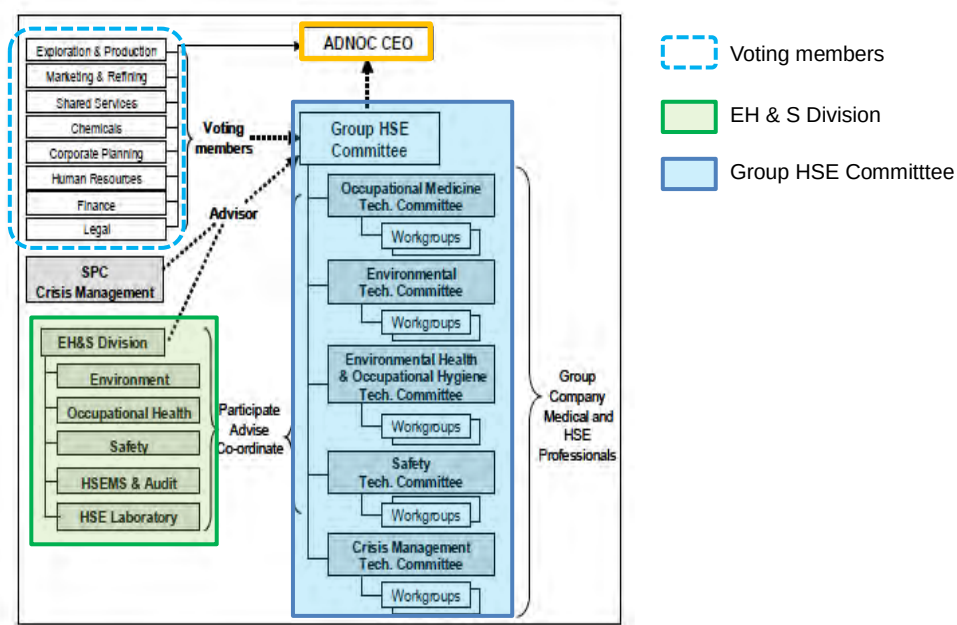
The organizational structure and interrelationship of ADNOC and its group companies are shown in Figure 3. 5.3-1.



Source: Code of Practice on HSE Administration Systems, ADNOC

Figure 3.5.3-1 Organizational Structure of ADNOC and its Group Companies

The Group HSE Committee (GHSEC), which consists of the HSE representatives of the Group Companies, has authorization for HSE management, in corporation with Environment, Health and Safety Division (HSE Div.) of ADNOC as shown in Figure 3.5.3-2.



Source: Code of Practice on HSE Administration Systems, ADNOC

Figure 3.5.3-2 ADNOC Group HSE Committee

1) ADNOC Group HSE Committee (GHSEC)

The ACNOC CEO appoints the GHSEC chairman, usually a Director of Group Company GM or AGM. The GHSEC consists of at least Division Management level representatives from each ADNOC Directorate.

The main role of the Group HSE Committee (GHSEC) is to advise the Chief Executive Officer on corporate HSE issues. This includes the role of reviewing and approving Health Safety and Environmental Impact Assessment (HSEIA). The committee also verifies that Group Companies' views were taken into account before new guidelines or standards are presented to the CEO for approval signature.

2) Environment, Health and Safety Division (EH&S Div.)

Environment, Health and Safety Division (EH&S Div.) has the combined functions of a 'conventional' corporate HSE advisor and also that of HSE regulator for the ADNOC Group.

The principal roles of the ADNOC EH&S Division are:

- Policy and strategy development: The Division develops these for approval by ADNOC senior management.
- Corporate governance: The Division develops HSE standards (e.g. Codes of Practice and Guidelines) for implementation through the ADNOC Group
- Corporate Assurance: The Division collects information on HSE performance from Group Companies and reports to ADNOC management who have the prime assurance responsibilities.
- Professional service: The Division provides training and assistance to Group Companies and contractors in HSE management. These services include HSE regulatory and management system guidance, risk management, laboratory services, crisis management coordination, occupational and environmental health services, HSE impact assessment and audit. The Division reports and collects performance data to/from third parties for benchmarking purposes.

ADNOC is the de facto regulatory body for HSE for the oil and gas industry in Abu Dhabi and EH&S Division, on behalf of ADNOC Group Companies, is single-point contact for professional liaison with relevant Federal and Abu Dhabi authorities in order to ensure that:

- Existing HSE Laws and Regulations are correctly interpreted.
- Emerging HSE Laws and Regulations are applicable to the industry.

(2) Framework of HSEMS

ADNOC is the de facto regulatory body for HSE for the oil and gas industry in Abu Dhabi and the Codes of Practice are a key component of ADNOC's regulatory responsibilities.

The ADNOC HSE Codes of Practice (COP) are the standards by which the Group manages HSE. They are ADNOC specific and refer to UAE Laws & Regulations, standards already in place in the Group Companies, and standards used by the international oil & gas industry.

1) Manual of Codes of Practice

The ADNOC 'Manual of Codes of Practice' contains:

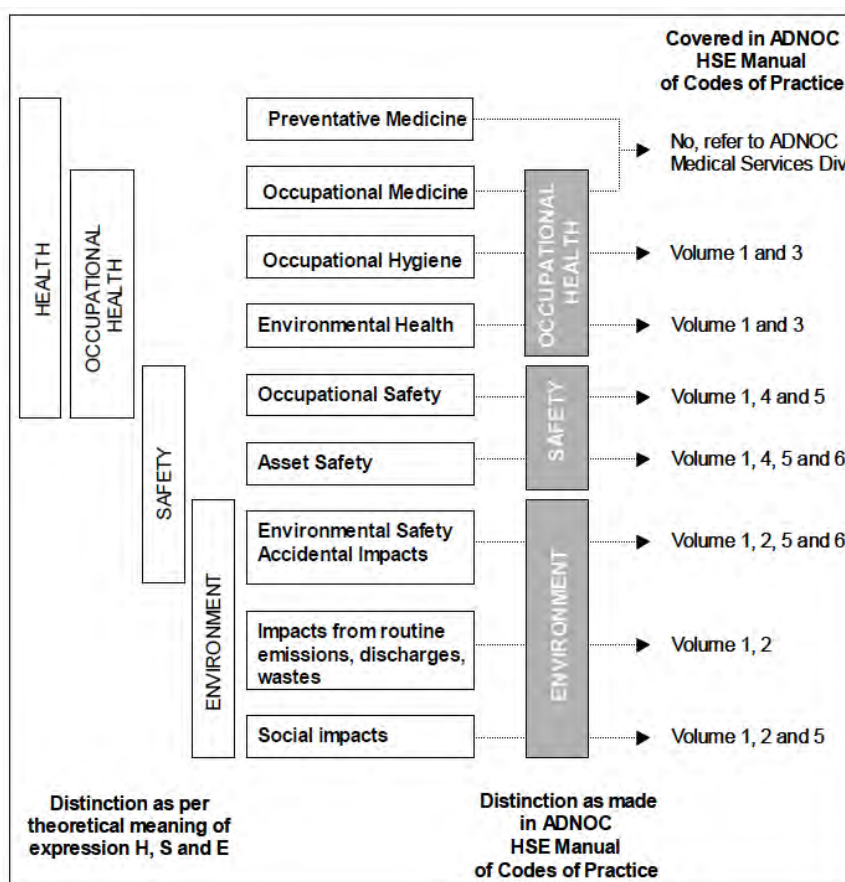
- **Documents named Codes of Practice (CoP)**, which are high-level 'standard setting' documents that set out a series of principles that must be incorporated in Group Company systems and procedures. CoPs are mandatory and ADNOC Group Companies must demonstrate that they meet the requirements of the CoPs either by showing that they have the necessary systems and procedures in place and/or by preparing additional systems and procedures to address identified 'gaps'. It is the responsibility of Group Companies to prepare

their own detailed systems and procedures as part of their HSE Management System.

- **Documents named Code of Practice Guidelines (CoP G/L)**, which provide ideas on how certain HSE issues may be approached. Unless stated otherwise, the CoP Guidelines are not mandatory, but it will be the responsibility of Group Companies to demonstrate that their chosen approach is at least as effective (in hazard/impact management and risk reduction terms) as the approach described in the relevant guideline.
- **Documents named Codes of Practice Best Practice Notes (CoP BPN)**, which provide detailed suggestions on how issues may be approached/managed. COP BPNs are not mandatory.

2) Boundaries between Health, Safety and Environment management

The actual practices of Health, Safety and Environment managements have a close relationship with each other and overlap. ADNOC defines various aspects of HSE activities and clarify the standards/guidelines to be applied, organizational responsibilities, and performance monitoring of each division, as summarized in Figure 3.5.3-3.

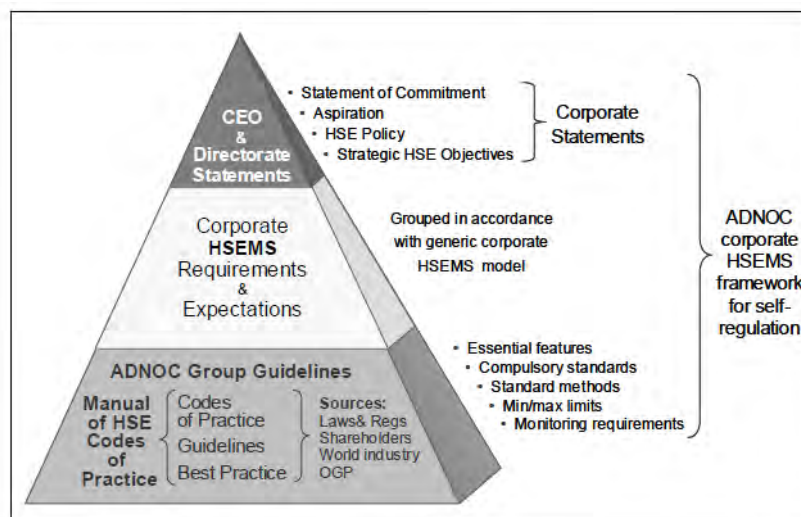


Source: Code of Practice on HSE Administration Systems, ADNOC

Figure 3.5.3-3 Boundaries between Health, Safety and Environment Management

3) HSE Management Structure

The HSE management system in ADNOC consists of a three-layered structure as shown in Figure 3.5.3-4; Corporate statements of Commitment and HSE Policy by top management, Generic Corporate HSEMS Model, and Group Guidelines.



Source: Code of Practice on HSE Administration Systems, ADNOC

Figure 3.5.3-4 Framework for ADNOC Corporate HSE Documentation

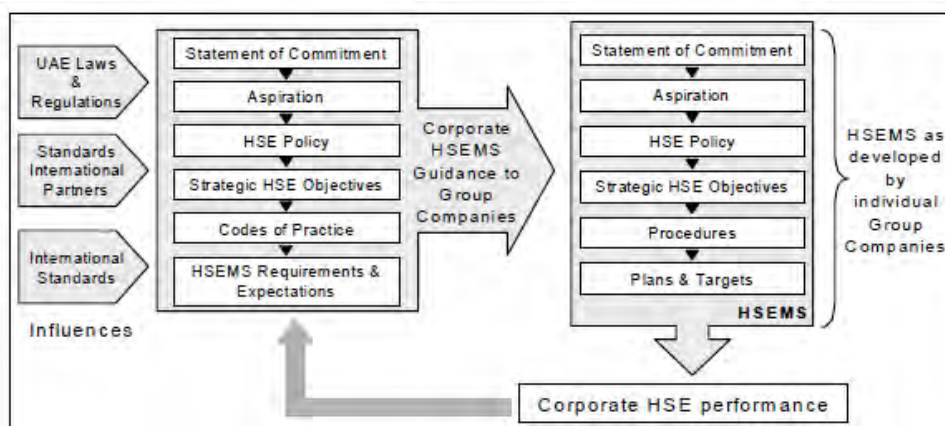
ADNOC has adopted a generic HSEMS model, which is compatible with the OGP (Oil and Gas Producers Association) as described in Subsection 3.5.1(1), ISO and OHSAS Standards, with reference to Figure 3.5.3-5.



Source: Code of Practice on HSE Administration Systems, ADNOC

Figure 3.5.3-5 ADNOC HSEMS Structure

Group Companies are not required to implement an HSEMS, which is identified to the ADNOC generic model. They may develop their own HSEMS framework to suit their particular needs of ADNOC 'Requirements' and 'Expectations'. They will translate the Corporate Guidance into the level of details as required to conduct their own specific business, within the boundaries and performance parameters defined by ADNOC. Figure 3.5.3-6 demonstrates how the ADNOC HSEMS guidance and the Group Company HSEMS are linked.



Source: Code of Practice on HSE Administration Systems, ADNOC

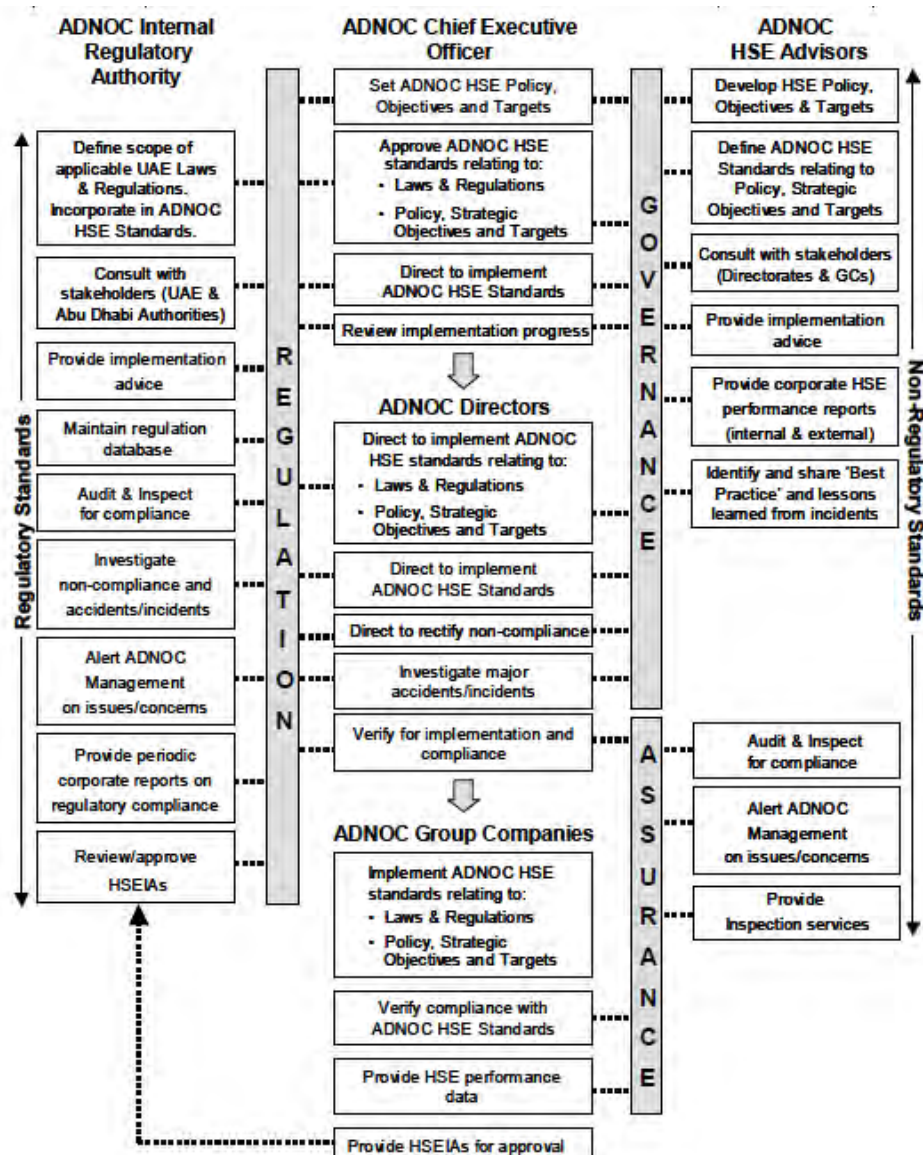
Figure 3.5.3-6 Relationship between ADNOC HSEMS Guidance and Group Company HSEMS

4) Regulation, Governance and Assurance of HSE

ADNOC HSEMS has three essential functions, i.e. regulation, governance and assurance;

- HSE regulation: to establish Self -regulatory Framework
- HSE governance: to set an apply HSE standards and performance parameters
- HSE assurance : to assure and monitor the compliance

The framework for HSE self-regulation, governance and assurance in ADNOC is illustrated in Figure 3.5.3-7.



Source: Code of Practice on HSE Administration Systems, ADNOC

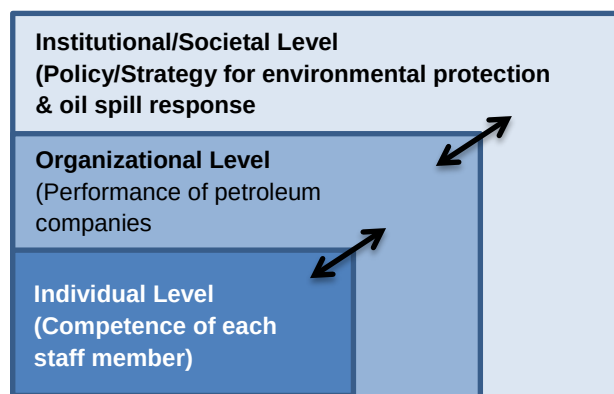
Figure 3.5.3-7 Framework for HSE Self-regulation, Governance and Assurance in ADNOC

3.6. Capacity of the Relevant Organizations for Environmental Management and Oil Spill Response

3.6.1. Outline of Capacity Assessment

Capacity assessment of the relevant organizations is one of the components to review and analyze the current conditions of marine and coastal environmental management and oil spill response in the project. The capacity assessment aims to identify issues that cause unsatisfying performance of the environmental management and oil spill response and to examine the contents of capacity development to strengthen the environmental management and oil spill response in the petroleum

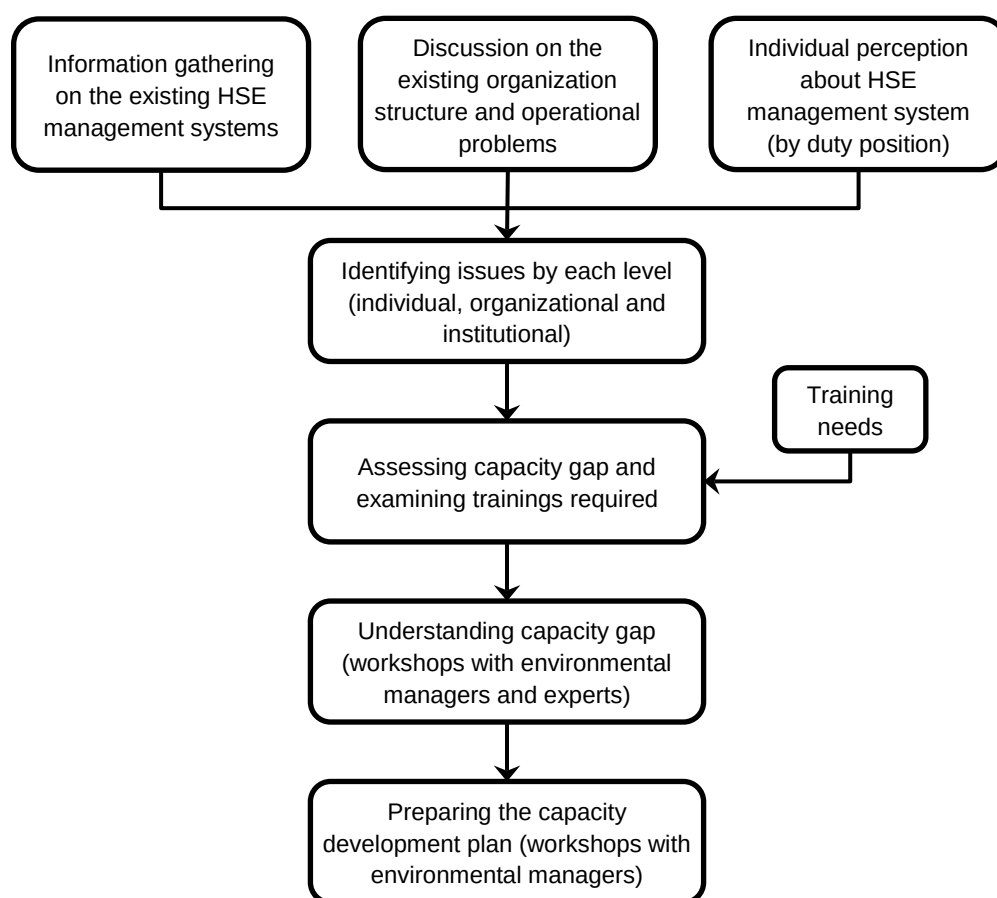
industry in the country. According to the United Nations Development Programme (UNDP), the capacity development is defined as “the process by which individuals, organizations, institutions, and societies develop “abilities” (individually and collectively) to perform functions, solve problems, and set and achieve objectives. The process can be classified into three layers, individual, organizational, and institutional or societal levels, and those three layers are mutually related (see Figure 3.6.1-1.).



Source: Prepared by the study team based on the JICA Report towards Capacity Development (CD) of Developing Countries based on their Ownership”

Figure 3.6.1-1 Three Layers of Capacity Development

The basic contents of capacity development is to improve competence of staff working for HSE in the HSE-MOP and petroleum companies at the individual level, to improve the petroleum companies’ performance of HSE management at the second level, and to formulate a policy or strategy to promote the environmental protection in the petroleum industry and raise the physical and institutional capacity for oil spill response at the third level. The study team conducted the capacity assessment with the relevant organizations, following the methodology shown in Figure 3.6.1-2. In Phase 1, the study team gathered information related to the existing HSE management systems and had meetings with national companies and its subsidiaries in Tehran and the pilot areas. The study team also distributed questionnaires to the HSE-MOP and the relevant companies to evaluate the individual perception about their HSE management systems, operation level of the systems, capacity to be improved and training needs. Based on the information collected, the study team assessed capacity gap and examined trainings required to strengthen the capacity of environmental management and oil spill response. However, a part of the information that is necessary for the capacity assessment was not available due to an information security reason within the companies. In Phase 2, the study team held workshops for capacity assessment and development and discussed the capacity gap with the environmental managers and experts of the HSE-MOP and the petroleum companies.



Source: Study team

Figure 3.6.1-2 Procedure of Capacity Assessment and Development

3.6.2. Result of Capacity Assessment

(1) Individual Level

Ten years have passed since the concept of HSE management was introduced in Iran. The relevant organizations have been providing training programs such as HSE management and risk assessment and the staff members in charge of environmental protection have the basic knowledge about the management system in the petroleum industry. However, opportunities for practice, such as how to apply the theoretical methodology to actual situations in their fields, are very limited. Besides, economic sanctions cause less opportunities for access to the latest information about advanced technologies for development, production and environmental management. The environmental managers and experts in charge of environmental protection in the HSE-MOP and the HSE department of petroleum companies are responsible for supervising the environmental protection activities and encouraging their company to implement the environmental protection

required. To fulfill the responsibility, they should have the systematic knowledge of environmental protection in the petroleum industry and oil spill response. However, the significant capacity gaps were observed for the subjects shown in table 3.6.2-1 and the gaps should be filled through trainings.

Table 3.6.2-1 Capacity Gap and Training Required at Individual Level

Subject	Capacity gap	Training required
Oil and gas development and integrated HSE management system	• Less experience of applying the risk assessment theory to the actual local conditions • Less experience of operating the integrated HSE management system	• Integration of plant operations and HSE risk management • Case study: Abu Dhabi National Oil Company (ADNOC)
Environmental survey and monitoring	• No information of sea water quality and sediment varying across the ages • No periodical reporting system for sampling and analysis of sea water quality and sediment • No experience of evaluation of sea water and sediment quality	• How to take samples (selection of sampling points, sampling method, etc.) • How to compile the sampling data • How to analyze the sampling data • How to report the result
Air pollution control	• Lack of time-series data • Lack of awareness about collective actions to reduce the air pollution in the region instead of individual activity • Limited access to technology information • Lack of information for flaring gas reduction measures (technology and operation)	• Indices to be monitored and measuring methodology • How to enhance the collective actions in the region, such as a total emission control system • How to set the target values of total emission control • How to improve the operation towards flaring gas reduction
Water pollution control	• Lack of awareness about handling water pollution in excess of the effluent standards • Lack of information related to strict enforcement of the effluent standards	• Requirements to improve the existing treatment facilities • Requirements to reduce the pollutants in the production process
EIA	• Weak enforcement in the petroleum industry • Insufficient survey and analysis • No consideration of existing accumulated environmental pollution	• Outline of EIA required for the petroleum industry • How to evaluate the EIA reports • Requirements for project owners (evaluation points) • How to utilize the EIA report for supervision of operations
Oil spill model	• No experience in using simulation model for risk assessment, prediction of dispersion of spilled oil and training for emergency preparedness	• How to operate the simulation model • How to utilize the simulation result for emergency preparedness and response
Waste management	• Lack of information related to how to treat the drill cuttings	• Understanding about the problem of drill cuttings discharge to the sea • How to treat the drill cuttings

Source: Study team

(2) Organizational Level

1) MOP

The primary responsibility of the HSE-MOP is to monitor and evaluate the petroleum projects from the HSE perspective. That is why dependence of the HSE department from other divisions is desirable. Otherwise, the organizational structure may cause less attention to the HSE components of the projects and a conflict between environmental protection and project implementation. However, the HSE-MOP falls under the Deputy of Engineering and Internal Construction in the current organizational structure of the MOP.

A vacancy in the Environmental Planning and Control Unit is another serious problem of the HSE-MOP. A change in the organizational structure of the HSE-MOP was expected to contribute to strengthening the capacity of the unit. However, some posts are still vacant.

A sense of cooperation and coordination with other sections such as industrial health, safety firefighting and project management, is not strong. For example, environmental monitoring records are useful for those sections to evaluate the ongoing projects from the industrial health and safety perspective. However, the information sharing has not been realized. The IPS has the contents of environmental protection and control. However, the Environmental Protection Section has not been involved in the revision and modification.

According to the job description of the HSE-MOP, the section manager (deputy level) has the responsibility to formulate a national environmental protection plan and set a target. This means that the environmental managers and experts do not work for planning and target setting without an instruction from the section manager. The job description may cause insufficient fulfillment of the responsibility.

The Environmental Protection Section does not have a training plan for the officials. The qualification of the official appointed to the Environmental Planning and Control Unit is a certain amount of work experience in the petroleum industry and academic degree of environment. This may affect the recognition that capacity building depends on the discretions of the individuals. They recognize that the daily work experiences are the opportunities for the capacity building. Therefore, this allows them to accumulate the knowledge and experiences only in the individuals.

The Environmental Protection Section supervises the petroleum companies and evaluates their performance by means of periodical site visits, monitoring reports, internal auditing and response to emergencies. Although the environmental monitoring indices depend on the production process, a unit of common indices used in the monitoring reports varies from one national company to another. The section thinks that the monitoring reports are not authentic because the monitoring method is not well designed. However, the section has not taken measures to improve the monitoring system. In addition, the subsidiaries have some projects that introduce the advanced technology related to the environmental protection, such as water flooding. However, the

Environmental Planning and Control Unit does not get to know about such projects. This may be caused by the situation that the attention about the environmental protection is mainly paid to the control at emission or discharge sources.

As discussed in Section 3.1.1, the state government promotes the privatization of the state-owned companies. Some petroleum companies have been privatized in line with the government policy. However, the HSE-MOP does not have a clear vision to regulate the activities of private companies.

2) National Companies

Each company group has its own reporting format. Such designated reporting format is very useful for the personnel in charge of environmental monitoring. However, the contents place an emphasis on abnormal incident finding or satisfaction of the standard values and do not include year-to-year changes in the values and examination of factors. It could cause weakening the capacity to analyze the monitoring results and the attitudes towards providing suggestions for improvement of environmental conditions. It may also help disguising a root cause of environmental pollution.

Lack of inter-departmental cooperation and coordination is also found in the national companies as it was identified in the MOP. Even though one offshore platform or onshore plant has a good practice to reduce the environmental pollution or operate the equipment efficiently, the good practice is not shared with another platform or plant operating in the same area. In another case, the HSE perspective was not considered in the process of project design. The national companies should initiate the inter-departmental cooperation and coordination and sharing of the good practices.

3) Subsidiaries

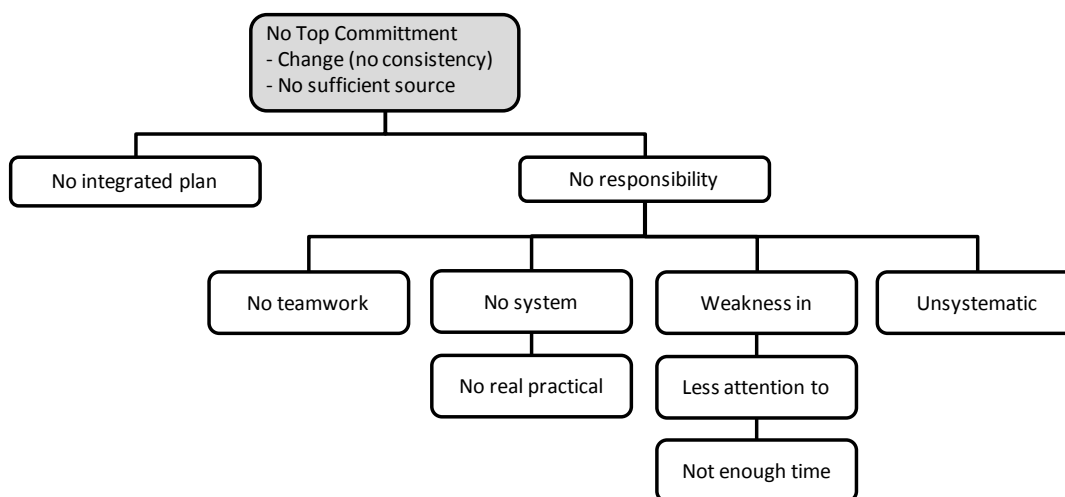
Problems that are similar to the national companies can be found in the subsidiaries. In addition, the subsidiaries are very active in registration of the integrated management systems (IMS) that consists of the ISO quality and environmental management systems and OHSAS occupational health and safety management systems. However, registering the IMS and preparing the management documents become a goal. It has not led to the practical HSE management yet.

The subsidiaries is responsible for only the environmental protection in their jurisdiction and do not have a system or culture to consider cumulative impact on the entire zone environment.

(3) Institutional Level

Existing problems that the petroleum industry faces were discussed in the workshops on strengthening the HSE management systems. Figure 3.6.2-1 shows the result of the problem analysis. The environmental experts have common recognition that the core problem of the HSE management systems is a weak commitment to the environmental protection by the top

management of the organization. They perceive that the weak commitment causes the lack of a policy and strategy and less awareness about responsibility for the environmental protection. This leads to less consideration to HSE, having the management documents but no execution, lack of teamwork and lack of systematic training courses.



Source: Study team

Figure 3.6.2-1 Result of Problem Analysis for the Petroleum Industry

As for the top commitment, the most serious problem is that the HSE-MOP does not have a strategy to promote the environmental protection and oil spill preparedness in the petroleum industry.

The Special Environmental Committee chaired by the Deputy of Environment Protection, the HSE-MOP, is supposed to discuss the matters of environmental protection in the petroleum industry. However, the committee has not functioned well.

Another serious issue is that expanding the project scale, such as increase in production, is more likely to be prioritized, while the environmental protection is considered less serious. The environmental experts feel that a policy consistency lacks because the policy changes with replacement of the top management. Sufficient resources are not allocated to activities related to environmental protection. For example, when the project components are reviewed to reduce the total cost, the environmental protection is likely to be eliminated from the project components. NPC decided that all the staff including the senior management should participate in the training program of environmental protection. However, it has not been realized yet. The weak top commitment leads to lack of the comprehensive plan and ambiguity over where the responsibility lies. This is not limited to NPC but the awareness about the environmental protection or the concept of the environmental management has not well penetrated the personnel in the petroleum industry, especially operating companies. Currently, the environmental protection is regarded as the

responsibility of environmental protection unit even though the primary responsibility of environmental protection should be taken by the operational units.

3.7. Issues related to Institutional Framework

This section summarizes the current issues related to the institutional framework, which was identified through the study. Table 3.7-1 shows the issues and present situations. Specific plans to address each issue are stated in Subsection 7.3.1 to 7.3.3 in detail.

Table 3.7-1 Issues and Present Situations of the Institutional Framework

Issue	Present Situation
Lack of strategy and plan	• Not reviewing the national HSE policy. • Not formulating a strategy to execute the policy
Inappropriate HSE implementation structure	• Not independent from the technical division in the MOP • Weak administrative structure of the Environmental Protection Section of the HSE-MOP • Not regarding the HSE implementation as the responsibility of operational units. • Not developing the HSE culture well • Not using the integrated environmental monitoring systems and not controlled by strong authority
Insufficient resource allocation to environmental management	• Paying less attention to the environmental management in the petroleum industry, compared to technical sections such as engineering and production control • Not allocating the sufficient budget to fulfill the responsibility of environmental management
Lack of coordination and collaboration	• Not fulfilling the responsibility of the zone management company • Not considering close collaboration between the HSE department and other departments • Not promoting coordination of the environmental management activities among the companies operating in one industrial zone
Weak implementation structure of EIA	• Not defining clear role of each organization • Lack of a step for scoping in the EIA Process • Not formulating the technical guidelines for preparation of EIA reports • Not analyzing the cumulative effect • Lack of information disclosure and public consultation

Source: Study team

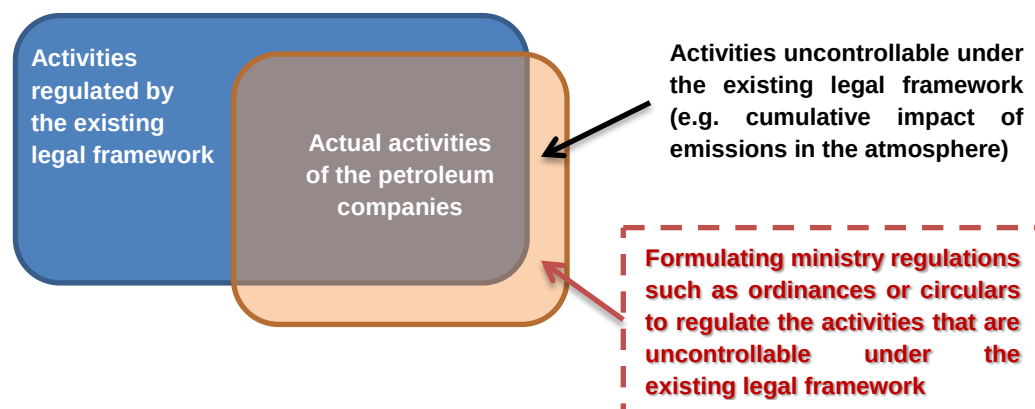
The following describes the detail of each issue related to the institutional framework.

3.7.1. Lack of Strategy and Plan

As mentioned above, the MOP has not reviewed the national HSE policy. The HSE-MOP cannot assess to what extent the policy has been realized because a strategy had not been formulated to

realize the policy. Therefore, the MOP should review the HSE policy and immediately examine objectives to be achieved in the petroleum industry, when and how, and the methodology to assess the performance. Based on the examination, the HSE-MOP should make an implementation plan of the policy and disseminate it to the petroleum companies.

The basic legal framework for the environmental protection is controlled by the DOE and the petroleum companies follow the environmental laws, regulations and standards. However, more restrict standards and regulations would be required to control the environmental management activities of the petroleum industry because the current legal framework cannot always function, for example on protecting from cumulative impact, as shown in Figure 3.7.1-1. The HSE-MOP should therefore have a plan or strategy to address such issues.



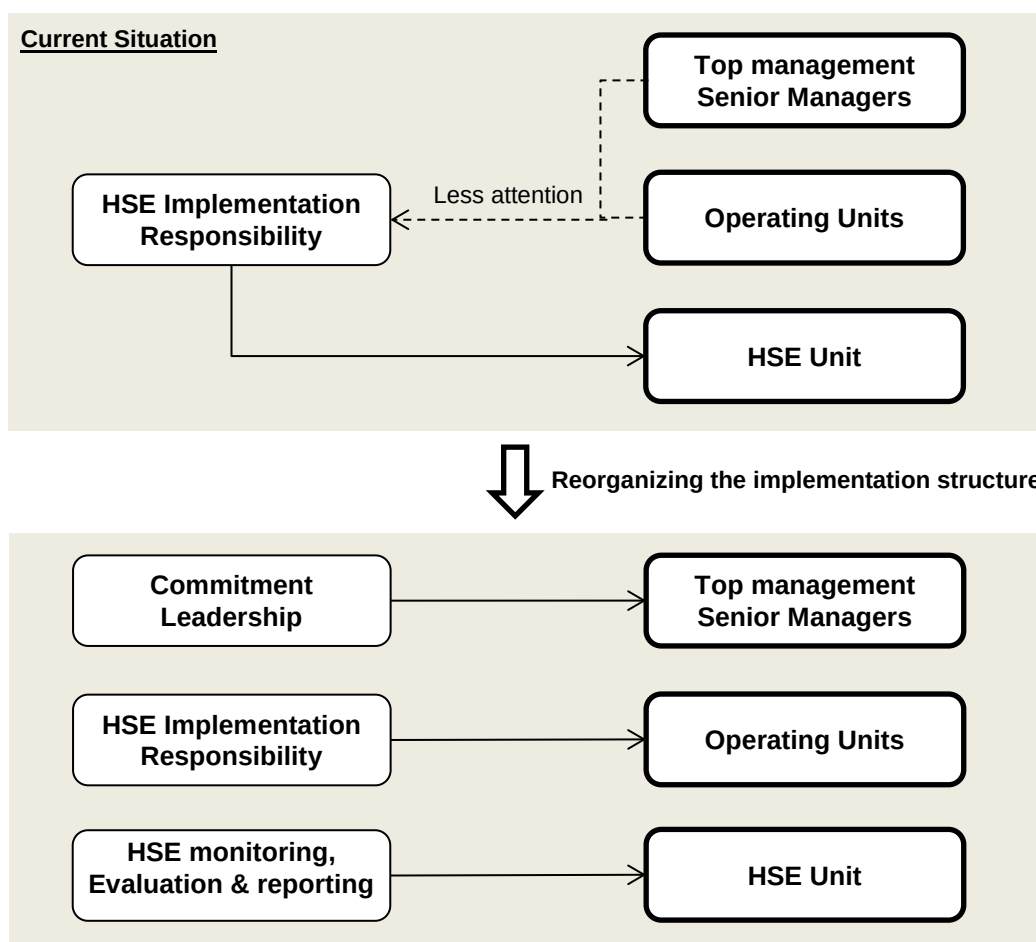
Source: Study team

Figure 3.7.1-1 Situation that Cannot be addressed by the Existing Legal Framework

3.7.2. Inappropriate HSE Implementation Structure

(1) Responsibility of HSE Implementation

As discussed in the previous section, executing the environmental protection is regarded as the responsibility of environmental protection unit and has been given less attention to. The environmental protection cannot be separated from the operational activities because the environmental pollutants are derived from the plant operations and the operation units are engaged in the control. The HSE-MOP should therefore encourage the petroleum companies to rationalize the HSE implementation structure as shown in Figure 3.7.2-1.

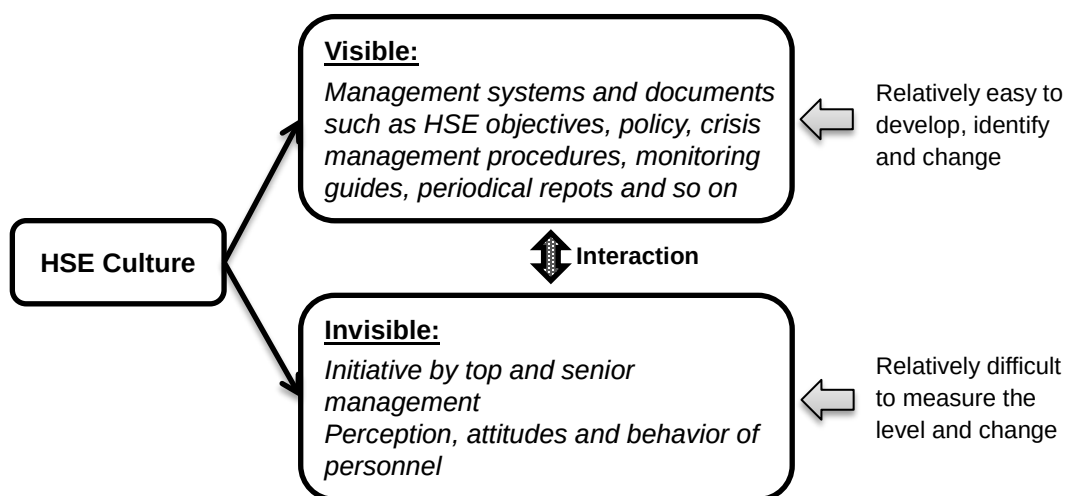


Source: Study team

Figure 3.7.2-1 Reorganization of HSE Implementation Responsibility

(2) HSE Culture

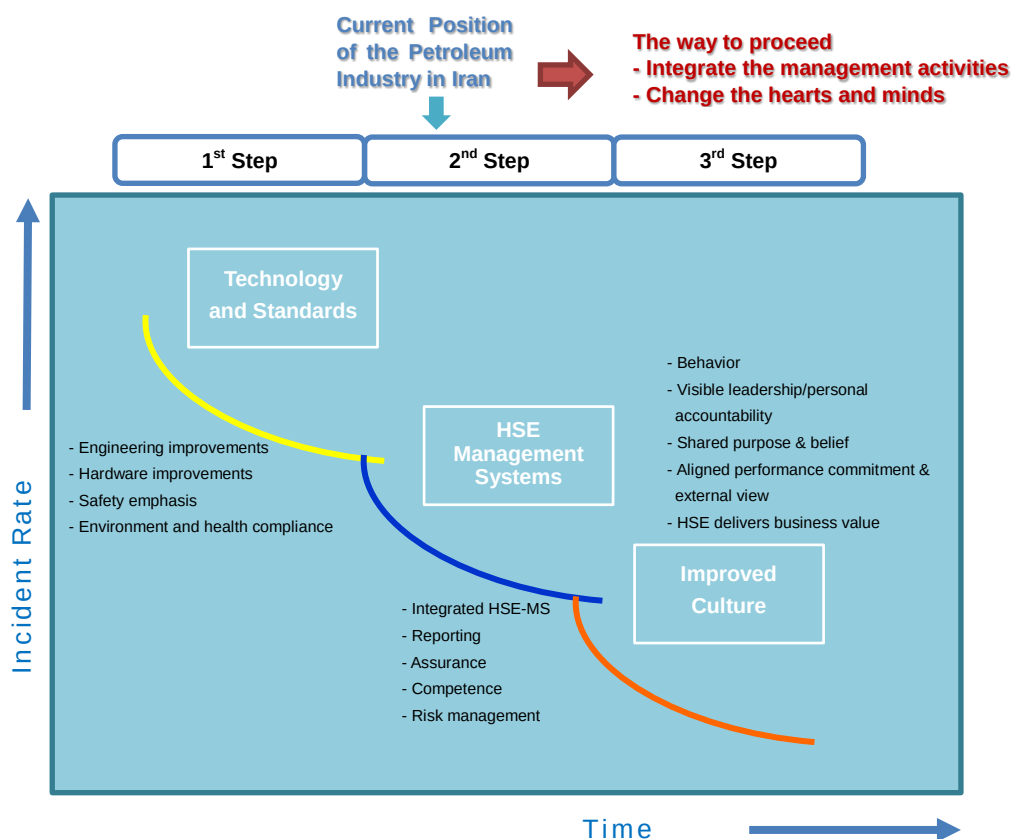
To make the HSE management systems function, the HSE culture should be developed in each organization. The HSE culture consists of two parts: visible and invisible. The visible part includes the management systems and documents such as HSE objectives, policy, crisis management procedures, monitoring guides, periodical reports, auditing and so on. This visible part is relatively easy to take actions. The other part of the HSE culture, invisible factors, includes initiative by the top management, employees' perception, attitudes and behavior that are relatively difficult to measure the level of achievement and change for the better. Figure 3.7.2-2 shows a concept of HSE culture.



Source: Study team

Figure 3.7.2-2 HSE Culture

It is said that the HSE performance can be achieved over time as shown in Figure 3.7.2-3. In the beginning of HSE culture development, applicable technologies and standards are introduced. Some time later, the technologies and standards are reviewed and improved. The technologies and standards can reduce the incident rate at certain level. However, to accelerate the reduction in the rate, the operational control should be systemized as management systems. The second step of the HSE culture development is introducing HSE management systems. The management systems define the operational procedures, risk assessment and management, environmental protection, communication, monitoring and evaluation, auditing and so on. The management systems can contribute to the systematic operation and control of the business activities. Information to evaluate or audit performance can be accumulated over time. The evaluation/auditing result will note the nature of problems in the management systems and suggest remedial measures to overcome the problems. The system itself can be improved through the evaluation/auditing procedures. However, the existence of the management systems do not guarantee realization of the HSE objectives, compliance with the relevant legal framework, environmental protection, and quality control. The HSE management systems should accompany with HSE behavior of the management and staff. The final step of the HSE culture development is a change in hearts and minds of the management and staff by executing the management systems.



Source: Prepared by the Study team based on the contents of “Minds and Hearts”, Energy Institute

Figure 3.7.2-3 Development Steps of the HSE Culture

The petroleum companies in Iran has developed their own HSE management systems and has been operating it. However, the management systems do not function well due to less inter-departmental coordination and collaboration and less attention to the environmental protection as well as lack of philosophy of continual improvement. The HSE-MOP should encourage the petroleum companies to develop and improve the HSE culture.

(3) Environmental Monitoring

The Environmental Planning and Control Unit of HSE-MOP reviews the periodical reports that the national companies submit. However, the units of monitoring indices used in the periodical reports vary one company to another and the Unit thinks that authenticity of the monitoring records shown in the reports is not high. The HSE-MOP should therefore designate what indices should be monitored and what measuring method should be followed.

3.7.3. Insufficient Resource Allocation to Environmental Protection

As discussed in the result of capacity assessment, less attention has been paid to the environmental protection in the petroleum industry. When the project components are reviewed due to a financial constraint, the first one that is excluded from the project is usually the environmental protection component. This may be caused by misunderstanding on financial impact of the environmental protection. The HSE-MOP should raise awareness about the financial impact of the environmental protection and encourage the petroleum companies to allocate financial source to physical development of the environmental protection.

Another aspect of resource allocation is deployment of human resources. For example, the EIA senior expert is a vacancy in the organizational structure of the HSE-MOP. The HSE-MOP is in a state of lack of function to fulfill the responsibility for EIA as the authority to control the petroleum industry. Majority of the subsidiaries assign only a few environmental experts. Those experts are demanded to be responsible for the whole EIA reports. However, EIA in most of cases cover not only a few subjects but various topics including air pollution, water pollution, waste management, soil contamination, flora and fauna, groundwater and geology, morphology, hydrology, culture, resettlement, gender, etc. It is understood draft EIA reports are prepared by contracted consultants, yet, members of the HSE-MOP and the petroleum companies are not still released from the responsibility. Therefore, assignment of adequate personnel for EIA is essential. Beside increase of personnel capacity through various form of training, utilization of specific institution for second party's review of concerning EIA report may be effective. For example, the Research Institute of Petroleum Industry (RIPI) may advise on water quality modeling, the PMO may supervise oil spill simulation and contingency plans, and the Iran Meteorological Organization (IMO) may review the results of atmospheric dispersion modeling. Such effective utilization of specific institutions will fill up the deficiency in human capacity and, thereof, improve the quality of EIA system.

3.7.4. Lack of Coordination and Collaboration

(1) Integrated HSE Management Systems

Occupational health, safety and environmental protection are not separated single components of the management systems but are inseparably connected with each activity. The HSE-MOP and the petroleum companies understand that operating the integrated management systems is necessary. Each company promotes registration in the integrated management systems. However, the system registration and preparation of the management documents itself became the goal of the activity. There is no common recognition about what the integrated management of the occupational health, safety and environmental protection mean. The HSE-MOP should examine what the integrated management systems can be defined as. The definition or concept of the integrated systems should

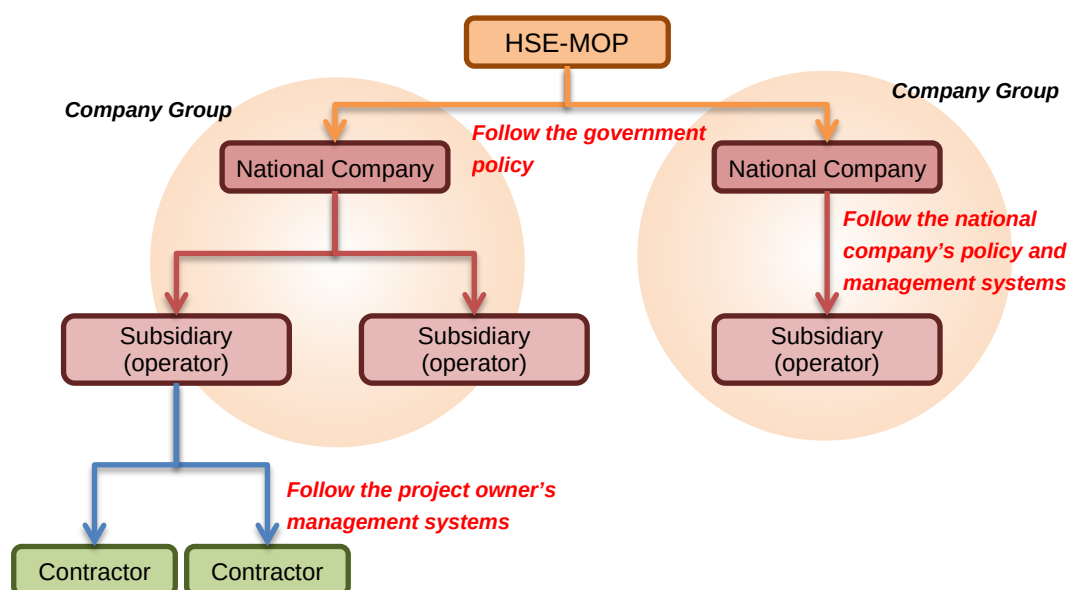
penetrate the petroleum companies. In addition to the definition, good practices of the integrated management system implementation should be shared with the HSE-MOP and the petroleum companies.

To properly implement the environmental protection, the operating companies should accommodate the results of EIA into engineering design and operation and maintenance. In this regard, what is very important for realization of the environmental protection is close collaboration between the HSE department and other departments. For example, oil fields in the Khark Island area recently decrease in the crude oil production and the pressure of oil layer is maintained by sea water injection. The volume of the produced water increases in proportion to the sea water injection. However, the capacity of the produced water treatment facility has not been expanded. As a result, a portion of wastewater is discharged to the sea without treatment. To change the wastewater treatment procedures, inter-departmental works are necessary. The HSE department should provide other departments with the information about risks of occupational health, safety and environmental protection and discuss how to manage the risks identified. Technical departments should accommodate the discussion results to the project design and implementation.

Such coordination is also of importance in reflection of environmental and operational consideration in the facility design capacity and its production management.

(2) Coordination and Collaboration

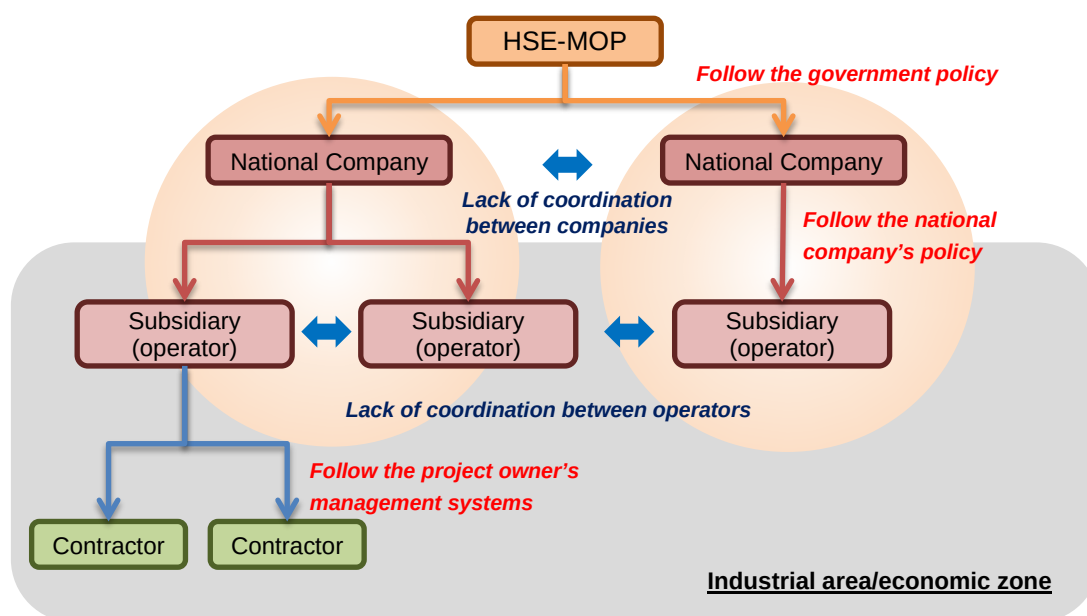
Cross- organizational coordination and collaboration is also an issue to be addressed. Some petrochemical companies operating in PETZONE, Mahshahr, were previously under supervision of NPC and PSEZ coordinated their environmental protection activities in the zone. However, the privatization process would affect the cooperative structure because the private sector is not subject to rules and regulations governing the state companies. Figure 3.7.4-1 shows the typical structure of the HSE-MOP and petroleum companies for coordination of HSE management activities. The subsidiaries follow the national company's policy and the HSE management systems, and also have to make contractor obey the HSE management systems. However, if the company group is different, coordination between the different company groups might be difficult because there are no rules for such cross-organizational coordination and no initiative by the zone management company. In particular, the relation of the company group is very complicated in Assaluyeh. PSEEZ organizing the activities in the whole area and Pars Oil and Gas Company (POGC) possessing the gas refineries fall under NIOC. South Pars Gas Company (SPGC) operating the gas refineries is the subsidiary of NIGC. The companies operating in the petrochemical zone is the subsidiaries of NPC and the privatized companies. To coordinate the HSE management activities among the companies operating in one industrial zone, the strong authority by the zone management company is therefore required. In addition, the HSE-MOP should examine how to establish the coordination system among the companies.



Source: Study team

Figure 3.7.4-1 Typical Management Structure of Group Companies

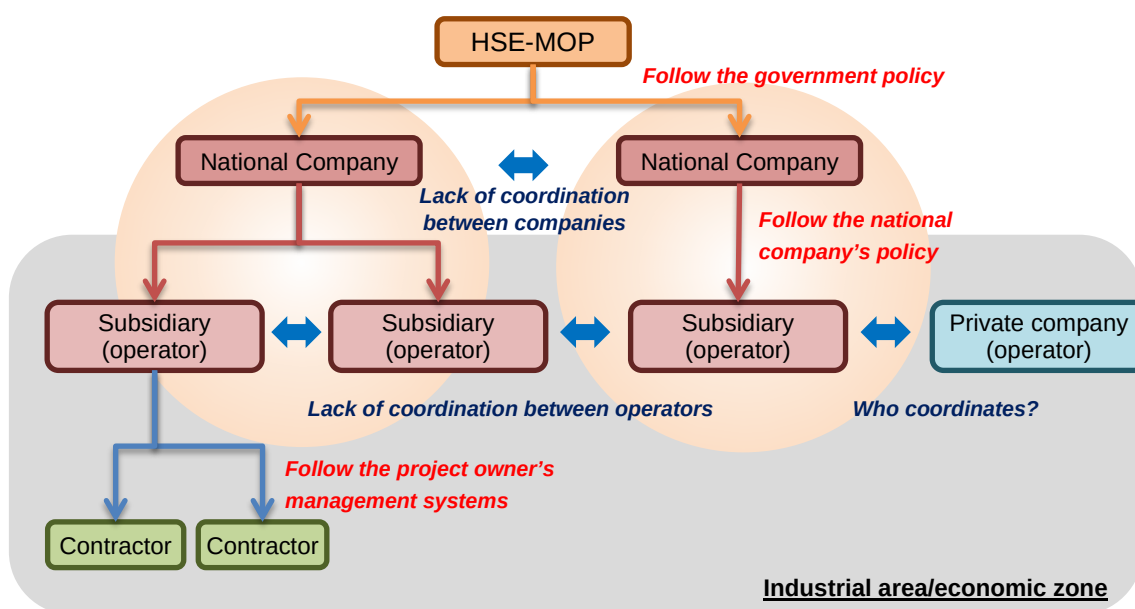
Figure 3.7.4-2 shows the relation of the HSE-MOP and petroleum companies for coordination of HSE management activities.



Source: Study team

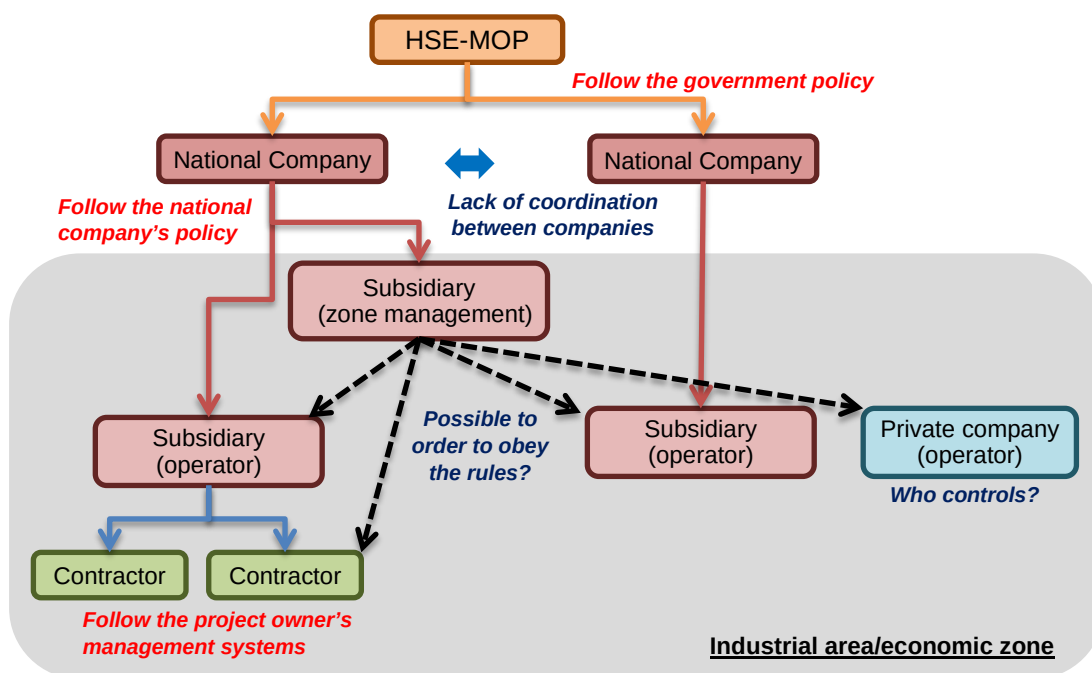
Figure 3.7.4-2 Coordination between National Companies and Subsidiaries

Figure 3.7.4-3 and Figure 3.7.4-4 show consideration of private companies into the HSE management systems and control by a zone management company respectively. The tenants could be not only the subsidiary (public companies) but also private/privatized companies. Public companies also could be privatized in the future, based on the privatization policy of the Iranian Government. Private operators have their own management systems and do not belong to the national company's group. Companies in charge of zone operation and management do not have a real authority to make tenants obey the environmental regulations and standards in the industrial zone/area. The HSE-MOP should examine what management structure will function in those cases. To enforce the proper environmental management and emergency oil spill preparedness, the legal framework should be reviewed and introduction of new regulations such as environmental agreement between public authority and oil and gas industry should be considered.



Source: Study team

Figure 3.7.4-3 Inclusion of Private Company into the HSE Management Systems



Source: Study team

Figure 3.7.4-4 Control by Zone Management

3.7.5. Weak Implementation Structure of EIA

(1) Unclear Role of Each Organization

Though the executing agency depends on the size of projects, majority of EIA studies have been undertaken by the subsidiaries because they are the developers and operators of petroleum industries. However, as supervisory and superior organization, the role of the MOP is to supervise EIA studies undertaken the subsidiaries. The project team observed the function of the MOP, national companies such as NPC, NIOC, NIGC and NIORDC and the subsidiaries have not been clearly established.

(2) EIA Process (Scoping)

The Iranian EIA process itself is defined by the attachment of minutes of meeting of the Environmental Protection Supreme Council dated 23 December 1997 and it is understood all proponents shall follow the flow as designated by the DOE. Although some EIA of the MOP may include this process, there is a lack of an important subject in Iranian EIA system. Scoping is the process to define those environmental topics that should be assessed as part of the environmental impact assessment, the methods to be used and the geographical scope of the environmental impact assessment, and scoping is an important facet of the environmental impact assessment process. In

some countries, the results of scoping may become the subject in public consultation meetings for determination of the following surveys and EIA process. This subject ultimately attributes to the relevant regulations and guidelines of the DOE, however, the MOP may recognize the importance of scoping.

(3) Lack of Technical Guidelines for Preparation of EIA Reports

The officials of the HSE-MOP declared that the MOP maintains good relationship with the DOE and EIA reports are prepared in accordance with instructions by the DOE. The DOE published EIA guidelines covering oil and gas development and refinery sectors. Yet, less penetration of such guidelines among the officials of the HSE-MOP is observed. Furthermore, the MOP and subsidiaries do not equip any practical guidelines for preparation of EIA reports. For improving and standardizing the quality of EIA, preparation of such technical guidelines are essential. For instance, such guidelines shall cover the standard method for forecast of the impact of air pollution through application of Gaussian Plume model to atmospheric dispersion.

(4) Lack of Cumulative Effect Analysis

A common issue associated with EIA is lack of analysis of cumulative effects from the existing facilities and other development projects. The future impact in the environment is forecasted based on solely the subject development projects and the total environmental impacts as the subject area is not considered. Consequently, the environmental impacts after accomplishment of the subject and other projects are greater than the predicted level in EIA reports. Similarly cumulative effects of the accumulated impacts shall be also taken into account in EIA.

As discussed in the later section of this report, the study team deems importance of introduction of the concept of total emission control in consideration of cumulative effects.

(5) Information Disclosure and Public Consultation

Both EIA and SEA are merely tools for keeping the transparency of decision making between the project proponent and stakeholders. Such stakeholders may include relevant ministries, provincial government and research institutions, but key stakeholders should not exclude such players as local residents and NGOs. For this purpose, holding public consultation meetings at the stage of scoping and drafting EIA report are obligatory in many countries. Such public view points are essential for project proponent self-motivation for complying the relevant regulations and standards.

4. Current Situation of Pilot Sites

4.1. Mahshahr

4.1.1. Outline of Mahshahr Industrial Zone

(1) Petrochemical Special Economic Zone (PETZONE)

The Petrochemical Special Economic Zone (PETZONE) is located on the southwest of Mahshahr city, Khuzestan province near the northern coast of Persian Gulf. The zone covers an area of 2,600 hectares. The zone is linked to international waterways via Bandar Imam Khomeini Port. The main reason behind establishing the zone was to bring industrial development especially in the petrochemical sector and its downstream industries in the region.

The zone locates in a marsh area, where is characterized as wider tidal flat area (see Figure 4.1.1-1). Part of the bay area is specified by Department of Environment (DOE) as restricted environmental protection zone on which are existed mangroves, wild sea animals and birds.

Mahshahr Terminal is located to east 8 km of PETZONE is owned by Abadan Refinery under the supervision of NIORDC.



Source: Google Earth

Figure 4.1.1-1 PETZONE

PETZONE is divided into five sites consisting of various factories as in Table 4.1.1-1. The layout of the complex is shown in Figure 4.1.1-2.

Table 4.1.1-1 Sites and Factories in Complex

	Factories
Site 1	Infrastructures area (none of petrochemical factories)
Site 2	3 Petrochemical complexes, and utility factories (Karooon Petrochemical Co. / Marun Petrochemical Co. / Laleh Petrochemical Co.)
Site 3	6 Petrochemical factories (Fanavaran Petrochemical Co. / Ghadir Petrochemical Co. / Shimi Baft Co. / Arvand Petrochemical Co. / Rejal Petrochemical Co. / Shahid Rasooli Petrochemical Co.)
Site 4	6 Petrochemical factories (Amir Kabir Petrochemical Co. / Khuzestan Petrochemical Co. / Buali Sina Petrochemical Co. / Shahid Tondgouyan Petrochemical Co. / Fajr Petrochemical Co. / Navid Zar Shimi Petrochemical Co.)
Site 5	3 Petrochemical factories (Bandar Imam Petrochemical Co. / Razi Petrochemical Co. / Farabi Petrochemical Co.)

Source: PSEZ, NPC



Source: PSEZ

Figure 4.1.1-2 Layout of PSEZ

4.1.2. Current Environmental Conditions in Mahshahr

(1) Air Quality

1) Summary of Air Quality

Emission sources of air pollutants in the PETZONE are assumed as the follows:

- (i) Flue gas emission from flare stacks
- (ii) Flue gas emission from incinerators for waste materials
- (iii) Flue gas emission of the combustion equipment (power generators, furnaces, boilers, etc.)
- (iv) Volatile organic compounds (VOC) released from the operation of process equipment, loading equipment, etc.

According to several air qualities monitoring data presented in an environmental report by PSEZ (as of 1391 of Iranian Calendar: March 2012 - March 2013), PM10 outstandingly exceeded the limit of acceptable concentration and some even reached at the hazardous level of concentration. The main source of PM10 in PETZONE is assumed to be above (i), (ii) and (iii). On the other hand, that main cause of PM10 from the outside of PETZONE is assumed to come from dust carried from deserts of Iran and neighboring countries by wind.

When it comes to the combustion equipment as the above (iii), the occurrence of SO_x is often caused by sulfur included in the fuel. However, SO_x in the atmosphere remains at the satisfactory level of acceptable concentration. This is because of main reasons such as the preliminary removal of the sulfur component, the fuel conversion from high-sulfur fuel to low-sulfur fuel, and the introduction of the sulfur recovery unit, presumably.

As for the release of the volatile gas of the above (iv), it has occurred partially and temporarily, leaving less concern for the total PETZONE. Nevertheless, it is vital to take relevant measures for the safety, such as setting the volatile gas recovery lines and devices, wearing the personal protection equipment (PPE), etc., in the operation sites dealing with the harmful volatile organic compounds (VOC). Furthermore the pollution situation of NO_x and VOC is unclear, because the environmental report does not present their monitoring data.



Source: PSEZ

Figure 4.1.2-1 Monitoring Point

2) Air Quality Monitoring Data

Air quality monitoring system is set on the roof of the laboratory of PSEZ (as shown in Figure 4.1.2-1).

The monitoring system enables the real time monitoring of PM, NO_x, SO_x, O₃, CO and VOC. However, the measuring instrument for VOC was malfunctioning at the time of the site survey. Table 4.1.2-1 shows the results of the air quality monitoring during the one year from March 2012. The system has monitored each of PM10, SO₂, O₃, and CO almost every day and assessed the air quality conditions at the three levels in accordance with the air quality standards shown in Table 4.1.2-2. The numbers of cases exceeding the acceptable concentration (the numbers of harmful concentration and hazardous concentration) included 122 cases for PM10 (60 during the daytime, 62 during the night time), 14 case for O₃ (7 during the daytime, 7 during the night time), 0 case for both SO₂ and CO. As for PM10 and O₃, they have reached at the hazardous level with 37 cases (21 during the daytime, 16 during the night time) and 1 case (1 during the daytime) respectively.

Table 4.1.2-1 Results of Air Quality Monitoring (Unit: Cases/year)

	Daytime				Night time			
	PM10	SO ₂	O ₃	CO	PM10	SO ₂	O ₃	CO
Acceptable concentration	296	356	348	356	294	356	349	356
Harmful concentration	39	0	6	0	46	0	7	0
Hazardous concentration	21	0	1	0	16	0	0	0

Source: PSEZ Annual Environmental Report 1391 (March 2012 - March 2013)

Note: There is no description about NO_x and VOC in the Annual Report.

Table 4.1.2-2 Air Quality Standards

	PM10 (µg/m ³ , 24 hr)	SO ₂ (ppb, 24 hr)	O ₃ (ppb, 1 hr)	CO (ppm, 8 hr)
Acceptable concentration	< 150	< 140	< 120	< 9
Harmful concentration	150-350	140-300	120-200	9-15
Hazardous concentration	> 350	> 300	> 200	> 15

Source: PSEZ Annual Environmental Report 1391 (March 2012 - March 2013)

Note: The acceptable concentration is the same as the one adopted by the US Environmental Protection Agency.

3) The Operational Conditions of Flare Stacks

As for 20 units of flare stacks in PETZONE, the flaring conditions are monitored. The monitoring data on the flare stack during the one year from March 2012 to March 2013 is shown in Table 4.1.2-3.

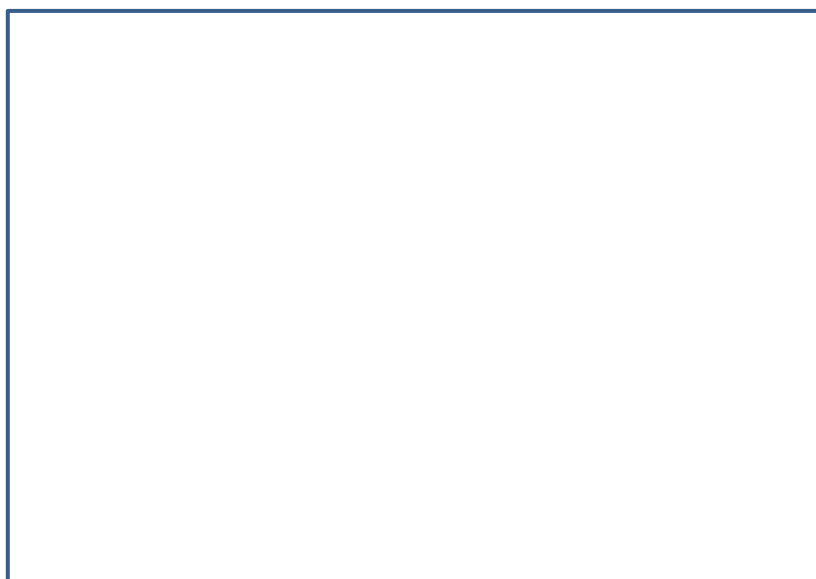
Table 4.1.2-3 Operational Conditions of Flare Stacks

Complex	Names of the flares	Flare condition (%)			Abnormal flaring hours (hr)			
		Holding	Normal	Abnormal	High-level Smoke	Mid-level smoke	Low-level smoke	Total
Amir Kabir	General Flare	0	99	1	17	16	10	103
	Olefin Flare	0	99	1	19	11	10	
	Inside Olefin Flare	0	99.7	0.3	0	0	20	
Buali Sina	General Flare	0	100	0	0	0	0	0
Bandar Imam	Aromatic Flare	0	99	1	18	17	0	192
	LPG Flare	0	99	1	12	1	6	
	Olefin Flare	0	99	1	18	12	2	
	MTBE Flare	0	99	1	25	9	12	
	NF Flare	0	98	2	32	18	10	
Razi	Razi Flare	0	99.6	0.4	3	2	0	5
Rejal	Rejal Flare	0	99	1	26	28	2	56
Shimi Baft	Shimi Baft Flare	0	100	0	0	0	0	0
Karoon	Karoon Flare	0	100	0	0	0	0	0
Fanavaran	Methanol Flare	0	99	1	0	47	0	66
	CO Flare	0	99.5	0.5	6	13	0	
Marun	Polymer Units Flare	0	97	3	67	45	0	662
	Olefin Flare	0	89	11	222	213	43	
	Tankage Flare	0	99	1	15	19	1	
	Local Flare	0	99	1	10	11	0	
	EO/EG Flare	0	99.6	0.4	0	16	0	
In Total		0	99	1	490	478	116	1084

Source: PSEZ Annual Environmental Report 1391 (March 2012 - March 2013)

The table above shows the flaring conditions (shutdown, normal and abnormal), the three levels of the smoke emission volumes (high, medium, and low) at a time of abnormal condition, and abnormal flaring hours according to smoke volume levels. It is observed that, as a whole, 1% of the operation hours of flare stack were in abnormal conditions emitting the smoke in the atmosphere. The occurrence rate of the abnormal flaring was especially high in Marun PC (Petrochemical Company), while the abnormal combusting hours extended to 478 hours (high smoke: 222 hours, medium smoke: 213 hours, low smoke: 43 hours) in the year in Olefin Flare (as shown in the Table 4.1.2-3).

As one example, Figure 4.1.2-2 shows the emission conditions of the smokes from the 2 flare stacks in Amir Kabir PC. The smokes flow to diffuse to the southeast direction by the wind.



Source: Google Earth (Shooting date: 2011.2.18)

Figure 4.1.2-2 Smoke from the Flare Stacks

4) Impacts of the Air Pollution

At the time of the preliminary survey conducted by JICA, a fire incident that had occurred in PETZONE a few years before was reported to the study team. The incident caused an abnormal emission of a huge amount of harmful gas, resulting in the health impacts on the local residents. According to the explanation by the HSE Section at PETZONE, however, there seems no air pollution occurred in the residential areas near PETZONE.

Currently, there is only one air quality monitoring station in PETZONE. It is necessary to grasp the air quality conditions covering the area as a whole, and to examine the expansion of the air monitoring system enabling the quick detection of the harmful gas.

(2) Water Environment

1) Summary of the Water Quality

Emission sources of water pollutants from PETZONE to neighboring sea area include the following factors:

- (i) Industrial wastewater
- (ii) Domestic wastewater
- (iii) Leakage and outflow of raw materials, products and fuels

Inside the PETZONE, the wastewater (industrial and domestic) is processed in the integrated

wastewater treatment facility of Fajr PC (ET-1 & 2) and each company's treatment facilities, while there are some cases that untreated water is discharged to the sea. The quality of discharged water is compiled in both monthly and annual environmental reports, in which there are many cases of unsatisfactory situations with figures of especially COD and pH exceeding the effluent standards. Data on heavy metals and other harmful substances are not in these environmental reports, so the concentration of harmful substances in wastewater is not certain, though it had been found that wastewater discharged from East Pond of Bandar Imam PC (BIPC) included mercury exceeding the effluent standard (about 40 µg/L). There are no relevant data regarding the leakage records of the contaminants (the above (iii)). However, the traces of the oil leakage had been confirmed.

Environmental survey was conducted consigning to the Research Institute of Petroleum Industry (RIPI), which is an institute as one of the subsidiaries of the NIOC, once a month from April 2013 to October 2013.

The result of the water quality was compared with the draft version of the National Standard for Ambient Water in Persian Gulf and Oman Sea prepared by the DOE and the result of sediment quality was compared with the guideline value (screening level) on dredging in Australia, respectively. Out of the water quality parameters, pH, COD, Total nitrogen exceeded the standard value and Cadmium, Mercury and Nickel out of the sediment quality parameters exceeded the guideline value.

Horizontal distribution of COD and Lead in water quality and Cadmium, Mercury, Nickel and Total Petroleum Hydrocarbon (TPH) in sediment quality shows a tendency that each value is high at upper stream in the watercourse of surrounded area of the PETZONE and low at downstream, suggesting the impact form the PETZONE.

Time series of minimum, maximum and average of monthly monitoring parameters such as T-N, COD and TOC suggests the possibility of increase of nutrient level in the area.

Since harmful substances such as Mercury and Chromium in water, and Arsenic, Cadmium and Mercury in sediment were detected although those concentrations are low and the possibility of increase of nutrient level is considered, continuous monitoring in sea area is necessary (see Section 4.1.2 4 for the details).

2) Monitoring Data of Discharged Water

Regular samplings of discharged water are conducted in the 41 sites inside the PETZONE to be measured at the laboratory of PSEZ in terms of the three items of COD, pH and turbidity.

The treated water from 8 wastewater treatment facilities is discharged to the environment. Table 4.1.2-4 shows results on discharged water monitoring from these 8 facilities within PETZONE (for one year from March 2012). Of these facilities, both ET-1 and ET-2 are wastewater treatment facilities operated and managed by Fajr PC, receiving and treating wastewater from a number of

facilities in an integrated manner. The overall achievement ratios of the effluent standards (the proportion of cases satisfying the effluent standards to the overall cases measured) are 27.6% for COD, 40.5% for pH, and 70.8% for turbidity. The excess of the COD effluent standard is particularly conspicuous: wastewater with COD concentration exceeding 1,000mg/L (10 times or more of the effluent standard) is confirmed at 5 facilities, of which the ratio of wastewater exceeding 1,000 mg/L is fairly high at Shahid Tondgouyan PC (Tondgouyan PC), Khuzestan PC and Farabi PC. The possible causes are as follows:

- Lack of wastewater treatment facilities
- Inflow of wastewater exceeding the design of wastewater treatment facilities
- Inflow of materials hindering physicochemical and biological treatment
- Inflow of materials that are difficult to be treated at wastewater treatment facilities
- Inappropriate operation and management of facilities

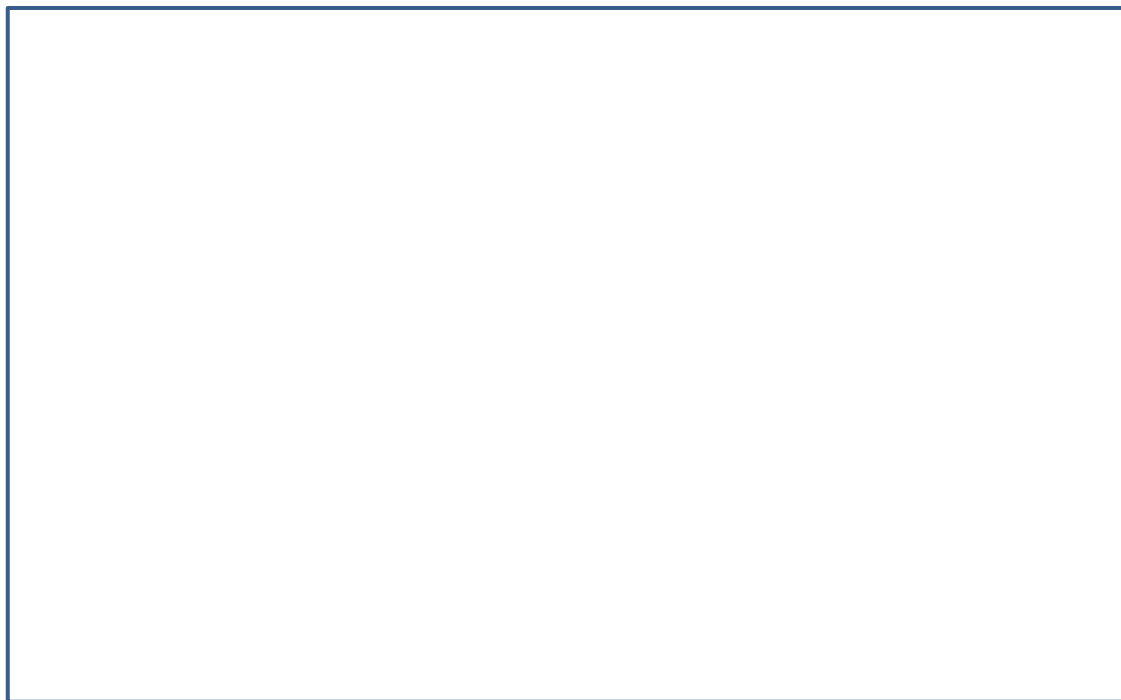
Table 4.1.2-4 Results of Discharged Water Monitoring

	COD (mg/L)					pH			Turbidity (NTU)	
	< 100	100-200	200-500	500-1,000	> 1,000	< 6.5	6.5-8.5	> 8.5	< 50	> 50
Bandar Iman	43	61	34	3	0	3	34	104	55	86
Tondgouyan	113	125	170	179	575	589	354	219	836	325
Khuzestan	0	1	4	8	32	8	20	17	32	13
Razi	183	102	87	30	10	38	191	183	292	115
Farabi	1	3	6	15	68	31	27	35	22	71
Fajr	102	4	2	0	0	4	67	37	106	2
ET-1	35	29	26	6	2	2	65	31	71	27
ET-2	141	41	1	0	0	3	149	31	169	14
Total	618	366	330	241	687	678	907	657	1583	653
Total (%)	27.6	16.3	14.7	10.8	30.6	30.2	40.5	29.3	70.8	29.2
Effluent standards (Environment Agency)	60 (Monthly average) 100 (Maximum)					6.5-8.5			50	

Source: PSEZ Annual Environmental Report 1391 (March 2012 - March 2013)

Figure 4.1.2-3 shows the amount of COD discharged from each facility to the environment each fiscal year in the last five years (from March 2008 to March 2013). In FY2011 and FY2012, the amount of discharged COD is the largest at BIPC, followed by Tondgouyan PC. In FY2012, COD discharged from these two facilities accounted for approximately 80% of the total discharged COD. The COD concentration in wastewater discharged from BIPC is relatively low, compared to that from Tondgouyan PC, but the amount of discharged water itself is greater (approx. 60,000 m³/day),

so the amount of discharged COD is large. There are considerable fluctuations in the amount of discharged COD from one fiscal year to another at some facilities; the reasons are assumed to be fluctuations in loads due to changes in production volume, enhancement of the wastewater treatment facilities, the state of operation and management and other factors.



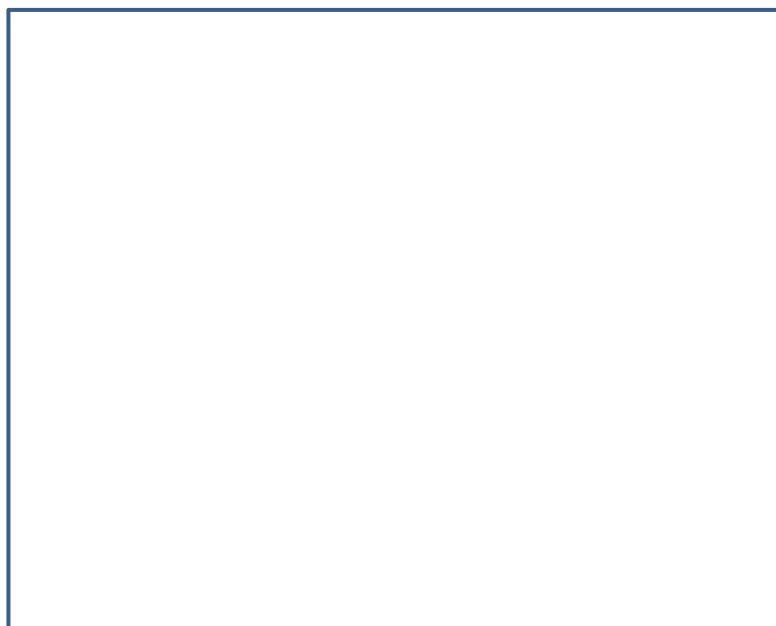
Source: PSEZ Annual Environmental Report 1387-1391 (March 2008 - March 2013)

Figure 4.1.2-3 Annual Total Amount of Discharged COD

3) Current Situation of Wastewater Treatment

In this section, the current situation of the wastewater treatment facility of the following plants with some problems about the treatment is arranged. Figure 4.1.2-4 shows layout of each plant.

- BIPC
- Tondgouyan PC
- Razi PC
- ET-1 (Fajr PC)



Source: PSEZ

Figure 4.1.2-4 Layout of Each Plant

(a) BIPC

BIPC comprises 5 subsidiaries producing the petrochemical products in Faravaresh Bandar Imam Co., Kimya Bandar Imam Co., and Basparan Bandar Imam Co. (Refer to Table 4.1.2-5.).

Table 4.1.2-5 Operations of BIPC Subsidiaries

Companies	Operations
Faravaresh Bandar Imam Co.	Natural gasoline fractionation, olefin, aromatic series, paraxylene, general facilities related
Kimya Bandar Imam Co.	Salt refinement, chlor-alkali business, production of ethylene dichloride, ethylene chloride monomer, and methyl tertiary butyl ether (MTBE)
Basparan Bandar Imam Co.	Production of high density polyethylene, polypropylene, low density polyethylene, polyvinyl chloride, and styrene butylene rubber
Abniroo Bandar Imam Co.	Utility related
Kharazmi Bandar Imam Co.	Maintenance & non-base service

Source: BIPC brochure

Table 4.1.2-6 shows the situation of wastewater treatment. Currently, process effluent is not completely treated but processed through the primary treatment (oil treatment, neutralization, coagulative separation, etc.) before discharged. Rinse water and cooling water are discharged via South Pond or East Pond to the sea without any treatment. Kimya Bandar Imam Co., an affiliate to BIPIC, engages in chlor-alkali business, and wastewater from the process of electrolyzing salt

water includes mercury, which is processed at a mercury removal facility and discharged via East Pond to the sea. However, residual mercury concentration in discharged water is around 40 µg/L, which exceeds the effluent standard. Mercury totaling 0.7 ton in volume has been discharged to the sea if the amount of water discharged from East Pond is estimated at 50,000 m³/day.

Table 4.1.2-6 Situation of Wastewater Treatment

	Wastewater treatment	Destination	Remarks
Process effluent	Primary treatment only	To the sea via East Pond*	There are 12 primary treatment facilities (including CPI, API, neutralization, separation, etc.). Of them, there is one treatment facility for wastewater containing mercury.
Rinse water / rainwater	No treatment	To the sea via South Pond	South channel has a width as wide as a drainage channel.
Cooling water	No treatment	To the sea via East Pond	Seawater is used.
Sewer water	No treatment	North Pond	

Note: * The role of East Pond: sedimentation and collection of oil

Source: Study team

Table 4.1.2-7 shows the discharged water's condition at the time of the site survey. The color of discharged water was light jade. Oil films and suspended substances were sometimes confirmed.

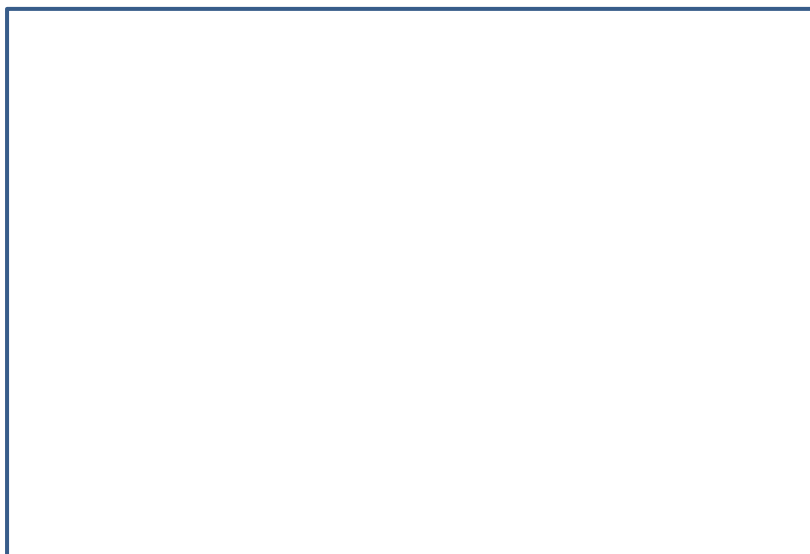
Table 4.1.2-7 Conditions of Discharged Water

Color	Light jade
Oil film	Oil films with diameters 20 - 100 mm were sometimes confirmed.
Suspended Solids	Suspended solids with diameters 5 - 20 mm were sometimes confirmed.

Note: Date of the site survey: 2012.10.1

Source: Study team

Figure 4.1.2-5 shows the satellite photos around the discharge point. The water flow of the colors varying from white to lighter jade discharged could be confirmed, depending on the season.



Source: Google Earth

Figure 4.1.2-5 Condition of Discharged Water from East Pond

With the renewal of the aged wastewater treatment facility, BIPC has a plan to construct a central wastewater treatment facility that can completely process wastewater. The facility to be constructed has the treatment process comprising separation of oil and water; neutralization, coagulation and sedimentation; biological treatment (MBBR*¹ to MBR*²); and discharge (to East Pond). Biological treatment that is not currently in possession will be added to the new facility. Planned construction site of central wastewater treatment facility is north side of East Pond (as shown in Figure 4.1.2-5).

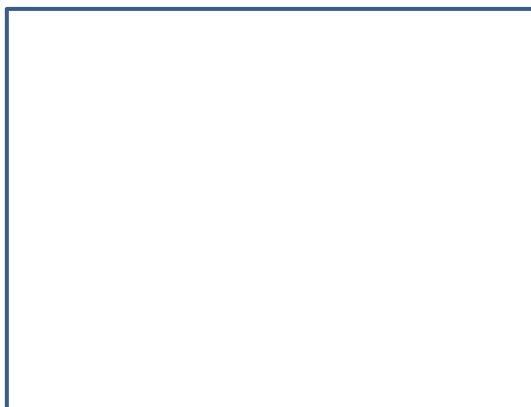
*1 Moving Bed Biofilm Reactor *2 Membrane Bio Reactor

The current water volume totals 60,000 m³/day, but BIPC is planning to reduce the amount of water to be processed to 40,000 m³/day by adopting stream segregation. It also considers the possibility of recycling used cooling water.

Regarding measures against mercury in wastewater, BIPC considers the switchover of mercury electrode to ion-exchange membrane that does not use mercury.

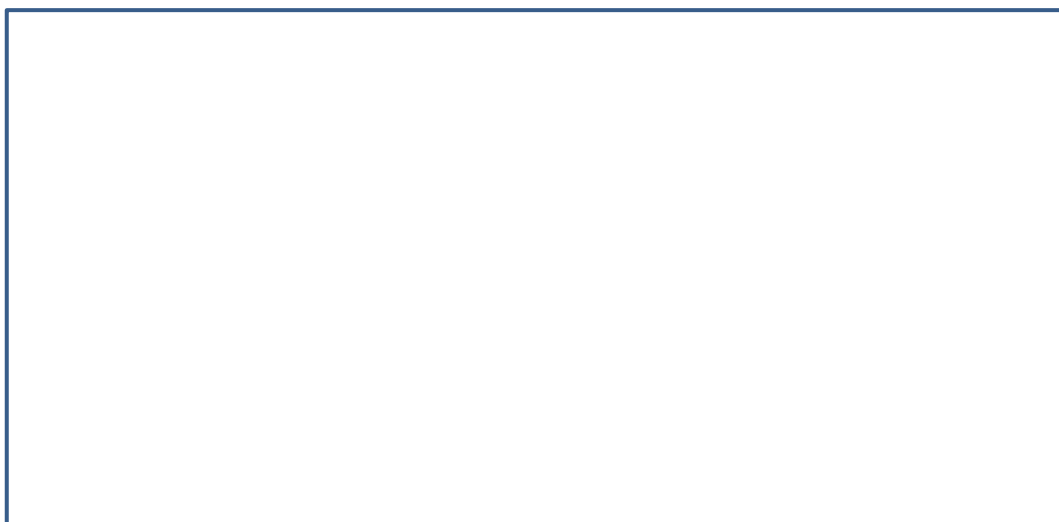
(b) Tondgouyan PC

Tondgouyan PC produces purified terephthalic acid (PTA) and polyethylene terephthalic acid (PET) that is a raw material of plastic bottles. The three drainages produced respectively from CTA (coarse terephthalic acid) manufacturing plant, PTA manufacturing plant, and PET manufacturing plant are treated in the wastewater treatment plant as well as sewage (see Figure 4.1.2-6). The wastewater treatment is implemented at the primary treatment and the secondary treatment, including physicochemical treatment to remove heavy metals, bio-treatment to remove COD (including anaerobic and aerobic treatment), solid-liquid separation in the sedimentation tank, and sand filtration (as shown in Figure 4.1.2-7).



Source: Google Earth

Figure 4.1.2-6 Wastewater Treatment Facility



Source: Study team

Figure 4.1.2-7 Flow of Wastewater Treatment

Tondgouyan PC treats wastewater with higher COD concentration compared to other companies in PETZONE, so has wastewater treatment facilities of higher performance. However, it faces a problem of having wastewater inflow that substantially exceeds the design value of the wastewater treatment facility (at the maximum, COD concentration up to three times more than the design value at the CTA line: see Table 4.1.2-8) and discharge excess wastewater without any treatment. This makes COD concentration in discharged wastewater exceed 1,000 mg/L and the amount of COD discharged from Tondgouyan PC the largest next to BIPC. Thus, it spent four months during March 2011 and March 2012 to remodel the facility to improve its functions. Table 4.1.2-9 shows the specific contents of the remodelling work.

Table 4.1.2-8 Inflow Raw Water with COD Concentration Exceeding Design Value

	COD (mg/L)		
	Design value	Daily value	Max. value
CTA line	19,200	25,00	60,000
PTA line	4,200	-	10,000
PET line	6,100	-	-

Source: Tondgouyan PC

Table 4.1.2-9 Improvements of Functions of the Wastewater Treatment Facility

	Measures taken	Improvements
Anaerobic treatment tank	Treatment temperature has been raised from 37°C to 50°C.	The treatment capacity increased threefold.
Aeration tank	Aerators have been replaced by highly-efficient diffusers.	DO concentration in the tank can now be maintained at 2 – 4 mg/L.

Source: Tondgouyan PC

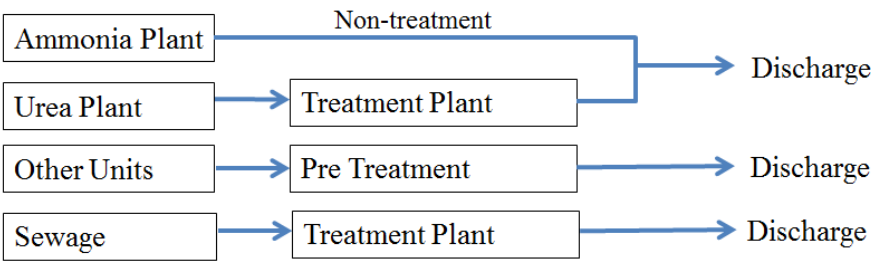
Tondgouyan PC is taking measures to effectively use waste materials from the wastewater treatment facility.

- The excess sludge produced in a process of the wastewater treatment includes cobalt utilized as a catalyst in factories and the burnt ash of the sludge is sold to local collection traders as a part of recycling.
- Since treated water has low salt concentration, it is used to dilute raw water at ET-1, the integrated wastewater treatment facility.
- Biogas (chiefly methane) generated in the course of anaerobic treatment of wastewater is used as fuels for incinerators adjacent to the wastewater treatment facility. (Biogas is primarily stored in a gas storage tank and constantly supplied to the incinerators.)

Tondgouyan PC is planning to double the treatment capacity by adopting the MBBR specifications to the aeration tank (though it does not consider the adoption of MBR at the moment). It also considers the possibility of processing treated water through RO (Reverse osmosis) membrane and using the filtered water as cooling water in future.

(c) Razi PC

Razi PC produces urea, ammonia, sulfuric acid, phosphoric acid, sulfur and so on. The wastewater from 2 ammonia manufacturing plants is not treated while the wastewater from the urea manufacturing plant was treated through both the primary and secondary treatment processes (as shown in Figure 4.1.2-8). Razi PC has a plan that is the renewal of the aged wastewater treatment facility to solve the problems of wastewater treatment. The planned site for this new facility is located in an empty place next to the sulfur storage yard (as shown in Figure 4.1.2-9).



Source: Study team

Figure 4.1.2-8 Flow of Wastewater Treatment



Source: Google Earth

Figure 4.1.2-9 Planned Construction Site of the New Wastewater Treatment Facility

(d) ET-1 (Fajr PC)

The wastewater treatment facilities (ET-1 and ET-2) operated and managed by Fajr PC accept wastewater of other companies, and conduct the primary treatment (oily water separation, neutralization, flotation, etc.) and the secondary treatment (biological treatment). The agreement on acceptance of wastewater between Fajr PC and these companies started in 1378 of Iranian Calendar (1999-2000) with the term of 25 years. The agreement was revised in 1391 of Iranian Calendar (2012-2013) due to a change in concentration of wastewater accepted compared to the time when the agreement was signed.

The charge of accepting wastewater is calculated according to the following formula:

$$P_1 + P_2 + P_3 + P_4$$

P_1 : basic charge

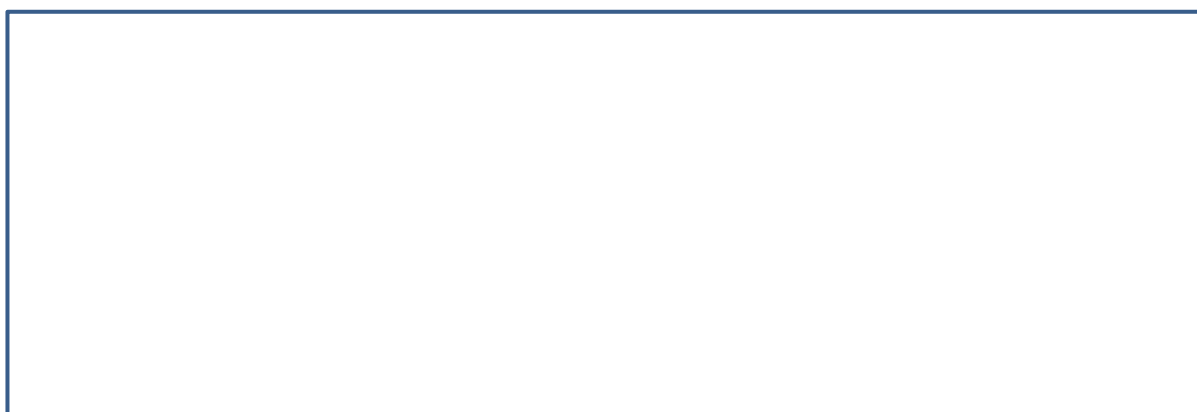
P_2 : charges linked to load (such as the amount of COD)

P_3 : charges linked to concentration (such as Oil, pH, COD and TDS)

P_4 : charges linked to the frequency of shutouts*

* The frequency of rejections of accepting wastewater to the integrated wastewater treatment facilities on the grounds that the quality of wastewater exceeds the predetermined conditions.

The formula above was created by NPC and also used by Mobin PC that runs integrated wastewater treatment facilities in Assaluyeh.



Source: Google Earth

Figure 4.1.2-10 Integrated Wastewater Treatment Facility (ET-1, ET-2)

Table 4.1.2-10 shows companies that send their wastewater to the integrated wastewater treatment facilities. Neither ET-1 nor ET-2 has any problem with the water volume, but the former receives raw water with high salt concentration and aromatic compounds, which is not suitable for biological treatment. Thus, Fajr PC uses treated water (100 m³/hr) from the wastewater treatment

facility of the neighboring Tondgouyan PC to dilute raw water at ET-1. But still it is unable to perform stable treatment. Raw water flown into ET-2, on the other hand, has low salt concentration and is treated well. Water treated at ET-2 is used as sprinkling water for plants and dilution water for ET-1.

Table 4.1.2-10 Origin of Raw Water

Inflow to ET-1		Inflow to ET-2	
• Amir Kabir PC	• Buali Sina PC	• Karoon PC	• Maroon PC
• Fajr PC	• Fanavaran PC	• Laleh PC	• Fanavaran PC
• Ghadir PC	• Karoon PC	• Ghadir PC	• Shimi Baft PC
• Marun PC		• Arvand PC	• Rejal PC
		• Shahid Rasouli PC	• R&D

Note: Of wastewater flown into ET-2, the portion with high salt concentration is transferred to ET-1.

Source: Fajr PC

Wastewater at Karoon PC includes toluene, chlorophenol and other harmful/toxic substances, so the company conducts preliminary treatment¹ to decompose them before sending wastewater to the integrated wastewater treatment facilities. As in this case, any harmful/toxic substance, if any, must be decomposed or removed from wastewater before sending to the integrated wastewater treatment facilities

The aeration tank is MBBR design for better treatment performance. Fajr PC is planning to accept wastewater with high salt concentration at ET-2 which has the treatment capacity to spare, since it wishes to avoid deterioration of the performance of ET-1.

4) Result of Monitoring Survey at Surrounded Area

Environmental survey was conducted consigning to the Research Institute of Petroleum Industry (RIPI), which is an institute as one of the subsidiaries of NOIC, once a month from April 2013 to October 2013.

Discussion for the establishment of a monitoring system and its methodology based on the result of the survey is also one of the objectives.

(a) Outline of the Survey

An outline of the survey, schedule and survey locations are shown in Table 4.1.2-11, Table 4.1.2-12 and Table 4.1.2-13 and Figure 4.1.2-11 respectively.

¹ Karoon PC applies fenton treatment to decomposition of harmful/toxic substances.

Table 4.1.2-11 Outline of the Survey

Survey	Layers	Frequency	Item	Survey Method
General conditions	-	-	Time, Weather Temperature, Water Temperature, Depth, Colour, Salinity, Transparency, Odour, Tidal Condition and Current	Observation
Water quality	Every 1m till 10m, below surface	1 time / month (7 times)	Water temperature, Salinity, Electro Conductivity, pH, Dissolved Oxygen	Field measurement by equipment
	3 layers*	1 time / month (7 times)	[General parameter] Turbidity, Suspended Solids, COD, Total Organic Carbon (TOC), Oil Contents, Coliform Bacteria, Total Nitrogen and Total Phosphorus	Sampling by water sampler, Laboratory analysis
		2 times during the survey (May and August)	[Heavy metal] Aluminum (Al), Arsenic (As), Cadmium (Cd), Cyanide (CN), Total Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Methyl Mercury, Total Mercury (Hg), Manganese (Mn), Magnesium (Mg), Nickel (Ni), Lead (Pb), Zinc (Zn), Phenols	ditto
Sediment quality	Bottom surface	2 times during the survey (May and August)	Specific Gravity, Moisture Content, Grain Size, Total Organic Carbon (TOC), Total Petroleum Hydrocarbon (TPH), Aluminum (Al), Arsenic (As), Cadmium (Cd), Cyanide (CN), Chromium (Cr ⁺⁶), Total Chromium, Cobalt (Co), Copper (Cu), Iron (Fe), Methyl Mercury, Total Mercury (Hg), Manganese (Mn), Magnesium (Mg), Nickel (Ni), Lead (Pb), Zinc (Zn), Phenols, Total Sulfur (T-S)	Sampling by sediment sampler, Laboratory analysis

Source: Study team

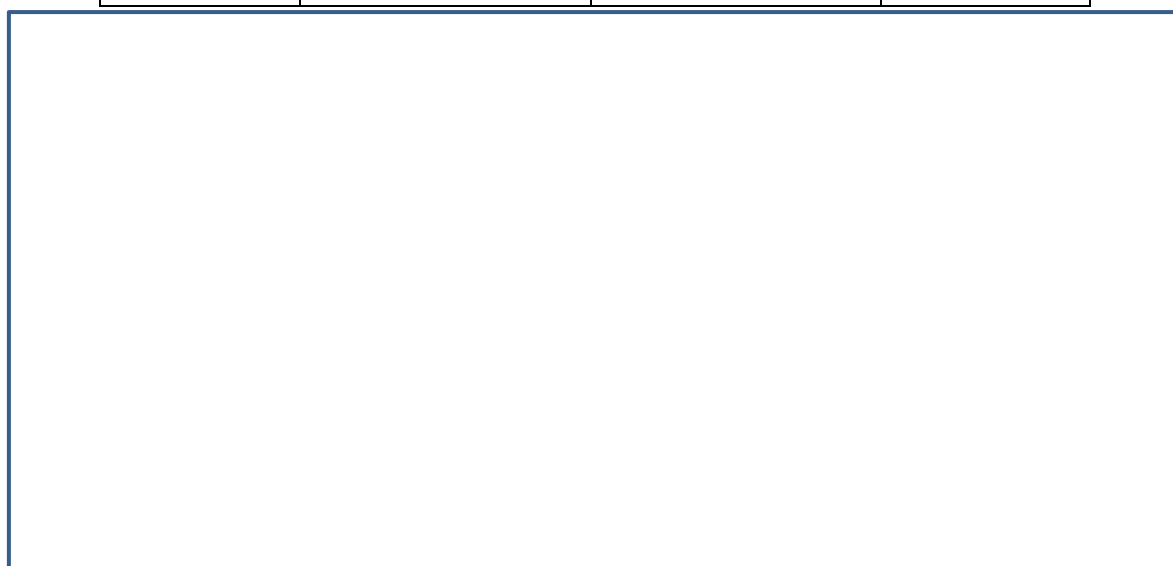
Note: * 3 layers: (i) 0.5 m below surface, (ii) 2 m below surface, (iii) 10 m below surface

Table 4.1.2-12 Survey Schedule

Source: Study team

Table 4.1.2-13 Survey Locations

Point	Latitude (N)	Longitude (E)	Depth (m)
MS-1	30° 27' 20.00"	49° 06' 06.10"	1.5
MS-2	30° 27' 26.09"	49° 06' 33.19"	>5
MS-3	30° 26' 56.30"	49° 07' 02.20"	>5
MS-4	30° 26' 07.40"	49° 07' 08.60"	1.8
MS-5	30° 25' 16.50"	49° 06' 15.70"	>20
MS-6	30° 25' 07.00"	49° 05' 00.60"	>30
MS-7	30° 24' 58.90"	49° 03' 06.70"	>30
MS-8	30° 23' 25.08"	49° 00' 29.52"	>40



Source of image: Google Earth
Others: Study team

Figure 4.1.2-11 Survey Locations

(b) Survey Results

An outline of the survey from April to October 2013 is described below. Every survey was conducted at the timing of ebb tide in the spring tide, which is considered that the discharged water from PETZONE spreads widely and the influence from the area would be easily understood. According to the tide table², semidiurnal tide is dominant in this area and the deference of tide level between the high-tide and the low-tide reaches 5m (refer to Figure 4.1.2-12)

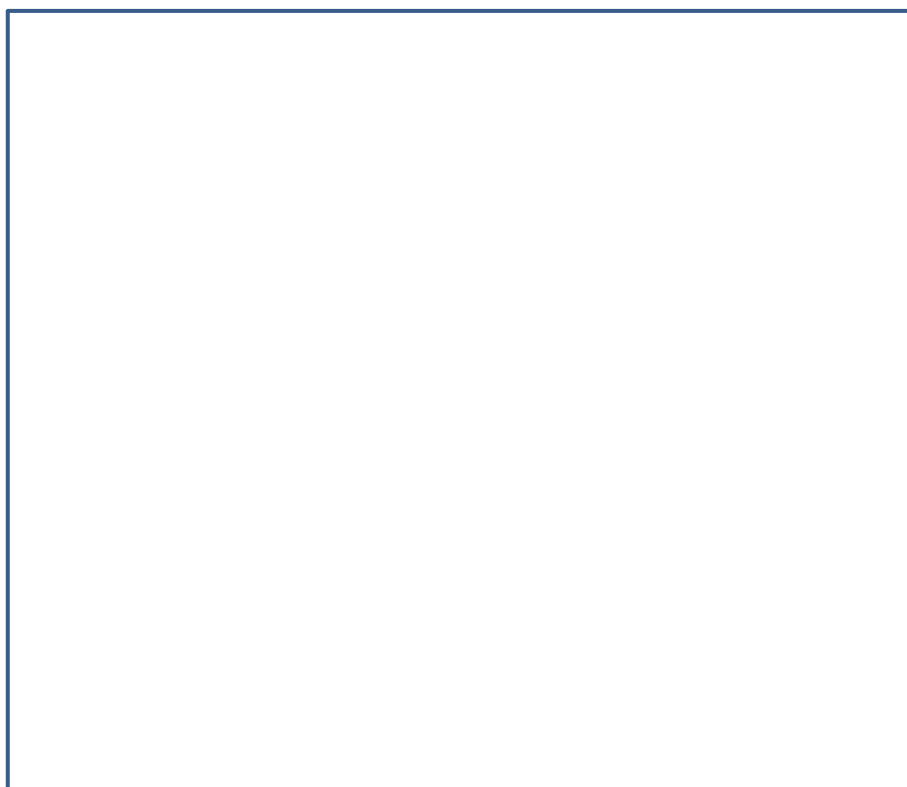
² <http://www.iranhydrography.org/default.asp>



Source: Study team

Figure 4.1.2-12 Survey Timing (April 2013 as an example)

This big difference of tide level causes high-speed tidal current and results in the active vertical mixing of water mass. Figure 4.1.2-13 shows vertical distribution of Water Temperature and Salinity as an example. The difference of the value at 0.5m below surface and 10m below surface is significantly smaller, suggesting that vertical mixing is great.



Source: Study team
Survey: April, May, June, 2013
Survey location: MS-6

Figure 4.1-2-13 Vertical Distribution of Water Temperature and Salinity

Table 4.1.2-14 summarizes the survey results. The result of the water quality was compared with the draft version of the Iranian standard³ and the result of sediment quality was compared with the guideline value (screening level) on dredging in Australia⁴, respectively.

Out of the water quality parameters, pH, COD, Total nitrogen exceeded the standard value and Cadmium, Mercury and Nickel out of the sediment quality parameters exceeded the guideline value.

Horizontal distribution of COD in each month is shown in Figure 4.1.2-14 and horizontal distribution of major parameters in May and August is shown in Figure 4.1.2-15. The figure of horizontal distribution of COD and Lead in water quality and Cadmium, Mercury, Nickel and Total Petroleum Hydrocarbon (TPH) in sediment quality shows a tendency that each value is high at upper stream in the water course of surrounded area of the PETZONE and low at downstream, suggesting the impact form the PETZONE.

Time series of minimum, maximum and average of monthly monitoring parameters is shown in Figure 4.1.2-16. Red line in each graph shows the standard value of the Standard for Ambient

³ National Standard for Ambient Water in Persian Gulf and Oman Sea, Class 6: Industrial zone or Port, DOE, draft version

⁴ National Assessment Guideline for Dredging, 2009, Australia

Water in Persian Gulf and Oman Sea (draft), Class 6: Industrial zone or Port, prepared by DOE. Water temperature is the highest in August, while DO shows the lowest in August. This is considered because of higher demand of oxygen consumption on decomposition process of organic matters in the water due to high water temperature. Fluctuation of pH is occasionally high leading excess of the standard value, suggesting some impacts of discharges from the PETZONE. T-N and COD steadily exceed the standard value and the temporal trend of COD and TOC shows increase of nutrient level in the area, suggesting the nutrient load from PETZONE might be increasing.

Since harmful substances such as Mercury and Chromium in water, and Arsenic, Cadmium and Mercury in sediment were detected although those concentrations are low and the possibility of increase of nutrient level is considered, continuous monitoring in sea area is necessary.

Table 4.1.2-14 (1) Summary of the Survey Result

Survey month: from April to October, 2013

Date	Time	Location	Weather	Temperature	Humidity	Wind Speed	Wind Direction	Cloud Cover	Visibility	Air Quality	Soil Moisture	Plant Growth	Animal Activity	Human Activity	Other Observations
2023-10-27	08:00	Field Station	Clear	15°C	65%	10 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None
2023-10-27	12:00	Field Station	Clear	22°C	70%	15 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None
2023-10-27	16:00	Field Station	Clear	18°C	75%	12 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None
2023-10-28	08:00	Field Station	Clear	16°C	68%	11 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None
2023-10-28	12:00	Field Station	Clear	23°C	72%	16 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None
2023-10-28	16:00	Field Station	Clear	19°C	76%	13 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None
2023-10-29	08:00	Field Station	Clear	17°C	70%	12 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None
2023-10-29	12:00	Field Station	Clear	24°C	74%	17 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None
2023-10-29	16:00	Field Station	Clear	20°C	78%	14 km/h	SE	10%	10 km	Good	15%	Stable	None	None	None

Source: Study team

Note: Red letter means excess of the standard/criteria value

- *1 Water: Standard for Ambient Water in Persian Gulf and Oman Sea (draft), Class 6: Industrial zone or Port, DOE.
Sediment: National Assessment Guideline for Dredging, 2009, Australia
- *2 Water temperature: ± 3 of natural temperature of receptive source
- *3 Salinity: It should be no more than 10 percent of minimum natural salinity of the region.
- *4 DO: 40% of Saturation
- *5 Suspended Solid: Its increase should not be more than its daily, monthly, annual average considering standard deviation.
- *6 Oil contents: There should be no oil layer, foam visible on its surface.
- *7 Coliform bacteria: Fecal coliform should be less than 100 CFU/100ml.
- *8 Total nitrogen: The value of Nitrate-nitrogen is used in this table.
- *9 Total phosphorous: The value of Phosphate-phosphorus is used in this table.
- *10 Total coliform was analyzed in Apr., May, Jun. and Aug-1, while fecal coliform analyzed in Aug-2, Sep. and Oct.

Table 4.1.2-14 (2) Summary of the Survey Result

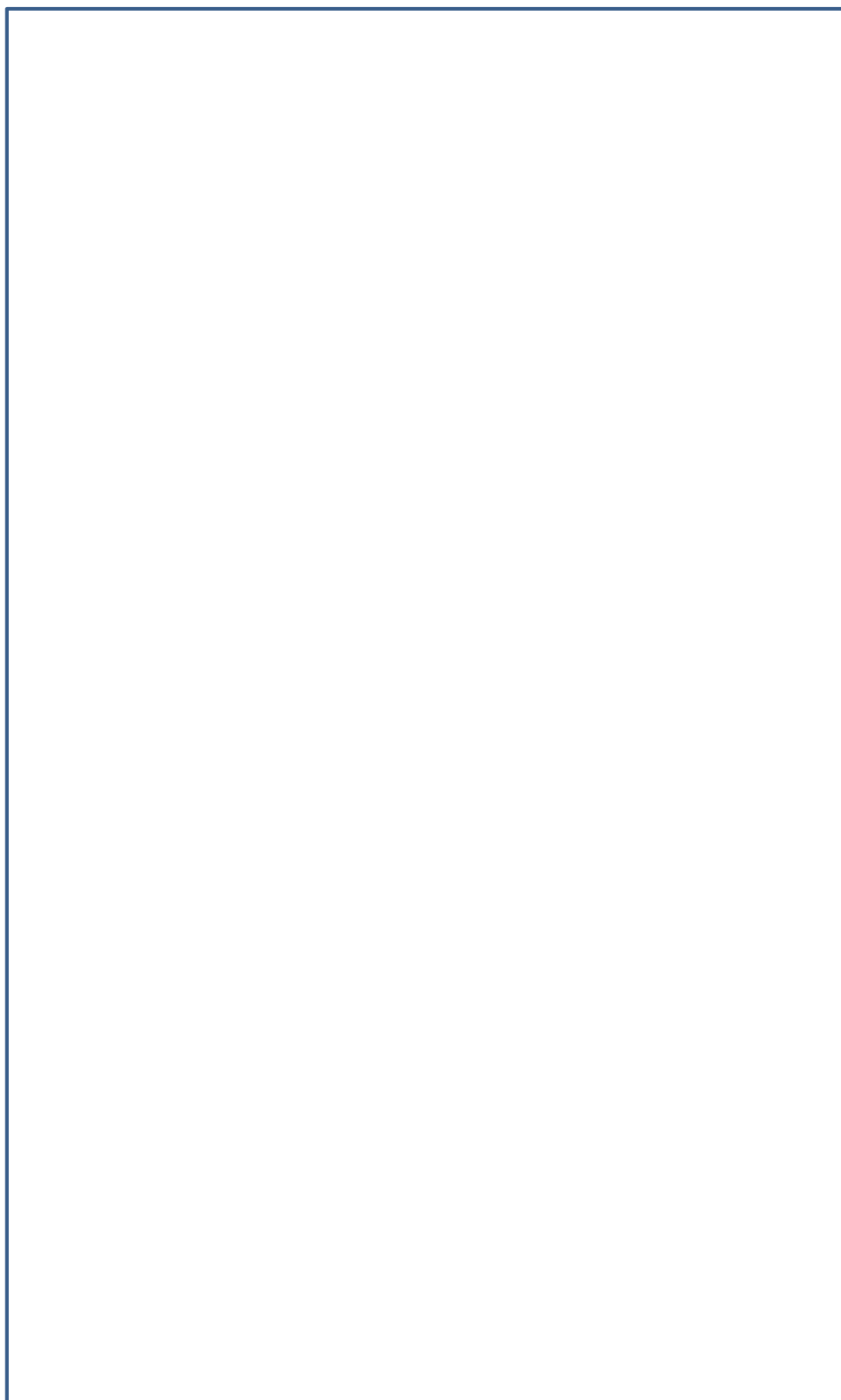
Survey month: from April to October, 2013

No.	Name	Age	Sex	Occupation	Marital Status	Religion	Education	Income	Health Status	Mental Health Status	Substance Use	Alcohol Use	Tobacco Use	Illicit Drug Use	Suicidal Thoughts	Self-Harm	Family History	Social Support	Stress Level	Anxiety Level	Depression Level	Mood Stability	Coping Mechanisms	Resilience	Life Satisfaction	Overall Well-being	Notes
1	John Doe	35	Male	Software Engineer	Married	Christian	High School	\$75,000	Good	Stable	No	No	No	No	No	No	No	No	Low	Low	Low	Stable	Exercise, Meditation	High	High		
2	Jane Smith	42	Female	Teacher	Single	Muslim	College	\$50,000	Fair	Anxious	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Fluctuating	Reading, Journaling	Medium	Medium		
3	Michael Brown	28	Male	Student	Single	Hindu	University	\$15,000	Good	Stable	No	No	No	No	No	No	No	No	Low	Low	Low	Stable	Studying, Sports	High	High		
4	Sarah Johnson	55	Female	Retired	Married	Buddhist	High School	\$30,000	Fair	Depressed	No	No	No	No	No	No	No	No	High	High	High	Unstable	Volunteering, Gardening	Low	Low		
5	David Wilson	30	Male	Freelance Writer	Single	Jewish	College	\$40,000	Good	Stable	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Stable	Writing, Traveling	Medium	Medium		
6	Emily Davis	22	Female	Intern	Single	Christian	University	\$20,000	Good	Stable	No	No	No	No	No	No	No	No	Low	Low	Low	Stable	Studying, Hobbies	High	High		
7	Robert Lee	60	Male	Retired	Married	Muslim	High School	\$35,000	Fair	Anxious	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Fluctuating	Walking, Prayer	Medium	Medium		
8	Alice White	38	Female	Marketing Executive	Married	Hindu	College	\$80,000	Good	Stable	No	No	No	No	No	No	No	No	Low	Low	Low	Stable	Yoga, Meditation	High	High		
9	James Black	45	Male	Engineer	Single	Buddhist	University	\$60,000	Fair	Depressed	No	No	No	No	No	No	No	No	High	High	High	Unstable	Reading, Hobbies	Low	Low		
10	Olivia Green	25	Female	Graphic Designer	Single	Christian	College	\$45,000	Good	Stable	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Stable	Art, Traveling	Medium	Medium		
11	Benjamin King	50	Male	Teacher	Married	Muslim	High School	\$40,000	Fair	Anxious	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Fluctuating	Teaching, Gardening	Medium	Medium		
12	Isabella Lopez	32	Female	Software Engineer	Single	Hindu	University	\$70,000	Good	Stable	No	No	No	No	No	No	No	No	Low	Low	Low	Stable	Exercise, Meditation	High	High		
13	Christopher Hall	40	Male	Freelance Writer	Single	Jewish	College	\$35,000	Fair	Depressed	No	No	No	No	No	No	No	No	High	High	High	Unstable	Writing, Hobbies	Low	Low		
14	Sophia Adams	27	Female	Marketing Executive	Married	Christian	College	\$55,000	Good	Stable	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Stable	Reading, Traveling	Medium	Medium		
15	Matthew Baker	58	Male	Retired	Married	Muslim	High School	\$30,000	Fair	Anxious	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Fluctuating	Walking, Prayer	Medium	Medium		
16	Ava Clark	33	Female	Software Engineer	Single	Hindu	University	\$65,000	Good	Stable	No	No	No	No	No	No	No	No	Low	Low	Low	Stable	Exercise, Meditation	High	High		
17	William Evans	48	Male	Freelance Writer	Single	Jewish	College	\$40,000	Fair	Depressed	No	No	No	No	No	No	No	No	High	High	High	Unstable	Writing, Hobbies	Low	Low		
18	Mia Foster	24	Female	Marketing Executive	Married	Christian	College	\$50,000	Good	Stable	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Stable	Reading, Traveling	Medium	Medium		
19	Lucas Garcia	52	Male	Retired	Married	Muslim	High School	\$35,000	Fair	Anxious	No	No	No	No	No	No	No	No	Medium	Medium	Medium	Fluctuating	Walking, Prayer	Medium	Medium		
20	Charlotte Hill	36	Female	Software Engineer	Single	Hindu	University	\$70,000	Good	Stable	No	No	No	No	No	No	No	No	Low	Low	Low	Stable	Exercise,				

Source: Study team

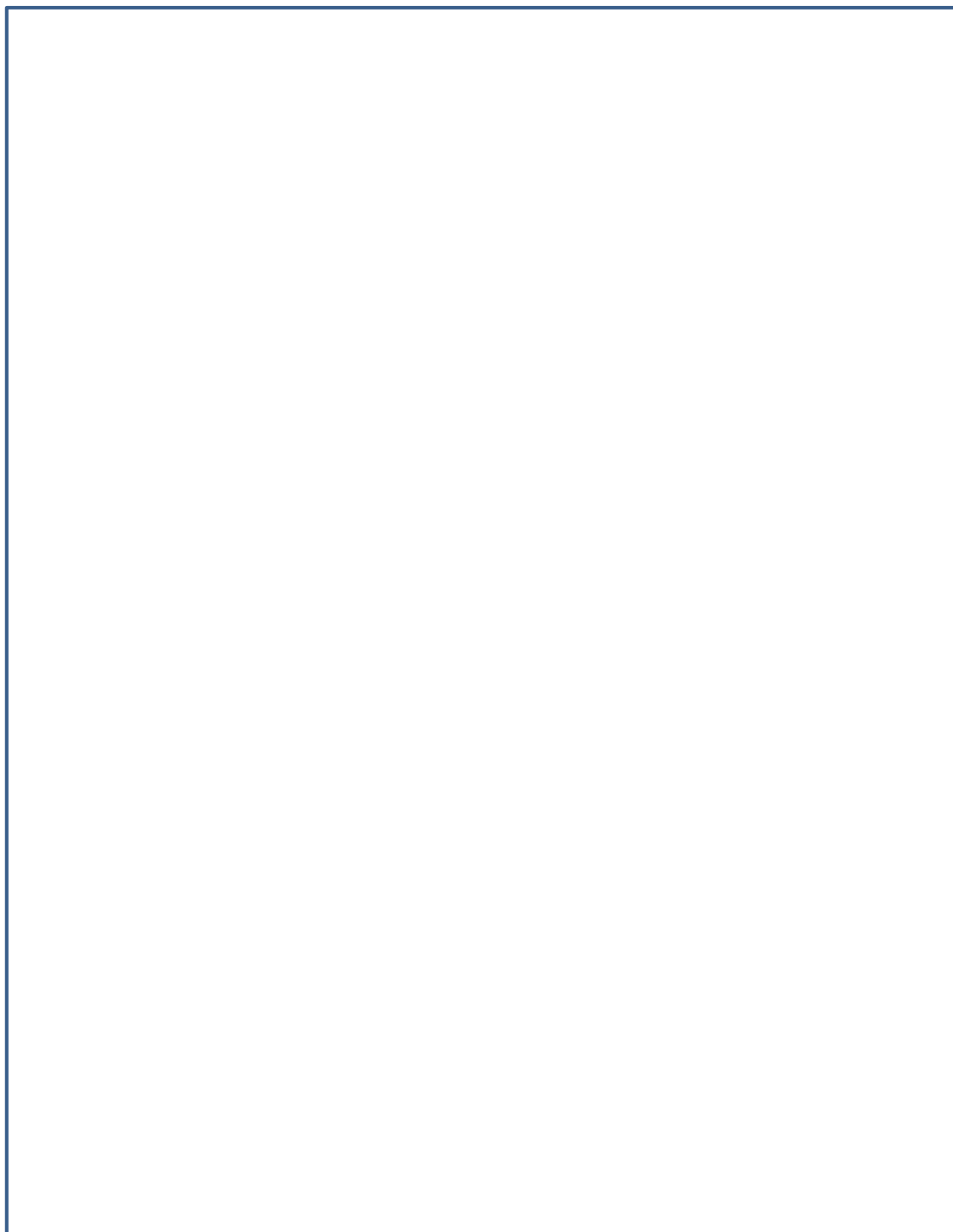
Note: Red letter means excess of the standard/criteria value

- *1 Water: Standard for Ambient Water in Persian Gulf and Oman Sea (draft), Class 6: Industrial zone or Port, DOE.
 *2 Sediment: National Assessment Guideline for Dredging, 2009, Australia
 *3 Water temperature: ± 3 of natural temperature of receptive source
 *4 Salinity: It should be no more than 10 percent of minimum natural salinity of the region.
 *5 DO: 40% of Saturation
 *6 Suspended Solid: Its increase should not be more than its daily, monthly, annual average considering standard deviation.
 *7 Oil contents: There should be no oil layer, foam visible on its surface.
 *8 Coliform bacteria: Fecal coliform should be less than 100 CFU/100ml.
 *9 Total nitrogen: The value of Non-organic Nitrogen is used in this table.
 *10 Total phosphorous: The value of Phosphate-phosphorus is used in this table.



Source: Study team

Figure 4.1.2-14 Horizontal Distribution of COD in each month, 2013

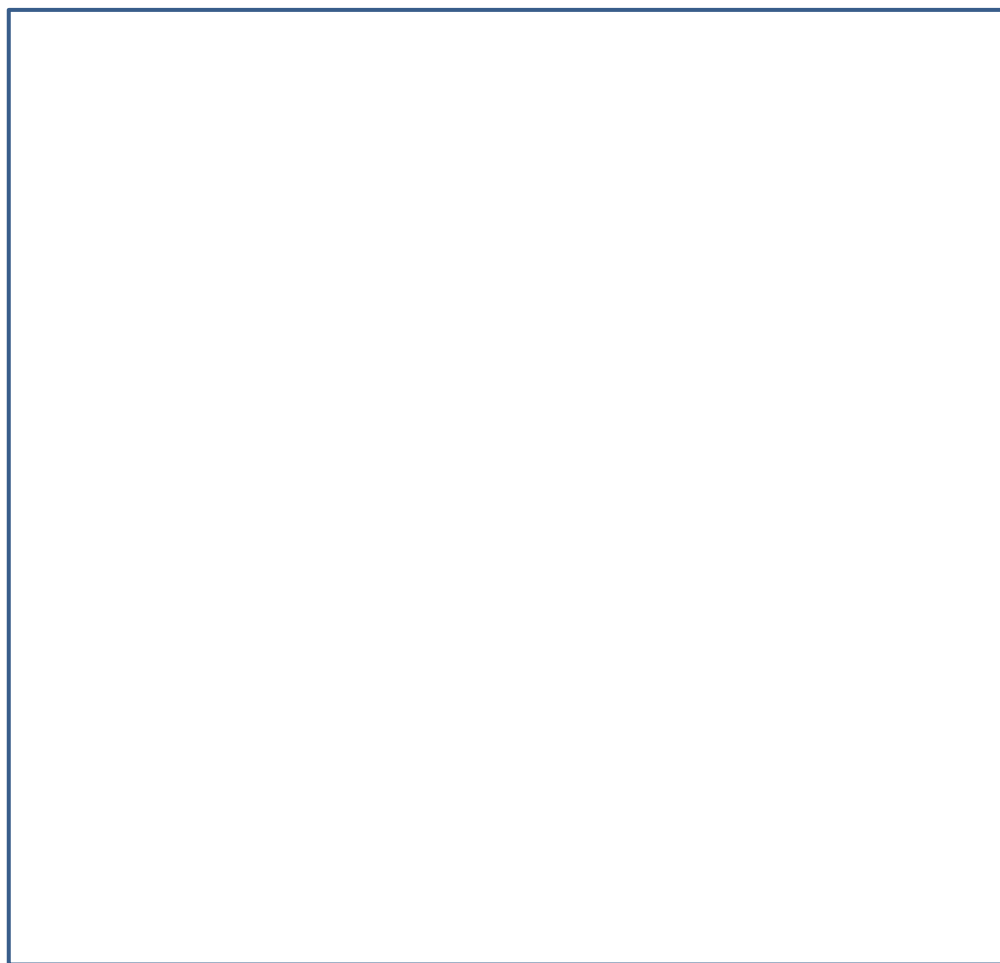


Source: Study team

Unit of water quality: micro-g/L

Unit of sediment quality: micro-g/g.dw

Figure 4.1-2-15 (1) Horizontal Distribution of Major Parameters (May and August, 2013)

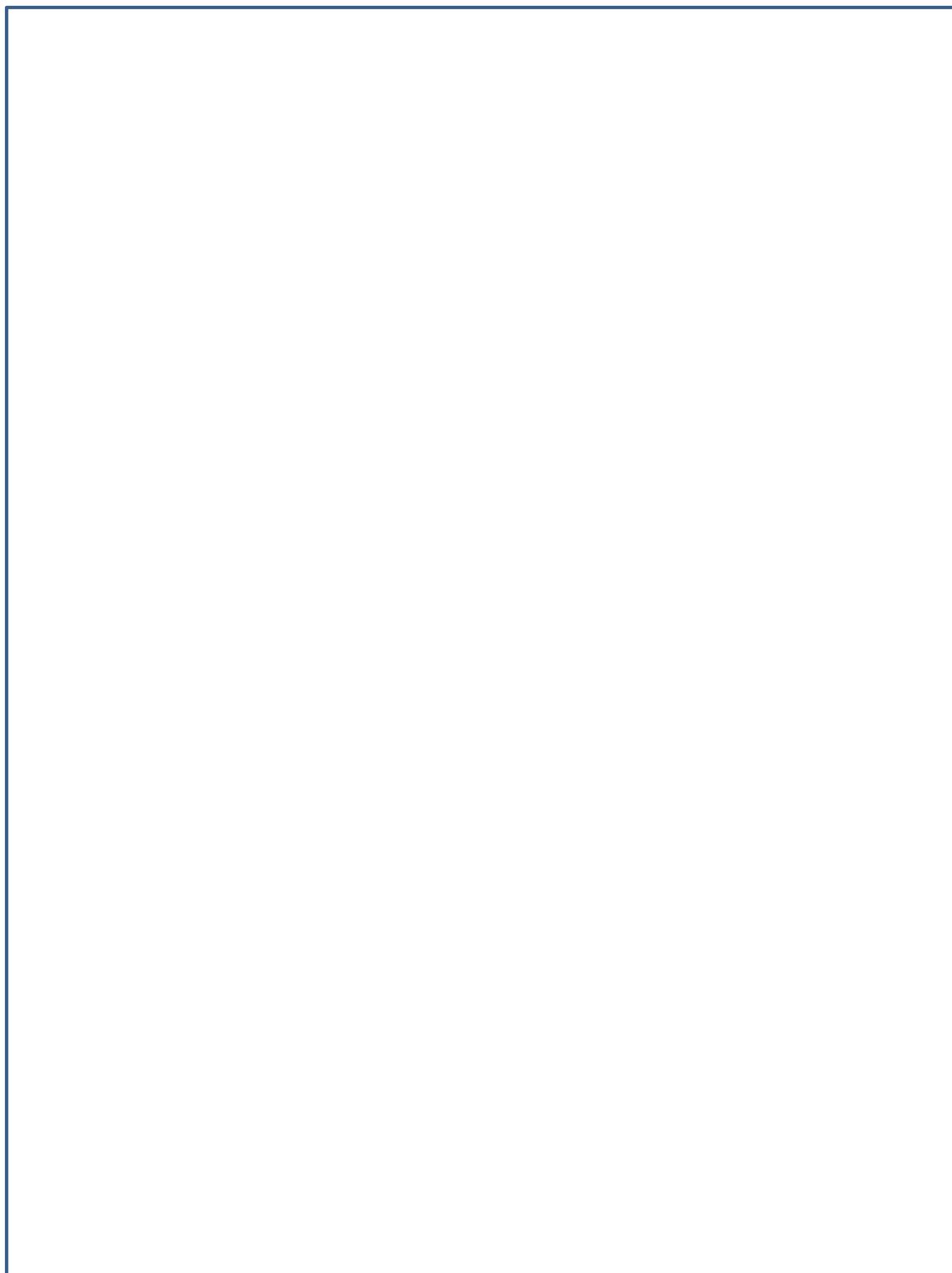


Source: Study team

Unit of water quality: micro-g/L

Unit of sediment quality: micro-g/g.dw

Figure 4.1-2-15 (2) Horizontal Distribution of Major Parameters (May and August, 2013)



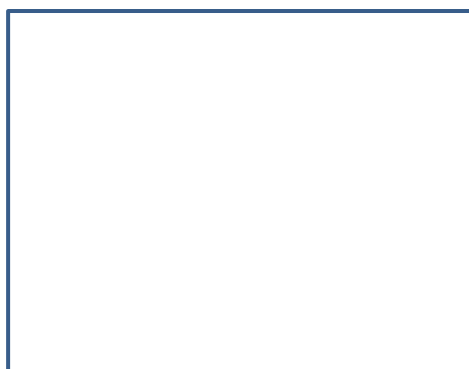
Source: Study team

Red line in each graph shows the standard value of the Standard for Ambient Water in Persian Gulf and Oman Sea (draft), Class 6: Industrial zone or Port, DOE

Figure 4.1-2-16 Time Series of Minimum, Maximum and Average of the Monthly Monitoring Parameters, 2013

5) Other Information

- Due to a huge amount of release of suspended solids (calcium sulfate, etc.) included in the discharged water to the sea zone, the suspended solids have been accumulated in the vicinity of shipping docks which has made it difficult to maintain their depth allowing boats and ships to berth easily, and therefore, there has been necessity of dredging.
- The traces of oil outflow (see Figure 4.1.2-17).



Source: Study team

Figure 4.1.2-17 Trace of Oil Drifted Ashore

(3) Waste Management

1) Waste Management and Disposal Conditions

The petrochemical companies in the PETZONE classify the solid wastes with coding, in order to grasp the sources, amounts, disposal methods and disposed amounts. Apart from being disposed by landfill and incineration, some types of valuable wastes are sold or recycled. Some petrochemical companies own their own incinerators within the PETZONE to treat their wastes. Table 4.1.2-15 shows the treatment conditions of the wastes during the one year from March 2012.

Table 4.1.2-15 Treatment Conditions of Wastes (unit: ton)

Amount of produced wastes	Amount carried over from the previous year	Details of disposal methods				
		Landfill	Incineration	Selling	Temporary storage	Recycling
93,632	6,195	57,889	1,119	26,419	13,942	458
		58.0%	1.1%	26.5%	14.0%	0.5%

Source: PSEZ Annual Environmental Report 1391 (March 2012 - March 2013)

Annual amount of wastes produced is 93,632 ton, with 6,195 ton carried over from the previous year. The total amount of disposed wastes excluding the temporarily stored amount is 85,885 ton.

The disposal methods could be listed up proportionately to their shares as landfill (58.0%), selling (26.5%), temporary storage (14.0%), recycling (0.5%), and incineration (1.1%) in which the landfill disposal shares more than half of the total waste disposal.

2) Final Disposal Site

The waste landfill site of BIPC is located 35~40 km away to the east of the PETZONE with the fence surrounding it. It has been used as the disposal site of industrial wastes under the management and operation by Kimya Bandar Imam Co. since last 2 years. The disposal site comprises 4 areas:

- Landfill site for general industrial wastes (no penetration-proof sheets, unused)
- Landfill site for hazardous industrial wastes (penetration-proof sheet: 1 layer, capacity: 6,000 – 7,000 ton/year)
- Landfill site for high level hazardous industrial wastes (penetration-proof sheet: 2 layers, capacity: 100 ton/year)
- Evaporation ponds (2 trains, penetration-proof sheet: 4 layers, unused)

The leachate from landfill areas for hazardous industrial wastes and high level hazardous wastes is collected in the catchment pit temporarily. When the level of the water in the pit exceeds the regulation level, it is designed to send the water to the evaporation ponds. However, the water has not sent to the pond so far. The leachate from the disposal sites are monitored monthly by the monitoring wells.

Major high level hazardous industrial wastes are spent catalysts and wastes with mercury which derive from chlor-alkali business in Kimya Bandar Imam Co. that are packed in drums and temporarily stored in the landfill area for high level hazardous industrial wastes. The term for this temporary storage is assumed to be until the time the recycle technology is established for the treatment of spent catalysts and wastes with mercury.

As far as the conditions confirmed at the time of the site survey are concerned, it is deemed that this disposal site does not have serious environmental impacts.

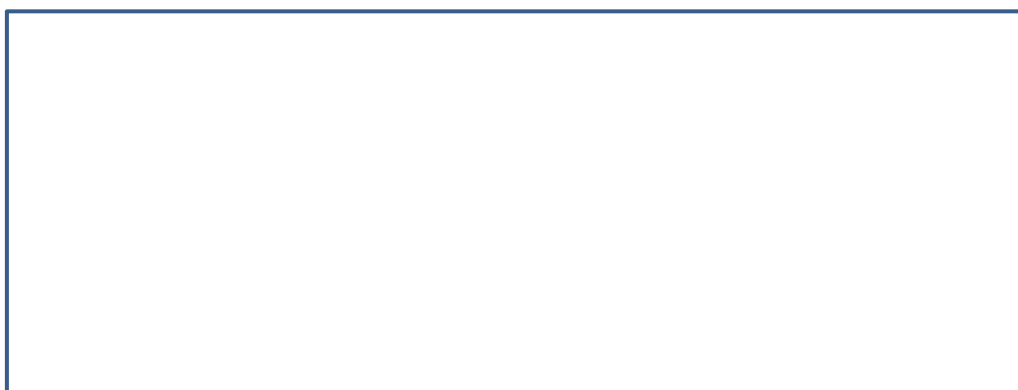


Figure 4.1.2-18

Landfill Site for Hazardous Industrial Wastes

Figure 4.1.2-19

Landfill Site for High level Hazardous Industrial Wastes



Figure 4.1.2-20
Evaporation Pond

Figure 4.1.2-21
Catchment Pit of Leachate

Source: Study team

3) Temporary Storage Site

The temporary storage site of the wastes within the PETZONE is located in Site 2, surrounded by the fences and locked to be controlled. The storage temporarily keeps drums storing spent catalysts or chemical substances, steel scraps, concrete bricks and so on.

(4) Biota and Conservation Area

1) Present Situation

The ecological significance of the Mahshahr region in Khuzestan province is worthy of notice. This region is a good example of a coastal region with multiple usages. This region is a shelter and rearing site for a variety of marine organisms, particularly fish, due to its unique characteristics and favorable biodiversity (NIOC-IOOC 2005)⁵.

Mangrove trees in the PETZONE have been transplanted for many years. The number of trees planted counts 8 million, according to the interview with a representative of the PSEZ. During the field survey at the area, Study team found that the color of the leaves of upper part of a mangrove shows degradation (brown color), while lower part of a tree is still green. According to the interview with DOE personnel, they consider following 3 causes regarding this phenomena:

- pollutants in water,
- pollutants in atmospheric depositions, and
- less fresh water in the area.

⁵ Waste Management Contract Persian Gulf Biological Report Khark Island Operational Area Pre FEED Document, Oct. 2005, NIOC-IOOC



Source: (Left) Study team, (Right) NOAA, 2010⁶

Note that this picture (in Honduras) shows degradation in whole individual tree, while degradation in a part of individual tree was recognized in PETZONE in Mahshahr.

Figure 4.1.2-22 Mangrove in Mahshahr (left) and Example of Degradation (right)

During the hydrobiological studies of creeks in Khuzestan, only the two creeks of Ghazaleh and Ahmadi have been investigated comprehensively to date. Thus the physical and chemical factors, species diversity of planktons, benthos, crustacean and fish as well as the state of sedimentation is more or less determined in these areas. Owing to the contact between soil and marine sedimentation, regional vegetation coverage is generally composed of halophytic plants with similar appearance to those prevalent in salt marshes (NIOC-IOOC 2005) ⁶.

DOE carries out the survey for macro benthos in bottom sediment in adjacent area of PETZONE:

- Number of sampling locations: 6
- Survey items: benthos, grain size composition, organic matters

It is planned that the number of survey locations is increased from 6 to 9.

This monitoring is expected to understand the situation of bottom environment by studying the transition of environmental indicator species of macro benthos such as Polychaeta or Bivalvia.

⁶ Oil Spills in Mangrove -planning & Response Conditions-, July 201, NOAA

To understand the pollutant level of the target area, transition of number of individuals of specific species such as Polychaeta and Bivalvia are studied.

Such species tends to comparatively resist to depressed oxygen environment by accumulating oxygen into its body with increasing of blood red cells, which turns the color of the individual to red.

Increasing of the number of the species means the bottom environment is getting worth.

(Example)



Polychaeta

Bivalvia

Aonides paucibranchiata

Theora fragilis

Picture source:

left: © Hans Hillewaert / CC-BY-SA-3.0

right: <http://www.pref.chiba.lg.jp/shizen/sanbanze/sanbanse/database/seibutsu/shizukugai.html>

Source: http://en.wikipedia.org/wiki/Bioindicator#Microbial_indicators_in_oil_and_gas_exploration

Figure 4.1.2-23 Environmental Indicator Species

The identification of larval populations in the Ghazaleh and Ahmadi Creeks of Khuzestan province, is verified following table 4.1.2-16 (NIOC-IOOC 2005) ⁷.

⁷ Waste Management Contract Persian Gulf Biological Report Khark Island Operational Area Pre FEED Document, Oct. 2005, NIOC-IOOC

**Table 4.1.2-16 Monthly Abundance of Fish Larva – Western Coasts of Khuzestan
(Sep. 1997 to Sep. 1998)**

Family	September	October	November	December	January	February	March	April	May	June	July	August	September
<i>Gobiidae</i>	29.96	17.95	-	-	-	89.25	41.07	46.86	58.34	41.75	37.19	90.79	15.59
<i>Engraulidae</i>	0	0	-	-	-	0	34.82	19.87	10.63	27.18	0	2.63	0
<i>Clupeidae</i>	59.8	41.03	-	-	-	0	0.3	2.08	10.38	0	2.89	0	44.12
<i>Scianidae</i>	10.78	5.13	-	-	-	0	11.9	17.54	6.06	4.85	38.84	6.32	13.82
<i>Soleidae</i>	0	10.26	-	-	-	10.75	4.46	3.2	1.11	0	0	0	0
<i>Bregmaceroidae</i>	0	12.82	-	-	-	0	0	0	0	0	0	0	0
<i>Cynoglosidae</i>	0	0	-	-	-	0	0	6.4	7.17	3.88	0	0	0
<i>Triacanthidae</i>	0	0	-	-	-	0	0	0	0.37	0.97	0.83	0	0
<i>Callionymidae</i>	2.45	10.21	-	-	-	0	0	1.58	2.6	0	1.65	0	3.82
<i>Syngnathidae</i>	0	0	-	-	-	0	0	0.07	0	0	0	0	1.18
<i>Sillaginidae</i>	0	0	-	-	-	0	0	0	0.49	0	0	0.26	0
<i>Leiognathidae</i>	0	0	-	-	-	0	0	0.18	0.99	4.85	0	0	0
<i>Carangidae</i>	0	0	-	-	-	0	0	0	0.49	20.39	0	0	0
<i>Mugilidae</i>	0	2.56	-	-	-	0	5.95	1.58	0	0.97	0	0	12.94
<i>Platycephalidae</i>	0	0	-	-	-	0	0.3	0.5	0.12	0	0	0	0
<i>Sparidae</i>	0	0	-	-	-	0	1.19	0.14	0	0	0	0	0
<i>Trichiuridae</i>	0	0	-	-	-	0	0	0	0.25	0	0	0	0
<i>Chirocentridae</i>	0	0	-	-	-	0	0	0	1.24	0	0	0	0
<i>Hemirhamphidae</i>	0	0	-	-	-	0	0	0	0.12	0	0	0	0
<i>Ephippidae</i>	0	0	-	-	-	0	0	0	0.12	0	0	0	0
<i>Stromateidae</i>	0	0	-	-	-	0	0	0	0.99	0	16.12	0	8.53
Total Number of Larva in 10m ²	204	39	-	-	-	214	336	2783	809	103	242	380	

Source: NIOC-IOOC,2005

2) Protected Area

At the westward of the PETZONE, quite large area named Shadegan March spreads, which is designated as the National Wild Life Refuge, also as international wetland (see Figure 4.1.2-24). The area was designated as wildlife refuge in 1972 and was designated as international wet land in 1975 (The Atlas 2006⁸).

The area, which is 328,926ha, is divided into two (2) major area, salt water area and fresh water area.

⁸ Atlas of Protected Areas of Iran, 2006, Department of Environment

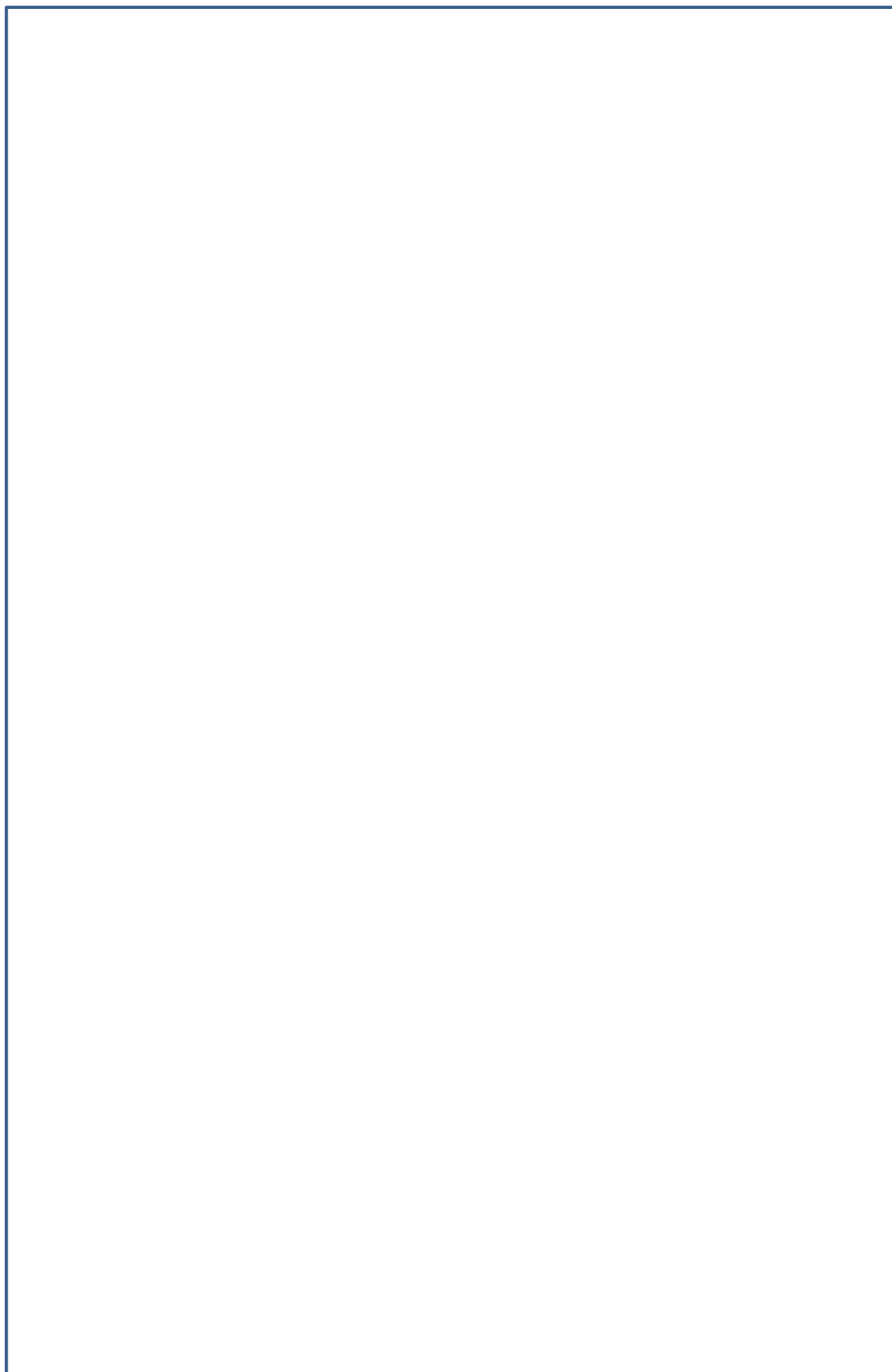


Figure 4.1.2-24 PETZONE and Shadegan Marsh

According to the interview with DOE, 35 bird species (4 domestic and migrate species), 110 plant species and 2 mammals (finless porpoise and dolphin) are observed in the area. The main plant species of the region area are Cypress grass, Cat's tail, Water lily, Sedge, saltwort. And the wetland is a perfect habitat for a great number of resident and migratory threatened birds such as Marbled teal, Dalmation pelican, Goliath heron, Squacco heron, Indian pond heron, Little bittern, Scaup, Ferruginous duck and Imperial eagle (The Atlas, 2006).

Information sheet on Ramsar Wetlands⁹ lists Golden jackal and wild boar as common land mammals in the area.

The species listed above are not categorized as endangered species in Iran according to the IUCN red list¹⁰. However the information sheet on Ramsar Wetland lists the existence of one endangered bird species, *Falco Cherrug* (Saker Falcon).

The marshes provide wintering habitat for some 30-60% of the world population of marbled teal (*Marmaronetta angustirostris*), and appreciable numbers of three other threatened species, namely Dalmatian pelican (*Pelecanus crispus*), ferruginous duck (*Aythya nyroca*) and imperial eagle (*Aquila heliaca*) (NIOC-IOOC 2003)¹¹.

The Atlas(2006) concludes that as the Shdegan wildlife refuge provides a suitable place for living and growth of various species of fish and birds, the area is one of great importance in terms of preserving generic reserves.

3) Impact to Biota from the Petrochemical Zone

It was confirmed in the interview that negative impact from PETZONE to the protected area introduced above is not recognized at moment.

However, PETZONE is very close to eastside of Shadegan Marsh.

Moreover the Atlas of Protected Area of Iran states in the article that over the past years, man-made developments have resulted in various problems and pollutions, especially oil pollution in the region. As for oil pollution, the site survey during the 1st work in Iran confirmed the traces of oil outflow (Figure 4.1.2-17), so there is a possibility that oil spilled out of PETZONE will reach and contaminate protected areas.

Thus it is considered that continuous monitoring for biota is important.

(5) Other Environmental Conditions (Noise)

1) Summary of Sound Levels

The flare gas from petrochemical plant is high pressure and the high noise associated with combustion of the high pressure gas from the flare stack is the issue to be considered. According to

⁹ <http://ramsar.wetlands.org/Database/Searchforsites/tabid/765/language/ja-JP/Default.aspx>

¹⁰ IUCN: International Union for Conservation of Nature, <http://www.iucnredlist.org/>

¹¹ Oil Spill Response Plan Prepared for NIOC-IOOC, Jan. 2003, NIOC-IOOC.

the annual environmental report prepared by PSEZ, 5 sites of 16 monitoring sites exceeded the acceptable level for the noise. For working in such sites where the noise levels are higher than the acceptable level, it is necessary for the workers to wear the protection devices (earplugs or earlaps) to prevent any hearing damages by the high sound. At 3 sites out of the 5 sites exceeding the acceptable levels, it is observed that they have quite frequently exceeded the sound levels. Furthermore, as for one of these 3 sites, it is located in the vicinity of Eskin Camp (an accommodation facility for the operation workers) and there are concerns about possible influences on the health conditions especially of the residents of the Camp. It is needed to implement efficient protective measure, in case that higher noise than the allowable level for human health is measured in the building.

2) Noise Monitoring Data

Noise monitoring is conducted in 16 sites within the PETZONE. The Table 4.1.2-17 shows the results of the noise monitoring during the one year from March 2012.

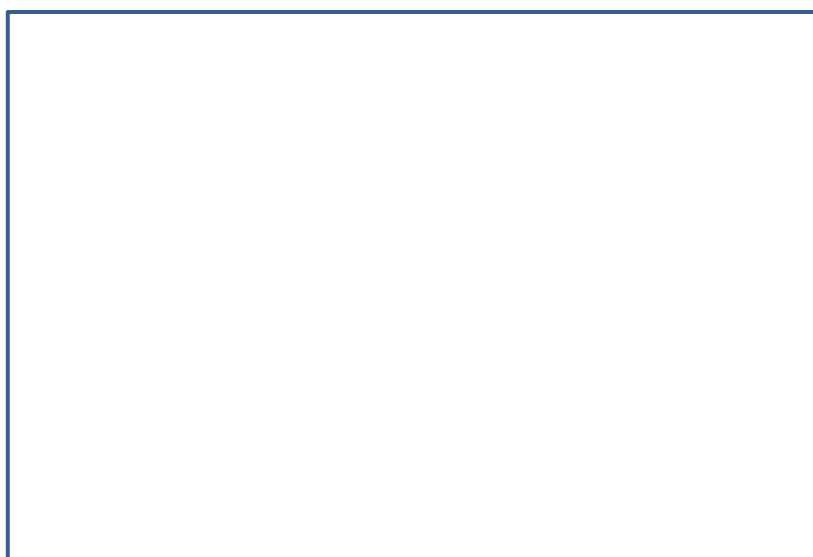
The monitoring result does not include the measured figures, but show the number of cases that meet the standard or not. The noise level that exceeds the acceptable level was recorded in five sites: E (Southern side of Maroon Petrochemical, F (Across from Amen Town), H (Southern side of Fanavaran Petrochemical), I (North side of Eskin Camp) and P (Next to liquid export port). Of which the noise level of three sites, E, I and P, exceeds the standard frequently.

Figure 4.1.2-25 shows the location of Eskin Camp where the noise level frequently exceeds the standard.

Table 4.1.2-17 Data Regarding the Noise Measured

Monitoring sites	Range of acceptable level (dB)	Less than acceptable level (Number of cases)	Over acceptable level (Number of cases)
A (Azadi Sq. Nakhil Zarin Center)	0-65	48	0
B (Street between Sadid and Looleh)	0-75	48	0
C (East side of the refinery-Plant1)	0-75	48	0
D (Main sq. of Plant2)	0-75	48	0
E (Southern side of Maun Petrochemical)	0-75	6	42
F (Across from Amen Town)	0-70	47	1
G (West side of Rejal Petrochemical)	0-75	48	0
H (Southern side of Fanavaran Petrochemical)	0-75	47	1
I (North side of Eskan camp)	0-70	11	37
J (Khor Zangi Channel middle road)	0-75	48	0
K (North side of Khuzenstan Petrochemical)	0-75	48	0
L (Across from Tondgouyan and Amirkabir Petrochemical)	0-75	48	0
M (West side of Amirkabir Petrochemical)	0-75	48	0
N (Southern side of Tondgouyan Petrochemical)	0-75	48	0
O (Across from Razi petrochemical's Northern Gate)	0-75	48	0
P (Next to liquid export port)	0-75	16	32

Source: PSEZ Annual Environmental Report 1391 (March 2012 - March 2013)



Source: Google Earth

Figure 4.1.2-25 The Vicinity of Eskan Camp

4.1.3. Environmental Management

(1) HSE Management System

As mentioned in Section 5.1.1, there are two industrial areas in Mahshahr: Petrochemical Special Economic Zone (PETZONE) and Mahshahr Terminal. PETZONE is managed by Petrochemical Special Economic Zone Company (PSEZ) under the supervision of NPC. Birth control such as shipment of products and fuel supply to vessels is implemented by Terminals and Tanks Petrochemical Company (TTPC) under the supervision of NPC. Mahshahr Terminal located in the south of Mahshahr City is owned by Abadan Refinery under the supervision of NIORDC. The HSE management system in those areas are as follows:

1) PETZONE

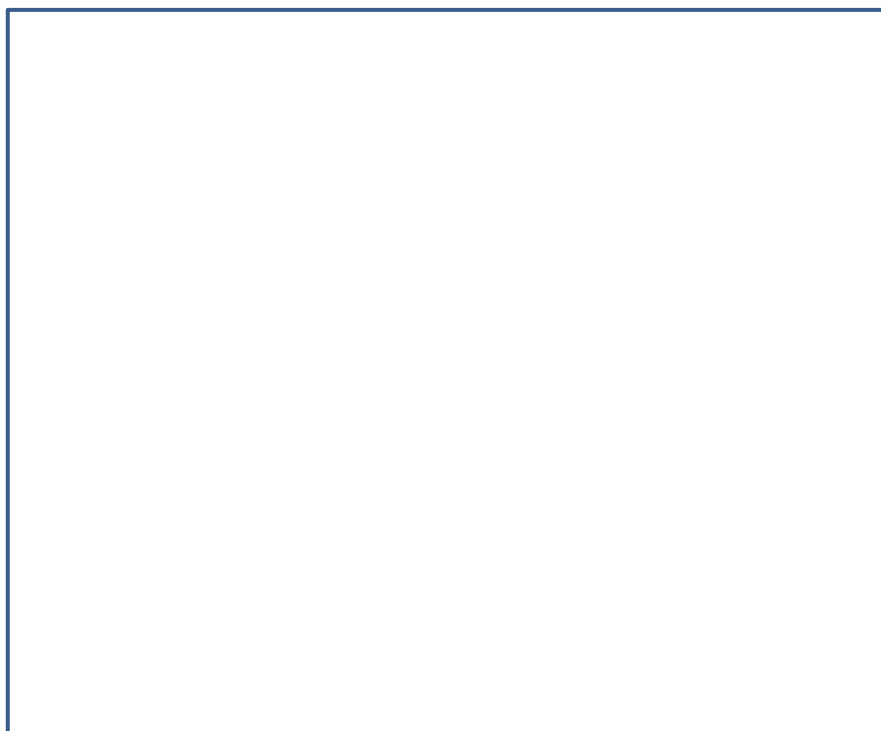
(a) Organization

HSE

The HSE Department of PSEZ manages general HSE matters in the zone. Figure 4.1.3-1 shows the organization of PSEZ's HSE Department. According to the chart, there are four (4) sections: crisis management, safety and firefighting, environmental protection and health. However, the staff members of Crisis Management Section have not been deployed. Table 4.1.3-1 shows responsibility of each section.

Oil spill response

The HSE Department does not have a function of oil spill response because no company produces and refines the crude oil in PETZONE. TTPC is in charge of product shipment in PETZONE and has the responsibility for handling oil spill to the sea at Tier 1, but has no materials and equipment for oil spill management. Thus, at the time of oil spill to the sea at Tier 1, TTPC requests PMO to respond it at the expenses of TTPC.



Source: NPC

Figure 4.1.3-1 Organization of HSE Department (PSEZ)

Table 4.1.3-1 Responsibility of HSE Department

Section	Personnel	Responsibility
Environmental Protection	18 (including laboratory)	• Supervising compliance of environmental regulations and standards • Monitoring environmental conditions within the Zone • Collecting samples and analyzing • Managing industrial waste treatment • Compiling the monitoring data and reporting to NPC
Health	11	• Managing and improving of employees' health • Protecting the employees from danger of harmful/toxic substance • Providing the employees with medical checks
Safety & Firefighting	4 (safety) 209 (Firefighting)	• Preventing accidents through recognizing unsafe conditions (hazard and crisis) • Firefighting • Maintaining equipment and tools • Compiling results of activities and reporting
Crisis Management	3 (planned)	• Addressing crises • Coordinating with relevant organizations when crises occurs

Source: PSEZ

The Environmental Section follows the management systems of NPC and PSEZ and implements the following activities:

- Continuous control and monitoring of wastewater, noise, soil and water pollutants
- Supervision of environmental activities carried out by the petrochemical companies in the zone
- Identification, assessment and control of environmental aspects and impacts in the zone
- Management of special wastes
- Preparation of analytical reports on environmental observations made by the petrochemical companies
- Holding regular (monthly) sessions and meetings on environment issues attended by Environment Department representatives of petrochemical companies and other urban and provincial organizations concerned
- Establishing relations with Iranian universities and scientific and research centers
- Carrying out needs assessment and environmental research projects
- Holding training courses, seminars, and meetings related to environmental issues, in order to increase scientific abilities of environmental managers and experts
- Promoting environmental culture
- Conducting environmental propaganda through preparation of brochures, films, boards, and posters in the region

The Environmental Protection Section of the PSEZ's HSE Department carries out their activities in line with their management system and the guidelines provided by NPC.

(b) Management System

Basically, PSEZ follows the NPC's management system and guidelines and also has their own guidelines related to HSE management and emergency response, such as crisis management, HSE inspection of complexes and relevant locations, monitoring and measuring harmful chemical factors in work environment, waste management, identification of environmental pollutions and monitoring of wastewater and air pollution. The NPC's guidelines provide the method of environmental inspection and monitoring of environmental pollution such as air, wastewater and industrial waste. The Environmental Protection Section of PSEZ's HSE Department implements the daily monitoring of the environmental conditions in the zone in line with the instructions stated in the NPC's guidelines. In PETZONE, Mahshahr, the petrochemical companies submit the environmental monitoring data to the Environmental Protection Section of PSEZ's HSE Department. The section prepares a monthly environmental report and submits the report to the Environmental Protection Section of NPC Headquarters. The environmental monitoring records are shared with the local DOE office every week. The environmental monitoring items are water

quality (COD, BOD, pH, turbidity, phenol and oil and grease), air (PM₁₀, SO₂, O₃ and CO) and noise (sound level).

The guidelines for identifying environmental pollutions provide points or places with potential of pollutions to be paid attention in the petrochemical complexes. The points or places with potential of pollutions are as follows:

< Ambient Air >

- Flaring systems
- Chimneys
- Venting (system) which are related to safe valves of tanks and connecting lines
- Heaters
- Gas turbine generators
- Incinerators
- Places of fugitives emissions such as evaporation ponds, pre-treatment ponds, wastewater treatment plants, waste storage tanks
- Giant reservoirs of Fire extinguishing chemicals and cooling gases
- All places which gases may leak or produce unpleasant odor during the process
- Silencers, pressure reducers and safety valves

< Water & Wastewater >

- Sanitary septic
- Septic and sump which are used for collecting industrial wastewater
- Undersurface of micro boilers
- Undersurface of micro cooling towers
- Surface waters (recognition and identification of surface water canals and their effluents)
- Knockout drum exit and drain drum for flares
- All places which can outflow or seep (chemicals or pollutants) into surface water
- Conveyance paths of all currents to final destination
- Chemical storage and storage tanks
- Desalination units and their rejected output
- Evaporation ponds
- Different units of treatment plant

< Noise >

- All rotary devices such as compressors, pumps, turbines, generators and ejectors
- All fixed devices such as control valves and pressure vessels
- Steam traps and processes with persistent steam out
- Silencers, pressure reducers and safety valves that act instantly but produce a loud noise

- All processing and non-processing points (or places) which produce unpleasant and harassing noise

< Waste >

- Places where oily wastes (such as tanks deposits, sludge of waste water treatment plants, oil used for machineries and engines, cut oil, transformers oils and polluted soils) are produced
- Places where drums wastes and processed containers are produced
- Places where non-oily wastes (such as acid tar, filters materials, activated carbon particles, sludge produced by desalinators, resins, absorbents, dehumidifiers, spent catalysts, desulphurizers and dust of waste incinerators) are produced
- Lab-based wastes
- Places where special wastes as well as radioactive wastes are kept
- All processing and non-processing places which have the potential for production of industrial wastes

PSEZ also has the manual of execution for preventing and facing emergency and crisis, based on the instruction of crisis management in NPC. The manual defines the emergencies as situation which people, facilities and environment are exposed to serious dangers. The emergencies are classified into the following four (4) cases:

- i) Emission, permeation or spill of poisonous and chemical materials, and serious increase in pollutants-beyond permissible level
- ii) Fire and explosion
- iii) Occurrence of natural disasters such as flood and earthquake, and
- iv) War and enemy's air attack

The HSE manager is responsible for the system's periodical practices and readiness. HSE Department supervises training, periodical practices, and readiness of safety equipment and fire-extinguishing equipment. In case that there is a crisis in the zone, Managing Director of PSEZ, Executive Manager Representative in Mahshahr, will act as the executive commander of the regional crisis. On the other hand, combating the emergencies depends on the level of the accidents that are classified by petrochemical companies. According to the NPC's guidelines for the emergency response (applied to petrochemical complexes in both Mahshahr and Assaluyeh), the accidents are classified into the following three (3) levels:

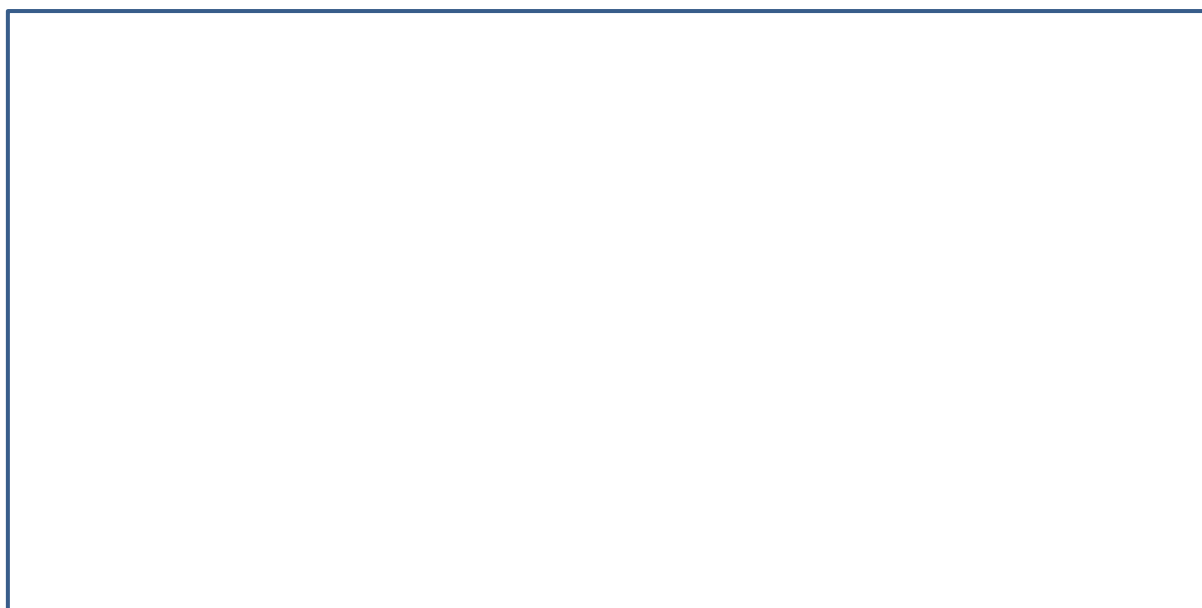
Level 1: Critical conditions are limited and can be controlled by capacity/equipment available in companies

Level 2: Conditions where companies cannot control by their own capacity/equipment and

restrictive or extensive support by other companies is required

Level 3: Conditions where individual companies cannot control and regional cooperation is required

Figure 4.1.3-2 shows the organization structure of crisis management committee in Mahshahr under the supervision of NPC. Main committee members are PSEZ, Razi Petrochemical Company, Bandar Imam Petrochemical Company and non-industrial operation company. PSEZ is a representative of other petrochemical companies such as Amir Kabir Petrochemical Company and Shahid Tondgouyan Petrochemical Company.



Note:  Privatized companies in Mahshahr and Assaluyeh

Source: NPC

Figure 4.1.3-2 Organization of Crisis Management Committee in Mahshahr

PSEZ has the integrated management system based on ISO 9001, ISO 14001 and OHSAS 18001. PSEZ's environmental objectives are composed of the following three (3) parts:

- Objective 1: Continuous monitoring and control of Regional Pollutants
- Objective 2: Source Management
- Objective 3: Enhancing environmental culture and participation attraction of the beneficiary parties

Action plans for each objective for last two (2) years are shown in Table 4.1.3-2. It is stated in the action plans of Objective 1 for 2012 that sampling and monitoring of water in the coastal area and estuaries includes not only water but also sediments. Monitoring of heavy metals also added in the action plans for 2012. As for Objective 2, activities for waste management are enhanced in the action plans for 2012.

Table 4.1.3-2 Environmental Objectives of PSEZ's HSE Department

No.	Activities for 1390 (from March 2011 to March 2012)	Activities for 1391 (from March 2012 to March 2013)
1	• Daily monitoring and observation of regional water and soil pollutants • Seasonal tests on wastewater discharged from wastewater treatment plants and smoke emitted from stacks by laboratory certified by DOE • Sampling and monitoring of water in the region's coastal area and estuaries • Purchasing and fixing two air quality display boards • Holding continuous meetings with the environment officials of the Petrochemical Companies in the special zone, city and province • Systematic identification, transfer and removal of petrochemical industries' wastes	• Daily monitoring and observation of regional water and soil pollutants • Seasonal tests on wastewater discharged from wastewater treatment plants and smoke emitted from stacks by laboratory certified by DOE • Sampling and monitoring of water and sediments in the region's coastal area and estuaries • <u>Monitoring of heavy metals in the discharge channels of surface water of complexes and wastewater treatment plants</u> • Purchasing and fixing two air quality display boards • Holding continuous meetings with the environment officials of the Petrochemical Companies in the special zone, city and province • <u>Transferring 600 tons of industrial wastes of petrochemical industries to the petrochemical landfill site</u>
2	• Implementation and completion of the plan on formulation of environmental principles, permits and offenses of the site 4, of Petrochemical Special Economic Zone • Ecological identification and classification of marine-coastal habitat within the coastal area of PSEZ • Carrying out the monitoring and control plan of air pollutants • Following the recycling of the region's hazardous and industrial wastes • Managing the region's urban wastes • Expansion of regional green space • Planting and maintenance operations of green spaces • Assessing the wastes of the Bandar Emam Petrochemical Landfill and Special Zone • Organizing the Khor Zangi Marginal Areas • Dredging of Mahshahr's estuary • Canalizing the Chamran City's sewage transfer line	• Following the studies of the ecological identification and classification of the marine and sea-side habitats in the PSEZs shores • <u>Carrying out heavy metals level measurement plan and oil hydrocarbons as the oil pollution criteria and offering practical removal methods</u> • <u>Accomplishing the comprehensive plan for monitoring and control of the air pollutants</u> • <u>Feasibility assessment of culturing Cherish or Neem Tree Azadirachta Indica</u> • <u>Pursuing establishment of the sanitary landfill for dangerous industrial wastes</u> • <u>Pursuing establishment of the industrial waste incinerator</u> • <u>Establishing a recycling site for systematic management of the region's industrial and urban wastes in Site 1</u> • <u>Systematic management of the urban and hospital wastes</u> • Feasibility of expansion of the green space • Planting and maintenance operations of the green space
3	• Programming a specialized 1000-hour training course or seminar on energy and environment for the energy and environment officials and experts • Holding cultural ceremonies • Active participation in provincial and national environment exhibitions	• Formulating and providing environmental messages as well as holding cultural ceremonies • Active participation in provincial and national environment exhibitions

Note: The parts underlined show the activities improved from those for 2011-2012.

Source: PSEZ

(2) Environmental Management Technology

Based on the survey results that have been obtained so far, possible measures to be taken for solving and mitigating the environmental problems concerned in the PETZONE are considered as follows.

1) Air Quality Control Technology

(a) Complete Combustion of the Flare Stacks

It is observed that, as a whole, 1% of the operation hours of flare stack were in abnormal conditions emitting the smoke in the atmosphere. The following things are considered as a cause of the incomplete combustion of the flare stack.

- Excessive amount of gas (exceeding the treatment capacity of the flare stacks)
- Incomplete mixing of surplus gas and air
- Contamination of liquid into gas

The cause of incomplete combustion must be investigated first. If the amount of surplus gas released does not exceed the treatment capacity of the flare stacks, dust generation can be suppressed by blowing steam or air into the combustor nozzle at the top of the flare stacks to facilitate the mixing of gas and air.

2) Water Pollution Control Technologies

(a) Wastewater Treatment Technologies

➤ BIPC

BIPC conducts the primary treatment for wastewater or no treatment at all, not to mention the secondary treatment, and thus discharged water fails to satisfy the effluent standards in terms of COD, pH and turbidity. In addition, BIPC discharges a large amount of wastewater with the amount of COD totaling 3,000 ton each year, so the environmental load is substantial. It can greatly improve the quality of discharged water by ensuring the primary treatment and adopting the secondary treatment. Currently, it is planning to build a central wastewater treatment facility, which is expected to improve the quality of discharged water and reduce the amount of pollutants in it.

➤ Tondgouyan PC

Tondgouyan PC treats wastewater with higher COD concentration compared to other companies in PETZONE, so has wastewater treatment facilities of higher performance. However, it faces a problem of having wastewater inflow that substantially exceeds the design value of the wastewater treatment facility. Eventually, it discharges excessive wastewater to the sea without any treatment. Possible countermeasures can be chiefly classified into the following two groups

- Improvement in the treatment capacity of the existing facility
- Introduction of the Cleaner Production (CP) technology

One way of improving the treatment capacity of the existing facilities is to improve the function of the secondary treatment facilities. The capacity of anaerobic treatment has in fact been improved by raising the treatment temperature from 37°C to 50°C. For aerobic treatment, on the other hand, it is possible to improve the treatment capacity by keeping the amount of biomass high concentration (high MLSS concentration). The following approaches are normally taken for these improvements.

- Taking longer sludge retention time (SRT)
- Making aeration tanks the MBBR (Moving Bed Biofilm Reactor) design
- Making aeration tanks the MBR (Membrane Bio Reactor) design

Currently, Tondgouyan PC is considering introducing MBBR.

The CP technology is an environmental preservation technology reducing pollutants at stages prior to wastewater treatment. Specifically, the technology aims, for example, to change the manufacturing methods, improve in the manufacturing efficiency and prevent organic substances from mixing into wastewater. Any change in the manufacturing methods or an improvement in the manufacturing efficiency cannot be realized by the department in charge of wastewater treatment alone, which must work together with the product manufacturing departments. The method of treating pollutants at the immediately preliminary stage before discharging from the wastewater treatment facilities is called the End of Pipe (EOP) technology.

➤ Razi PC

The wastewater from the urea plant is treated through the primary and secondary treatment process, the discharged water from the two ammonia plants is released without any treatment. A new treatment facility is currently at the design stage, which enables to expect that the wastewater problems could be solved in the future.

➤ ET-1 (Fajr PC)

ET-1 receives raw water with high salt concentration and aromatic compounds, which is not suitable for biological treatment. Such water must be basically mixed with dilution water to lower salt concentration before biological treatment. But it is difficult to secure supplies of dilution water in some cases. Moreover, adding dilution water increases the overall amount of water to be processed, resulting in the shortening of the treatment time. At present, Fajr PC is considering the possibility of treating some of inflow raw water at ET-2, which is another solution. At the same time, companies sending wastewater with high salt concentration to ET-1 must consider measures to reduce the salt concentration.

If wastewater contains harmful/toxic substances such as aromatic compounds, the plants sending it to the integrated wastewater treatment facility must introduce any pre-treatment equipment (See

Figure 4.1.3-3) or consider measures to reduce the concentration of the harmful/toxic substances.



Source: Study team

Figure 4.1.3-3 Image of an Integrated Wastewater Treatment System

(b) Mercury Measurement

Kimya Bandar Imam Co., an affiliate to BIPIC, engages in chlor-alkali business, and wastewater from the process of electrolyzing salt water includes mercury, which is processed at a mercury removal facility and discharged via East Pond to the sea. However, residual mercury concentration in discharged water is around 40µg/L, which exceeds the effluent standard. For further removal of mercury, it is technically possible to apply the absorbent method using mercury absorbent called chelate resins and activated carbon, though the method costs a lot and waste materials generated need to be properly disposed of. To convert mercury electrode to a membrane electrode that does not use mercury is fairly effective.

3) Noise Mitigation Technology

(a) Noise Mitigation Technology for the Flare Stacks

There are 3 sites in the PETZONE where the noise has quite frequently exceeded the acceptable levels. One of these sites is located in the vicinity of the accommodation facility for workers, causing concerns about health of the residents. The major source of the noise is the flare stack installed in the area adjacent to the site. The flare stack, in general, burns out the off-gas and surplus gas from the process plant in the atmosphere at a height, which mitigates radiant heat on the ground by the distance of the height direction. However, this possesses some negative aspects such as radiant heat, noise, and visible flame that impact on the neighboring environment widely.

First of all, it is necessary to investigate the root source of the noise problems and to consider

possible measures to be taken. Probable causes of high noise at flare stack seem to be excessively higher flow and pressure of the flare gas than the design capacity of the equipment. For this case, the improvement of the situation could be made by the operational adjustment.

One effective measure against noise problems in future is the application of the ground flare system (see Figure 4.1.3-4). The ground flare is a device to burn out the flare gas inside the cylindrical furnace on the ground, which causes less impact on the said neighboring environment. In recent years, the demand for this type of the flare system has been increasing out of consideration for the impact on the neighboring residents and the landscape.

It might not be appropriate for this case to introduce the ground flare system taking into account the financial and technical feasibility. Meanwhile, as a physical approach to mitigate the noise impact for those who utilize the accommodation facility, installing sound barriers and double-glazed windows will be useful.



Source: http://www.m-kagaku.co.jp/kashima/rc/knowledge/knowledge_02.html

Figure 4.1.3-4 Ground Flare

4.1.4. Future Development Plan of Mahshahr

Currently, there are 18 petrochemical complexes in the PETZONE, and PSEZ continues to welcome domestic and overseas investments. Table 4.1.4-1 shows 11 NPC-related projects that are on progress in the PETZONE. There is concern that the commencement of production under these projects will accumulate negative impacts on the environment via the release of pollutants to the air and an increase in pollutant loads of waste water. It will also increase the amount of waste materials. Therefore, consideration must be given to environmental conservation in future including upgrade or new construction of treatment facility.

Table 4.1.4-1 Ongoing Projects in PETZONE

	Project title	Contractor	Product Capacity (‘000 ton/y)	Physical Progress (as of March 2012)
1	Isocyanates — Phase 2	Karoon PC.	MDI ¹ : 40 Hydrochloric acid: 45	72.8%
2	Chlor Alkali & PVC ²	Arvand PC	PVC: 340、EDC ³ : 330 Liquid chlorine: 187 Caustic soda: 634 Sodium hypochloride: 16	99.9%
3	Bandar Imam 3 rd NF ⁴	PIDMCO	Ethane: 443、Propane: 870 Butane: 668、C5+: 649 Fuel gas: 35	96.4%
4	PDH ⁵	Salman-e-Farsi PC	Propylene: 450	6.8%
5	Centralized Utility (Fajr, Phase 2)	Fajr PC	Electricity, Steam, RO water, Cooling water, Potable water, Nitrogen, Oxygen etc.	90.8%
6	Acrylonitrile	Prg PC	Acrylonitrile: 100 Acetonitrile: 3.2 Hydrogen Cyanide: 11 Ammonium sulfate: 12	-
7	Acrylates	Ofogh Polymer Petro Technology Co.	Acrylic acid: 30 Oxo Alcohols: 25 Acrylic Esters: 62 Super Absorbing Polymers: 45 Liquid CO ₂ : 7	-
8	MAH ⁶ , BDO ⁷ and PBT ⁸	Ibn-e-Sina Petro Kimiya Co.	MAH: 25、BDO: 20 PBT: 60、Isobutane: 50 Tetrahydrofuran: 24	-
9	2 nd Liquid Products Jetty	PSEZ Organization	-	97%
10	MAH ⁶	Modabberan Shimi Co.	MAH: 20 Fumaric acid: 4 Unsaturated Poly ester resins: 15	-
11	Methyl Ethyl Ketone	Arya Shimitex Co.	Methyl Ethyl Ketone/ Butyl Alcohol: 8	98%

Source: NPC Projects Petrochemical Industry, 7th Edition, April 2012

Note:

1 MDI: Methylene diphenyl di-isocyanate

2 PVC: Polyvinyl chloride

3 EDC: Ethylene di chloride

4 NF: Natural Gasoline Fractionation

5 PDH : Propane Dehydrogenation

6 MAH: Maleic Anhydride

7 BDO: Butanediol

8 PBT: Polybutylene Terephthalate

4.1.5. Issues

(1) Air Environment

Table 4.1.5-1 shows the issues on the air environment in Mahshahr.

Table 4.1.5-1 Issues on Air Environment

Item	Present situation	Issue
Air pollution	PM10 outstandingly exceeded the limit of acceptable concentration and some even reached at the hazardous level of concentration. (SO ₂ satisfies the limit of acceptable concentration.)	• Survey to find the source generating dust • Consideration of countermeasures • Setting numerical targets to improve the air quality
Air monitoring	Currently, air monitoring station exists at one point only.	• Installation of additional monitoring stations, if necessary

(2) Water Environment

Table 4.1.5-2 shows the issues on water environment in Mahshahr.

Table 4.1.5-2 Issues on Water Environment

Item	Present situation	Issue
Excess of the effluent standard	A large amount of wastewater exceeding the effluent standard is released, raising a concern about the impact on the water quality of the surrounding sea zone, progress of contamination of bottom sediment and the ecological system.	• Construction of new wastewater treatment facilities • Strengthening of the existing facilities • Consideration of introduction of CP technology • Consideration of segregation of wastewater • Wastewater control
Excess of the effluent standard (mercury)	There is wastewater exceeding the effluent standard of mercury, raising a concern about impact on the health of the neighbouring residents through the food chain.	• Shift from mercury electrode to ion exchange membrane electrode
Monitoring of the surrounding sea area	Excess of standard/guideline value in some parameters (draft standard in Iran and criteria from other countries was used) was recognized from the result of monitoring survey at surrounding area of PETZONE. Its distribution pattern shows a tendency that each value is high at upper stream in the water course of surrounded area of the PETZONE and low at downstream, suggesting the impact from the PETZONE.	• Continuous monitoring • Investigation of the causes • Consideration of countermeasures

(3) Waste

Table 4.1.5-3 shows the issues on the waste management in Mahshahr.

Table 4.1.5-3 Issues on Waste

Item	Present situation	Issue
Waste management	The petrochemical companies in the PETZONE have classified the solid wastes with code numbers, in order to grasp the sources, amounts, disposal methods and disposed amounts. The primary storages and final disposal plant have been appropriately managed, so no particular environmental issue has come to the surface.	- Continuous and appropriate waste management - Appropriate management of waste catalysis and waste containing mercury provisionally stored at the final disposal site and recycling of valuables

(4) Biota and Conservation Area

Table 4.1.5-4 shows the issues on biota and conservation area in Mahshahr.

Table 4.1.5-4 Issues on Biota and Conservation Area

Item	Present situation	Issue
Negative impact of the industrial area	According to hearings, no negative impact of PETZONE on Shadegan National Wild Life Refuge is observed. The Atlas of Protected Area of Iran (2006) states that artificial development of the area in many years has caused various problems and contamination (particularly, oil contamination).	- Continuous monitoring to grasp any negative impact of the industrial area to nature preserves - Consideration of countermeasures when monitoring has found any negative impact on the environment

(5) Other Environmental Conditions (Noise)

Table 4.1.5-5 shows the issues on other environmental conditions (noise) in Mahshahr.

Table 4.1.5-5 Issues on Noise

Item	Present situation	Issue
Noise	The noise exceeds the acceptable level at some points near the flare stack.	- Investigation of the causes - Consideration of countermeasures

(6) Future Development Plan

Table 4.1.5-6 shows the issues on future development plans in Mahshahr.

Table 4.1.5-6 Issues on Future Development Plan

Item	Present situation	Issue
NPC-related projects	Currently, a total of 18 petrochemical complexes, where 11 NPC-related projects are in progress.	- Mitigation and avoidance of accumulate negative impacts of contaminants on the air environment and water quality - Control of the amount of waste generated

4.2. Khark Island

Khark Island is located approximately 57 km offshore in the northwest of the provincial capital Boushehr, at latitude twenty nine degrees fifteen minutes north (north latitude 29° 15') and longitude fifty degrees twenty minutes (50° 20'), with the length of around 8 km from north to south and the width of 4-5 km from east to west. The total size of the Island is approximately 35 km². The island and its surrounding area have a rich natural environment: they are surrounded by coral reefs and sea turtles come ashore of the island to lay their eggs. It is at the same time an industrial zone, where Iran's biggest crude oil loading facilities for export, onshore crude oil treatment facilities and tank yards of crude oil, as well as petrochemical plant, are situated.

4.2.1. Outline of the Industrial Zone of Khark Island

(1) Summary of the Oil Industry

The petroleum facilities in Khark Island are operated by the following three national companies.

Iranian Offshore Oil Company (IOOC)

IOOC is affiliated to National Iranian Oil Company (NIOC), with the headquarters located in Teheran City and 6 branches inside the country. One of these branches is in charge of the offshore oil, gas field development, and crude oil production around the Island. Crude oil with associated gas and produced water produced in the offshore oil fields are processed in the Island, and the treated crude oil is stored in the crude oil storage tank terminal in the Island. Table 4.2.1-1 shows the crude production rate from each oil field.

Table 4.2.1-1 Crude Oil Production in Khark Island Area

Name of Oil Field	Production quantity (Barrel/day)	Distance from the Island
Aboozar Oil Field	140,000	Approx. 76 km
Dorood Oil Field	140,000	Approx. 10 km
Foroozan Oil Field	80,000	Approx. 100 km
Total Amount	320,000	

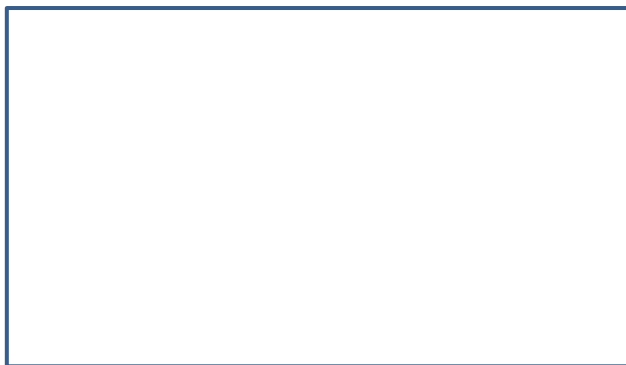
Source: IOOC Brochure

Iranian Oil Terminal Company (IOTC)

Iranian Oil Terminal Company (IOTC) is a subsidiary company of NIOC, with the headquarters located in Khark Island. IOTC is in charge of the operation management of the crude oil storage

tank terminal and the loading operations of the loading facilities (the crude loading berths in the east and west coasts, see Figure 4.2.1-1).

The crude oil storage tank terminal in Khark Island with the storage capacity of around 31 million barrel, stores the crude oil produced in the offshore oil fields surrounding the island and the crude oil produced on the main land transferred through the subsea pipelines. Around 93% of the Iranian crude oil was exported from this terminal to other countries in 2007.



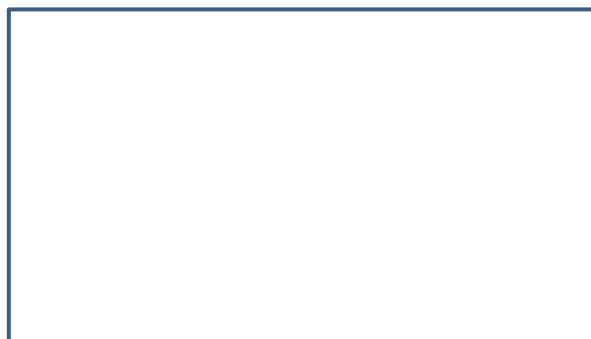
Source: IOTC

Figure 4.2.1-1 Crude Loading Berth in the East Coast and Crude Storage Tanks

Khark Petrochemical Company (KPC)

KPC was a subsidiary company of the National Petrochemical Company (NPC), but it is privatized, and produces mainly approximately 400,000 ton/year of methanol, approximately 100,000 ton/year of LPG and approximately 50,000 ton/year of solid sulfur, utilizing the natural gas as raw material produced from the crude - gas treatment facility in IOOC.

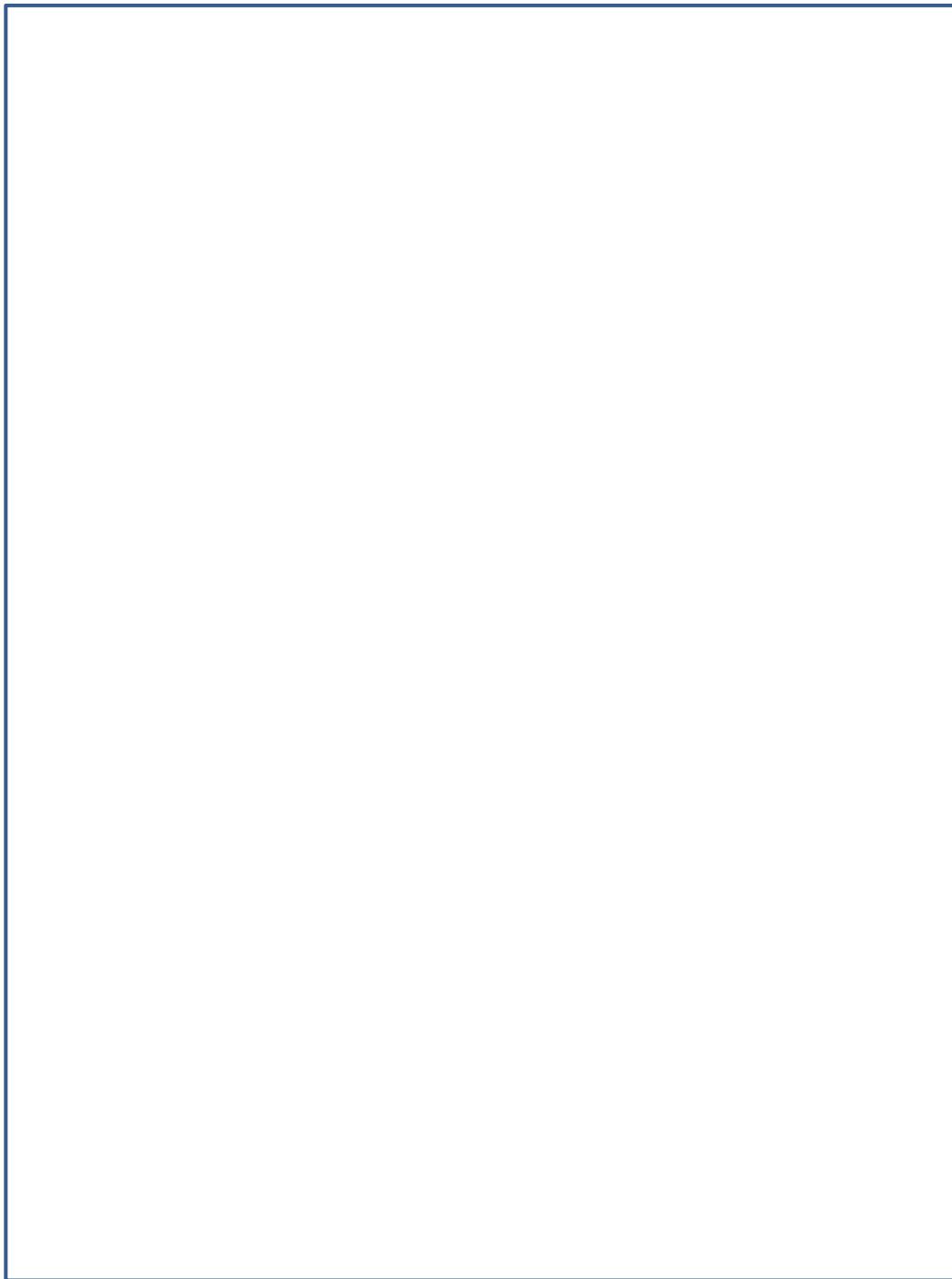
The production facility removes H₂S in the natural gas through the desulfurization facility and extracts methane, ethane, propane and butane by the distillation unit. Propane and butane gases are converted to LPG, methane and ethane gases are made into methanol as products.



Source: KPC Brochure

Figure 4.2.1-2 Overview of KPC Plant

Figure 4.2.1-3 is the layout of each facility in Khark Island.



Source: IOOC

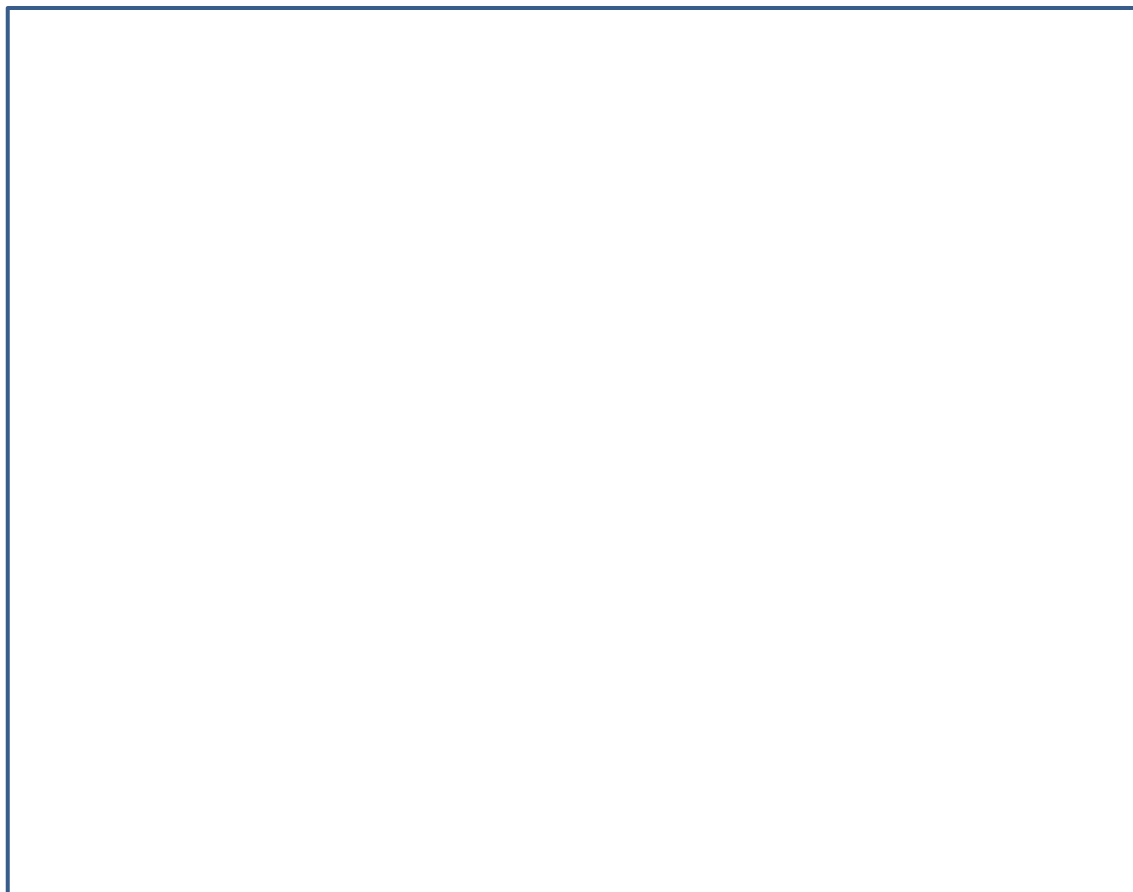
(○ : IOOC, ○ : IOTC, ○ : KPC)

Figure 4.2.1-3 Layout of Facilities of IOOC, IOTC and KPC in Khark Island

(2) Production Facilities of IOOC

1) Offshore Oil Fields

IOOC manages production in four offshore oil fields surrounding Khark Island.



Source: IOOC

Figure 4.2.1-4 Marine Oil Fields and Khark Island

The crude oil from the offshore oil fields (Aboozar, Esfandiar, Foroozan, and Dorood) is processed by the production separator installed on each offshore platform to be separated into crude oil, associate gas and produced water, while the crude oil is transported via pipelines to the treatment facilities in Khark Island. Meanwhile, the associate gas in these oil fields is burnt out by the flare stacks on the sea, while the produced water is basically released to the sea after eliminating the oil content by the on-board wastewater treatment equipment (Oil Floatator).

2) Onshore Crude Treatment Facility

As shown in Table 4.2.1-2, there are 3 trains of crude treatment facilities in Khark Island.

Table 4.2.1-2 Oil Field and the Production Facility

Oil-Gas Treatment Facilities	Name of Oil Field	Marine Production Facility/ Pipeline toward Khark Island
Train 1	Aboozar	Marine Production Platform: 3 units 24 inch pipeline, 80 km: 1 line
Train 2	Esfandiar	Marine Production Platform : 1unit 16 inch pipeline, 20 km: 1 line
	Foroozan	Marine Production Platform: 1unit 20 inch pipeline, 100 km: 1 line
Train 3	Dorood	Wellhead Platform: 10 units 8 inch pipeline, 10 km: 7 lines

Source: IOOC Brochure

The above crude treatment facilities Trains 1/2/3 comprise the following process equipment.

- Oil/gas separator: to separate the gas/produced water (associated water) in the crude oil
- Crude oil desaltor: to remove the salted water from the crude oil
- Crude oil stripping unit: to remove H₂S from the crude oil
- Gas flare system: to burn out the surplus gas produced from the production facilities
- Gas sweetening unit: to remove H₂S component from the produced gas
- Wastewater treatment equipment: to eliminate the oil content from the produced water (the residual oil after the treatment is less than 10 mg/L)

The crude oil processed in the treatment plant is transferred to the crude oil storage tanks of IOTC and exported from the crude loading berths.

In the recent oil upstream sector, enhancement of crude production and pressure maintenance of the oil reservoir are in general conducted by reinjection of the surplus gas which is burnt out by the flare stacks and produced water. Likewise in Iran, for the purpose of enhancement of the production in the Dorood oil field by pressure maintenance, the modernized reinjection systems with seawater treatment facility of 250,000 barrel/day capacity and 1.2 million cubic feet of surplus gas were built in 2008 in the Aboozar Oil-gas treatment facility (Train 1). IOOC is currently testing the systems.

Furthermore, IOOC has launched a new project for recovery and effective utilization of the surplus gas flared in the offshore, which is in progress currently. (The details are described in subsection 4.2.4.)

In addition, mainly IOOC has been considering a plan of increasing the crude oil production by the reservoir pressure maintenance, based on the previous achievements and experiences in the areas other than Khark Island. Therefore, the basic research on applied technologies to contribute to the petroleum reservoir which requires the technological competence most, has been intensively promoted in collaboration with the following 6 universities.

- Sharif University of Technology
- Shiraz University
- Sharif University
- Teheran University
- Amir-Kabir University of Technology
- University of Petroleum Industry

(3) Current Conditions of Facilities in IOTC

1) Crude Oil Storage Tank Terminal

The total storage capacity of the crude oil tanks in the terminal is approximately 31 million barrel, with the biggest tank of 1 million barrel (160,000 m³). The total number of tanks reaches at around 40 units. Their details are shown in the following Table 4.2.1-3.

Table 4.2.1-3 Break-down of the Storage Tanks

Category	Share of the storage capacity
Tanks for both Iranian Heavy Crude Oil and Light Crude Oil	70%
Tanks specified for Iranian Light Crude Oil	25%
Fuel Oil (to be supplied for the visiting tankers)	5%

Source: Study team

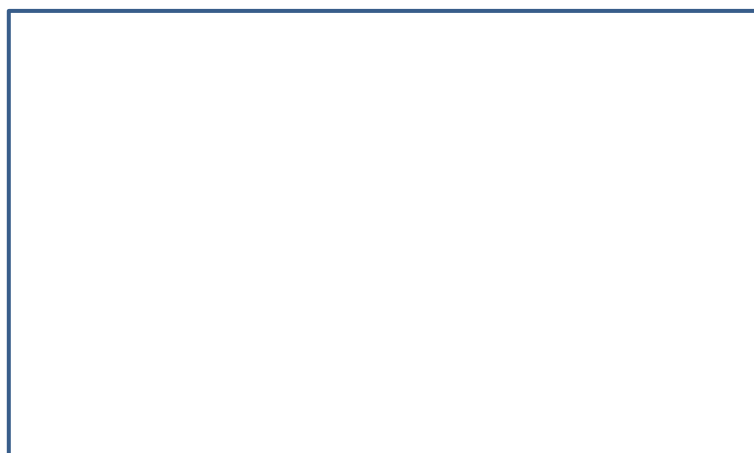
Furthermore, there is a plan to expand the storage capacity to more than approximately 4 million barrel by building storage tanks.

2) Crude Loading Facilities

Crude loading facilities include two offshore crude loading berths located in the east and west coast of Khark Island.

East Loading Berth

The east loading berth is located offshore extending the land bridge from Khark Island by around 1.0 km and its depth is around 20-23m. Therefore, it is confined to berthing of the tanker of approximately 200,000 DWT (deadweight tonnage). The berth with the length of around 1,600m is a base facility that possesses 3 crude loading facilities in each coast and these 6 facilities in total enable the operation of berthing and loading.

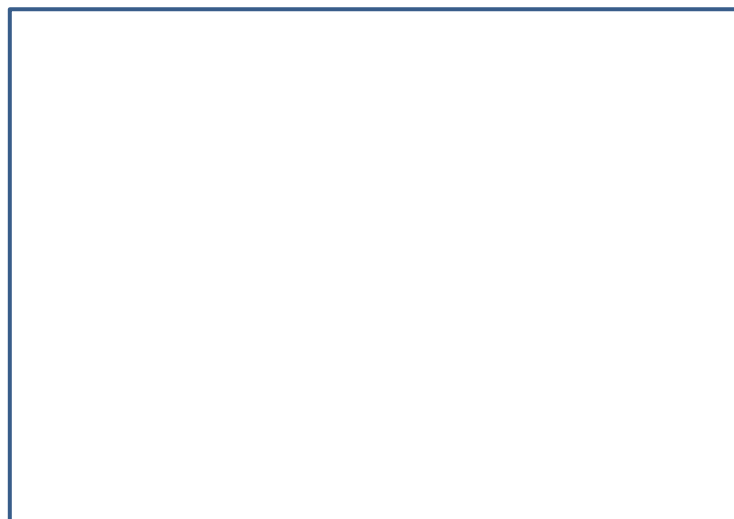


Source: IOTC Brochure

Figure 4.2.1-5 East Loading Berth

West Loading Berth

The west loading berth is located with the depth of around 30-35m, allowing the arriving tankers of around 300,000-500,000 DWT to come along the dock. It possesses the 3 loading facilities and is specialized for super tankers.



Source: IOTC Brochure

Figure 4.2.1-6 Overview of West Loading Berth

4.2.2. Outline of Current Environmental Conditions in Khark Island

(1) Air Quality

1) Outline of Air Quality

The following factors are regarded as emission sources of air pollutants.

- (i) Flue gas emission from flare stacks
- (ii) Flue gas emission of the combustion equipment (power generators, furnaces, boilers, etc.)
- (iii) Hydrocarbon gas (VOC) released from the operation of process equipment, crude oil tank and crude loading equipment

Since the above factor (ii) and (iii) is small as air pollution sources in Khark Island, the flare stacks of surplus gas of the crude oil treatment facility in IOOC and the flare stack in KPC could be identified as the main air pollution sources. The flare stacks emit air pollutants such as SO_x, NO_x, PM (particulate matter), greenhouse gases such as CO₂, and black smoke due to incomplete combustion. Four air monitoring stations exist in the island but are not under any integrated management because each company has their station for purpose of its own.

2) Flare Gas

Table 4.2.2-1 estimates the amount of flare gas generated from each crude oil treatment facility as the main sources of air pollution. Each flare gas amount is estimated based on the size of flare gas pipelines and the flame size of the flare stacks due to lack of measurement data.

Table 4.2.2-1 Estimated Quantity and Features in the Flare Stacks

Name of treatment base		Flare amount Million SCF/day	Features of the flare gas
Train 1 Aboozar Oil Field	High pressure	10-20	Most of the high pressure associate gas is transferred to KPC, while the residual gas is flared.
Train 1 Aboozar Oil Field	Mid-pressure	10-20	Surplus natural gas
Train 1 Aboozar Oil Field	Low pressure	10-20	H ₂ S gas from desulfurization unit and surplus gas
Train 2 Esfandiar, Foroozan, Dorood	High pressure	10-20	Surplus natural gas
Train 2 Esfandiar, Foroozan, Dorood	Mid-pressure	10-20	Surplus natural gas
Train 2 Esfandiar, Foroozan, Dorood	Low pressure	10-20	H ₂ S gas from desulfurization unit and surplus natural gas
KPC (Petrochemical)	Low pressure	20-30	H ₂ S gas from desulfurization unit and surplus natural gas

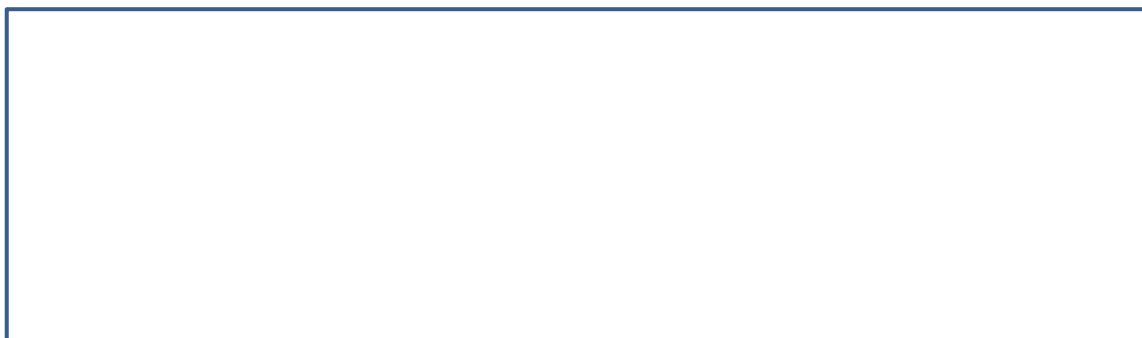
Source: Study team, 2012

The total amount of flare gas in Khark Island depends on the crude oil production rate and is roughly estimated as 80-150 million SCF/day. When the acid gas including H₂S content out of this is estimated around 5% of the total amount of gas, or 4-7 million SCF/day as the gas amount. It is assumed that this concentrated sulfurous acid gas and the incomplete combusted gas after the combustion are the main factors for the air pollution.

The flare stack is installed at the upland in Khark Island, enabling the winds to diffuse the gas and the air pollution inside the Island to be relatively limited.

The flaring of the surplus associate gas from the crude oil treatment facility is the matter to be examined as one of the biggest environmental issues in the oil field development, in light of preventing the proliferation of the global warming gas and the air pollution substances, the reduction or abolishment of which are of the current world-wide trends.

Especially, as shown in Figure 4.2.2-1, it is observed that the flare stack release the black smoke due to the incomplete combustion of the flare gas which includes SO_x, NO_x, and PM (particulate matter). This is an issue to be considered in the coming period, where any measures including a plan of strengthening facilities in the future (further details are explained in 4.2.3 (2) Environmental Management Technology and 4.2.4 The Future Plan).



Source: Study team

Figure 4.2.2-1 Flare Stacks (left: Train 1, right: Train 2)

3) Air Quality Monitoring

Table 4.2.2-2 shows the locations of the air quality monitoring stations in Khark Island.

Table 4.2.2-2 Air Monitoring Stations

Monitoring stations	Monitoring site	Purpose
IOOC-1	Plant site of Train 2	Management of the working environment and health of operation workers
KPC-1	Plant site of KPC	
IOTC-1	Entrance of the tank yard	
IOTC-2	Residential areas in Khark Island	Aerial environment of the residential areas, health management of the residents

Source: Study team

Table 4.2.2-3 shows an example of air quality monitoring data of IOTC-2 for reference.

Table 4.2.2-3 Air Quality Monitoring Data (10:00, 14th October, 2012)

Item	IOTC-2 (Khark Island residential areas)
SO ₂ (ppb)	35 – 40
NO (ppb)	30 – 35
NO ₂ (ppb)	100 – 105
NO _x (ppb)	130 – 140
CO (ppm)	2.32 – 2.33

Source: IOTC

The data above shows that the SO₂ concentration (35 - 40 ppb = 0.035 - 0.04 ppm) in a residential area of Khark Island was less than the environmental standards (0.035 ppm), leading to a conclusion that there is no concern about possible influences on health conditions of the residents. Even so, it is still needed to refer to more data and clarify the current situation.

These air monitoring data are managed in the HSE Office of IOTC. In case of any abnormal data to be detected, this is to be reported to the manager in charge of industry in the local government agency of Khark Island, the HSE Manager of IOOC, and the HSE Manager of KPC. Meanwhile, each company in the island has their own air monitoring stations for each purpose, while there is not comprehensive management system on the installation locations and data compiling.

The data obtained from the site survey is more or less equal to the values set out by the environmental standards. If the enhancement of the facilities in future and preparation for accidents are taken into account, more monitoring stations will be needed, details of which are described in Section 7.5.

(2) Water Environment

1) Outline of Water Environment

While Khark Island is surrounded by the rich natural environment, the island itself has an industrial zone, so wastewater from the facilities must be appropriately treated. The main source facilities in the industrial zone discharging wastewater are as follows:

- Onshore treatment facilities for the crude oil of IOOC
- Crude oil tank yards of IOTC
- Petrochemical plants of KPC

IOOC and IOTC face the following problems among other things about wastewater treatment.

- Because of increase in produced water, the amount of discharged water from crude oil treatment facilities has been increasing over years compared to the time when the crude oil production started. As a result, some wastewater in excess of the capacity of the existing wastewater treatment facilities is being discharged to the sea without any treatment.
- Tank drain from the Crude oil tank yards of IOTC are processed simply to separate oil it before discharged to the sea.
- Since the facilities of IOOC and IOTC discharge wastewater to the sea without thoroughly treated, so the wastewater is likely to exceed the effluent standards of oil and COD. The wastewater discharged is also likely to contain various other chemical substances, heavy metals and NORMs (Naturally Occurring Radioactive Materials).
- The soil in wastewater ponds and drainage paths of IOOC and IOTC is contaminated by oil and other substances contained wastewater.

On the other hand, KPC treats its wastewater appropriately at wastewater facilities within the plant, so it seems to have almost no impact on environment.

2) Present Situation of Wastewater Treatment Facilities in Khark Island

This section describes the present situation of industrial wastewater discharged from the onshore crude oil treatment facilities of IOOC, the crude oil storage tank yards of IOTC and the petrochemical plant of KPC.

(a) IOOC

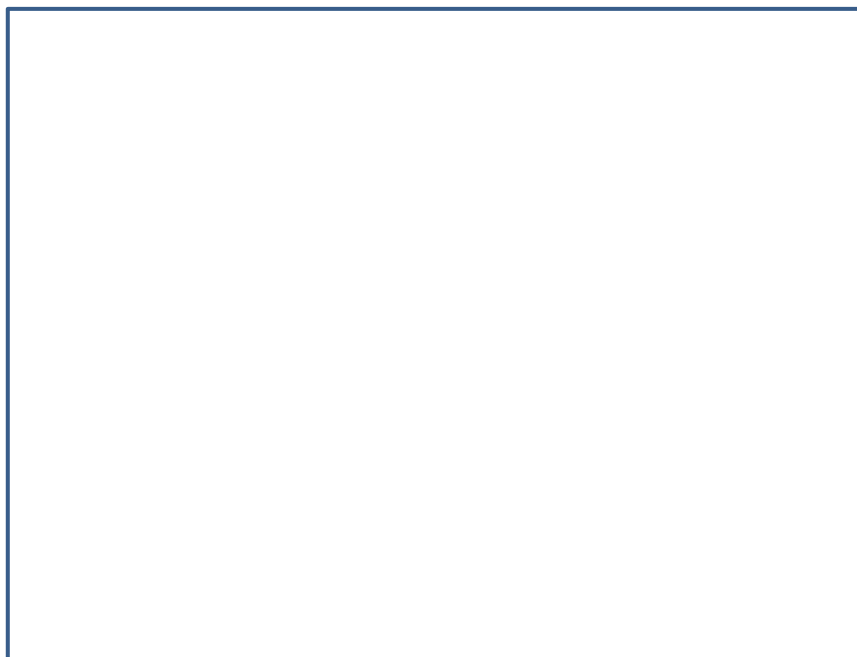
The IOOC onshore treatment facilities for the crude oil comprise two facilities: Train 1 and Train 2 Facilities. The wastewater from these facilities is chiefly oily produced water. Table 4.2.2-4 presents the amount and characteristics of the wastewater from each facility.

Table 4.2.2-4 Wastewater from Onshore Crude Treatment Facilities

Wastewater	Wastewater amount (m ³ /day)	Characteristics
Train 1, 2 Facility (Produced water /oily wastewater)	9,600 or more	The produced water shares more than 95% of the total wastewater. The proportion of the produced water in the crude oil is expected to increase and its amount also to increase. The oil concentration is estimated around 2,000 mg/L.
Train 3 Facility (Produced water /oily wastewater)	Less than 1,200	The amount of the produced water is currently low, while it is expected to increase in the future. The oil concentration in the wastewater is estimated around 2,000 mg/L.

Source: Study team

Each of Train 1 and Train 2 Facilities is equipped with a treatment facility which is primarily for removal of oil from wastewater. Figure 4.2.2-2 shows the flow of the basic wastewater treatment process.



API Separator: To make floatation by utilizing a difference in specified gravity that the oil contains in the water

IGF: To make air floatation by injecting the gas bubbles in the discharged water to catch the oil contents

Settlement tank: To make sedimentation separation of the suspend solids in the water

Source: Study team

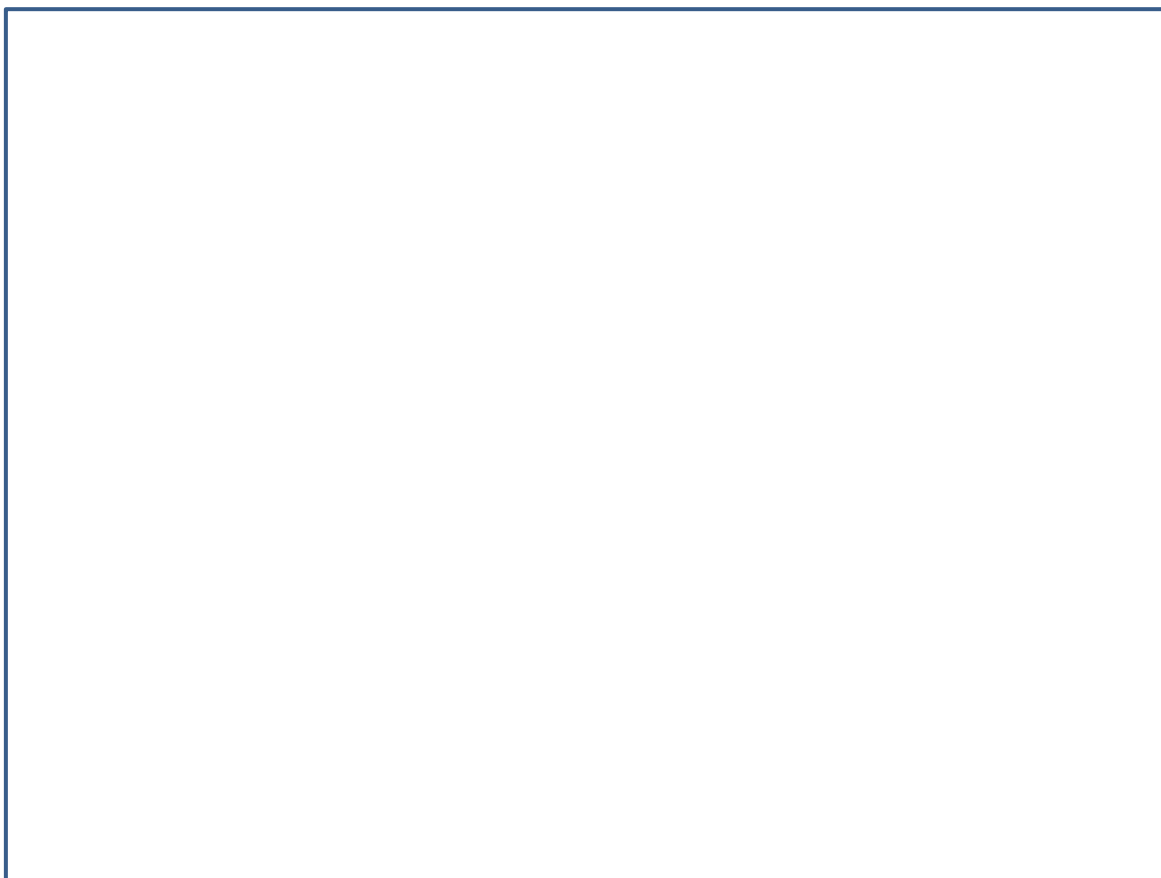
Figure 4.2.2-2 Wastewater Treatment Flow (IOOC)

Oily wastewater discharged from the crude oil treatment facilities is processed to remove the oil through a series of three stages wastewater treatment facilities, including API Separator, Induced Gas Floatator (IGF) and Compact Floatation Unit (IFU), and then to make sedimentation separation for the suspend solids in the treated water by the Sedimentation Pit. The processed water, together with other wastewater, is to be transferred to the two wastewater ponds (catchment basins) and

released to the sea via the drainage exit at the bottom of the wastewater pond.

These wastewater treatment facilities as a whole, with the capacity of minimizing the oil concentration in the treated water to less than 10 mg/L, are capable of processing the quantity of approximately 8,000 m³/day (50,000 barrel/day). Meanwhile, the amount of the produced water in the crude oil has, in recent years, increased in the crude oil treatment facilities, causing the amount exceeding the capacity of the existing treatment facilities. Therefore, that exceeded part of the oily wastewater is released directly to the wastewater pond without having been processed in the treatment facilities. Thus, it is likely that the water exceeding the effluent standards of oil and other pollutants is being discharged to the sea (IOOC conducts regular sampling surveys at the discharging and other points of the wastewater treatment facilities and checks the concentration of oil, COD, etc., though measured data is not obtained.)

Figure 4.2.2-3 shows the conditions of the untreated wastewater flowing into the catchment basins and the vicinity of the outfall point along the shoreline. Approximately 50% of the surface of the pond is covered by the oil, and the oil is from time to time collected and returned to the crude oil tank.



Source: Study team

Figure 4.2.2-3 Catchment Basins and Outfall Point

(b) IOTC

The IOTC crude oil tank yards are on both the west and east sides, and the company discharges drain wastewater (water accumulated at the bottoms of the tanks) from each crude oil tank. Drain wastewater contains oil. Table 4.2.2-5 shows the amount of wastewater discharged and characteristics.

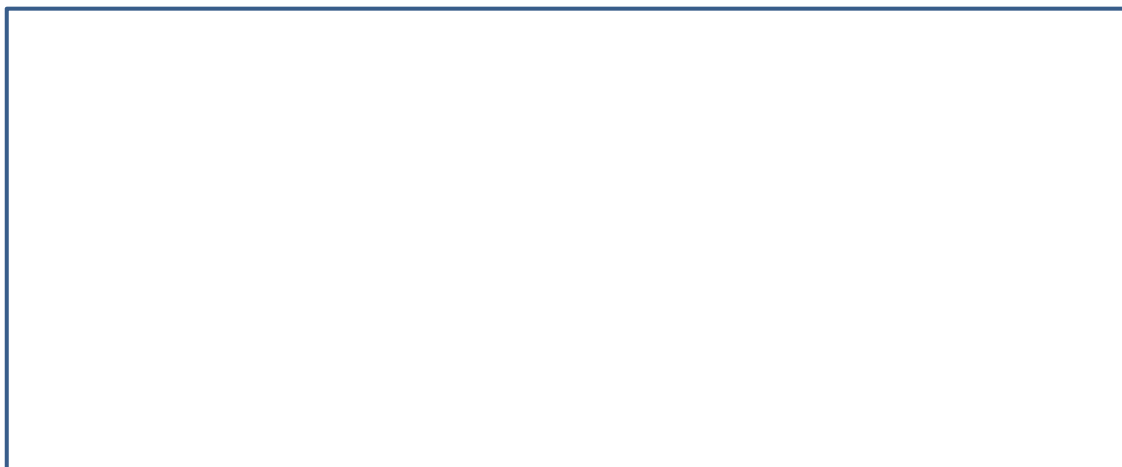
Table 4.2.2-5 Summary of Wastewater from the IOTC Tank Yards

Wastewater	Discharged amount (m ³ /day)	Characteristics
IOTC Crude Oil Tank Yard (Tank drain: oily wastewater)	Around 400	This is discharged at the time of drain the water accumulated at the bottom of the crude oil tanks. The oil concentration in the wastewater is approximately 200-500 mg/L.

Source: Study team

- Tank drain treatment system in the east tank yard

Drain discharged from the tanks is transferred to the drain pit to remove oil from water in a simplified method. The treated drain is then transferred, using the height difference, to the catchment basin, the oil recovery pit and to the sea. The oil collected in the oil recovery pit is brought back to the crude storage tanks, using vacuum vehicles. Figure 4.2.2-4 illustrates the tank drain wastewater system.



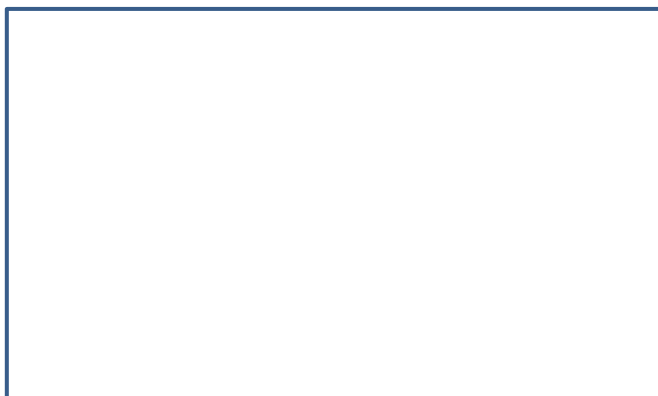
Source: Study team

Figure 4.2.2-4 Tank Drain Water Treatment System (IOTC)

- Tank drain treatment system in the west tank yard

Likewise in the west side tank yard, the oily tank drain water is transferred to the catchment basin (see Figure 4.2.2-5). The floating oil on the surface of the pond is collected by the vacuum

track and the water is released to the sea.



Source: Study team

Figure 4.2.2-5 Catchment Basin in the West Side

As described above, the tank drain of IOTC is discharged to the sea after the simply oil-water separation process, so the wastewater discharged to the sea is likely to contain oil and other substances exceeding their effluent standards.

(c) KPC

Wastewater from the facilities of KPC contains oil is chiefly generated at the methanol production facilities, which is treated at the wastewater treatment facilities within the plant of KPC. The discharged amount is 480 m³/day.

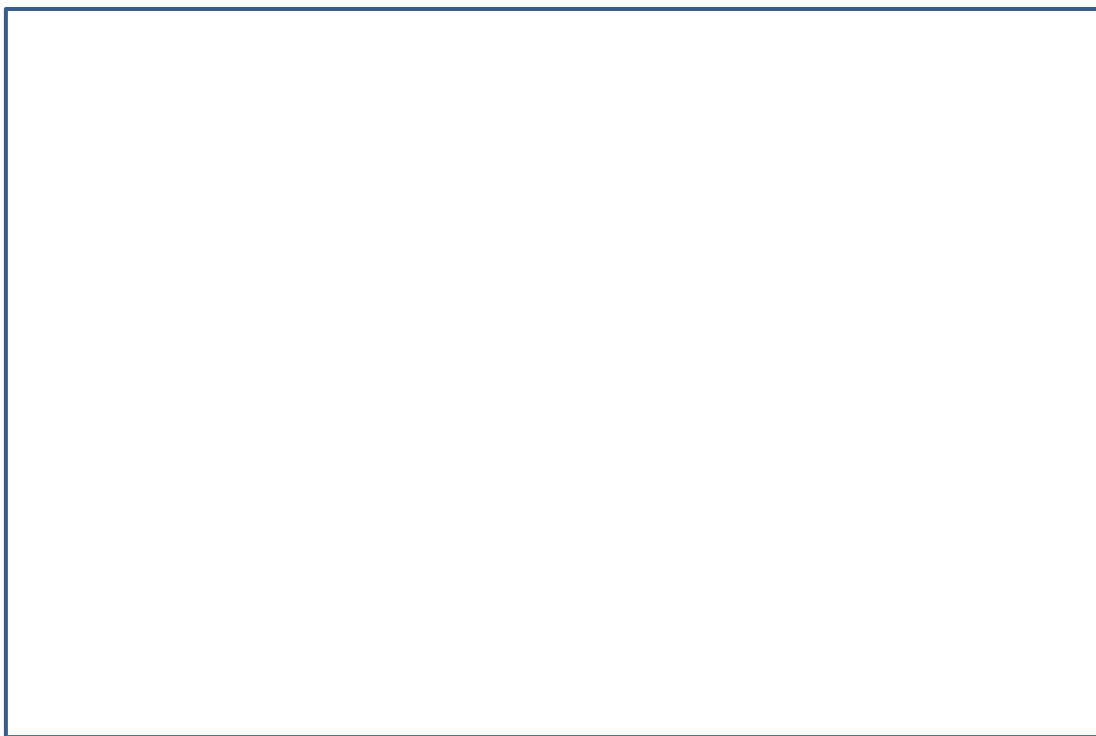
3) Present Situation of Wastewater Treatment on the Offshore Platform

The crude oil from the offshore oil field is separated into the crude oil, associated gas and produced water by the production separator. The crude oil is sent via pipeline to the crude oil treatment facilities in Khark Island. Associated gas is incinerated in the offshore flare gas facilities, while produced water is basically treated to remove oil in the compact floatation unit (CFU) and, after processed with the caisson separator, discharged to the sea.

At Abozar AB Platform, the amount of produced water separated by the separator exceeds the capacity of CFU, so produced water beyond the capacity is sent to the crude oil treatment facilities in Khark Island. Produced water treated in CFU is transferred to the caisson separator (see Figure 4.2.2-6). The separator adopts the gravity separation method to separate the remaining oil, and discharge separated water from the lower part. Oil separated by the caisson separator is transferred by the oil recovery pump to the production separator. The oil recovery pump, however, was out of order at the time when the study team made a visit. If oil cannot be recovered for a long time, oil will be likely to be drained from the lower part of the caisson separator: it is hoped that the oil recovery pump will resume the operation as soon as possible. The deck work floor of the platform

is not equipped with any oily drain sump system, because of which oil is drained to the sea and oil films were observable on the sea surface: a deck drain system must also be installed.

There is a possibility that other platforms may have the problems about wastewater treatment that have been confirmed in the Abozar AB Platform.



Source: IOOC

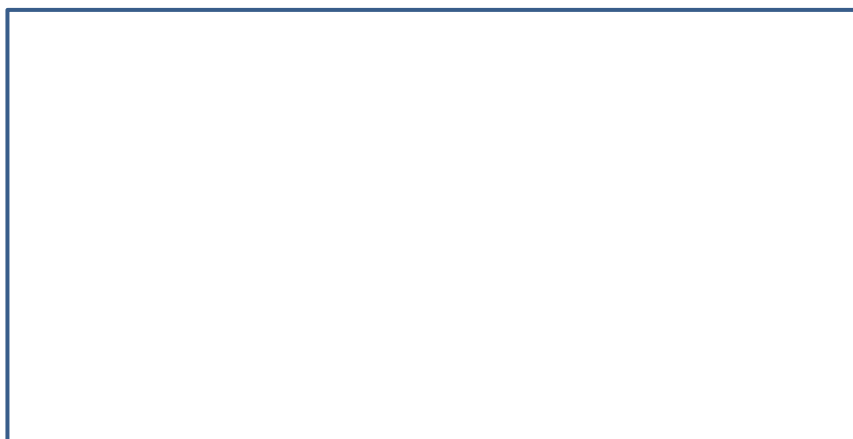
Figure 4.2.2-6 Process Flow Diagram

4) Discharged Water

As pointed out above, since IOOC and IOTC discharge wastewater to the sea without sufficient treatment, the wastewater is likely to exceed the effluent standards of oil and COD and also contain various other chemical substances, heavy metals and NORMs. It must be analyzed to clarify the actual situation of contamination.

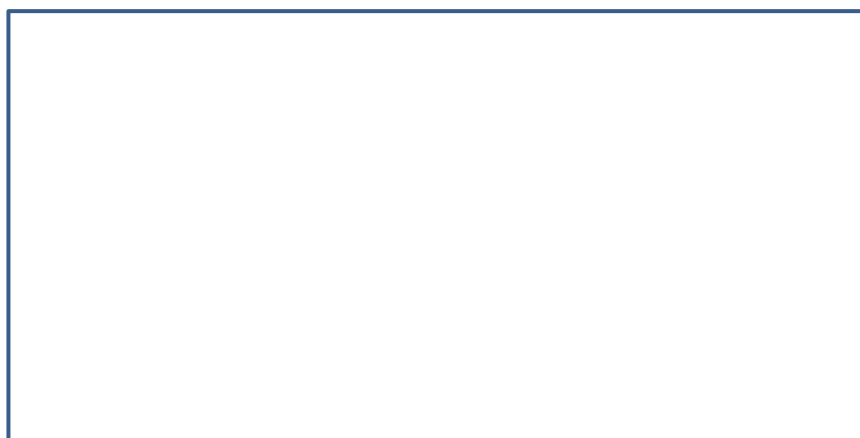
5) Catchment Basin and Drainage Path

As shown Figure 4.2.2-7 and Figure 4.2.2-8, the soil in the wastewater pond and drainage paths of IOOC and IOTC is contaminated by oil contained in wastewater. It is also likely to contain, as in the case of wastewater, various chemical substances, heavy metals and NORMs. It must be analyzed to clarify the actual situation of contamination.



Source: Study team

Figure 4.2.2-7 Catchment Basin (IOOC)



Source: Study team

Figure 4.2.2-8 Drainage Path to the Sea (IOOC)

(3) Waste Management

Table 4.2.2-6 shows the wastes that may be generated from each facility in Khark Island. One of the most significant issues in the waste management in Khark Island is the treatment of huge amount of drill cuttings.

Table 4.2.2-6 Expected Wastes and their Volume

Company	Type of wastes	Characteristics
IOOC	Drill mud and drill cuttings accompanying oil well drilling in the Island	Generated volume of the wastes is estimated around 300-500m ³ per well (2000-4000m depth), with some variations according to the depth of the oil well. Proper treatment is necessary.
IOOC	Oily sludge from the process equipment of the plant	This waste is generated at the time of regular inspection of the plant equipment, with an estimation of around 10 m ³ per year.
IOTC	Oily sludge at the time of regular inspection of the tank	Since the sludge reduction system has been introduced, the sludge volume, at the time of regular inspection, is estimated 1-2 m ³ /year by 1 million barrel tank and around 10 m ³ /year at a maximum level.
KPC	The sludge and spent catalysts of the processing equipment	Due to the small capacity of the plant, the quantity is estimated less than 5 m ³ /year. The management of the spent catalysts is considered an important issue like in other pilot districts.

Source: Study team

Conditions of the wastes treatment in each company are explained as follows.

- **IOOC**

Wastes from oil well drilling

Oily drill cuttings generated from the oil well drilling site are processed by the solidification treatment utilizing special cement inside the Island.

As for the drilling the offshore oil field, implementing the same treatment is reported. However, taken into account the limit in the disposal sites, proper measures need to be considered for the future when the number of drillings is to increase.

Wastes from the crude oil treatment plant inside the Island

Oily solid wastes such as sludge, etc. generated from the crude oil producing facilities are treated according to the wastes management plan by IOOC. However, more comprehensive measures for the wastes management, as earlier mentioned, need to be taken in light of a long-term vision.

- **IOTC**

Most of the wastes generated from IOTC operation are tank sludge, but its volume is quite limited since the Company has introduced Crude Oil Washing (COW) System by Japanese TAIHOU Industries, Ltd. Therefore, few problems on the wastes management are estimated at the present point.

- **KPC**

Though the quantity of wastes is small since the size of the plant is small, proper measures,

including the management of spent catalysts and solid sulfur in other pilot districts, need to be considered.

(4) Biota and Conservation Area

1) Present Situation

Intertidal cliffs are considered as the most important habitats of algae. These habitats can be found in Persian islands of the Persian Gulf such as Khark and Kharko islands. There are plenty of other groups which have industrial, medicinal, and medical and food values from the view point of population dependency such as industrial shrimps (penaeidea), green sea turtle, Dogung and manatee. A major species of economic- worthy alga in Khark and Kharko islands is shown in Table 4.2.2-7.

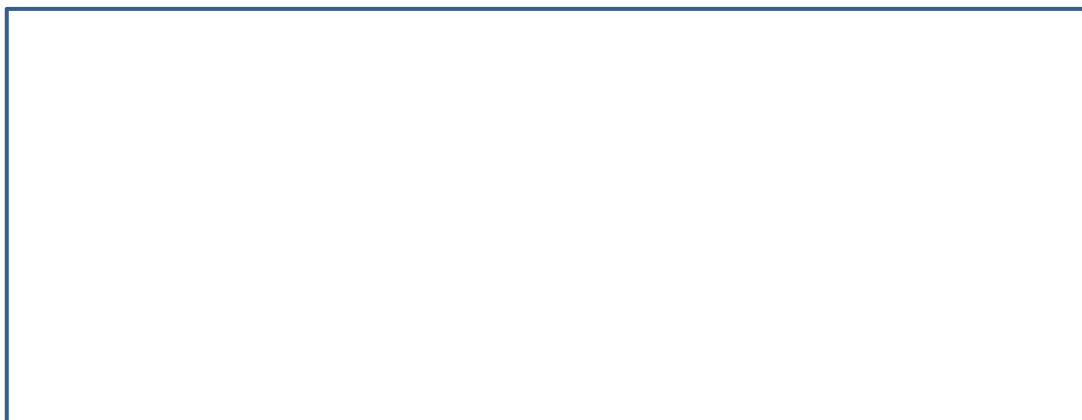
Table 4.2.2-7 Major Species of Economic-Worthy Algae in Khark and Kharko Islands

Group	Species	Application
<i>Chlorophycophyta</i> (green algae)	<i>Caulerpa Peltata</i>	Edible usage for human (it's edible)
	<i>Enteromorpha Compressa</i>	Edible usage for human (it's edible)
	<i>E. intestinalis</i>	Edible usage for human (it's edible)
	<i>Ulva fasciata</i>	Edible usage for human (it's edible)
<i>Phaeophycophyta</i> (brown algae)	<i>Saragassum sp.</i>	Industrial and rock based consumption (use)
<i>Rhodophycophyta</i> (red algae)	<i>Ahnfeltia plicifera</i>	Extraction of Agar
	<i>Ceramium sp.</i>	Extraction of Agar
	<i>Spyridia sp.</i>	Extraction of Agar
	<i>Laurencia obtus</i>	Edible- medicinal use
	<i>Digenea simplex</i>	Edible- medicinal use- extraction of agar
	<i>Jaina rubens</i>	Medicinal use
	<i>Hypnea musci formis</i>	Extraction of agar- production of medicine
	<i>Gelidiella acerosa</i>	Extraction of Agar

Source: IOOC, 2002¹²

The fishery is one of the important industries as Khark Island is isolated in the ocean, Persian Gulf. The Serranidae, Haemulidae, Lethrinidae, Scorpaenidae, Tetradontidae, Scaridae, Chaetodontidae, and Lutjanidae families are most important species of fishes in this region. Concerning the fish fauna, dominant families are mainly coral reef fishes in the Khark region (IOOC 2002)¹². Fish caught in the Khark region was *Scomberoides tol*, Drumfish, Grouper and so on (see Figure 4.2.2-9).

¹² Project on Environmental Studies of Siri, Lavan, Bahregan, Khark Operational Regions, spring, 2002, IOOC.



Note: i; Drumfish family, ii; *Scomberoides tol*, iii and iv; Grouper family, v; nemipterus.

Source: shooting by study team

Figure 4.2.2-9 Fish Caught around Khark Island

Despite small area of Kharko Island, extension area of coral reefs is vaster than Khark Island. Perhaps, one of the main reasons of this issue is because severe insusceptibility of shallow coasts of this island rather than Khark Island since the latter is greatly impressed by adverse effects of human activities and different types of environmental pollutants (IOOC 2002)¹². Table 4.2.2-8 shows the list of most important coral families of Khark and Kharko Region.

Table 4.2.2-8 Most Important Coral Families of Khark and Kharko Region

Row	Persian name	English name	Scientific name
1	Marjane artisho ya marjane omani	Fleshy artichoke coral (Oman)	<i>Acanthastrea maxima</i>
2	Marjan derakhtcehi	Bush coral #	<i>Acropora sp.</i>
3	Marjaane shakh gavazni	Staghorn coral	<i>Acropora cervicornis</i>
4	Marjanahaye narm	Soft coral	<i>Alcyonaceae</i>
5	Marjane setareieh motekhalkhel	Perous stars coral	<i>Astreopora myriophthalma</i>
6	Marjane habee koochak	Lesser knob coral	<i>Cypastrea microphthalma</i>
7	Marjane bache kheresi	Teddy bears coral	<i>Dendronephthya klunzingeri</i>
8	Marjane loobiaei	Beam coral (Dhofar, Oman)	<i>Euphyllia fimbriata</i>
9	Marjane setarei bozorg	Larger star coral ##	<i>Favia fava (Favites)</i>
10	Marjane gol davoodi	Daily coral	<i>Goniopora sp. (oldest coral)</i>
11	Marjane banafsh	Purple coral (Soft coral)	<i>Gorgonian sp. 2</i>
12	Marjane badbezani	Gorgon corals	<i>Gorgonian sp. 3</i>
13	Marjane khardar	Spine corals	<i>Hydnophora excesa</i>
14	Marjane kahoeieh soorakh dar	Porous lettuce coral	<i>Oxypora lacera</i>
15	Marjane tavoosi	Peacock coral (boulder forming)	<i>Pavona sp. 2</i>
16	Marjane gol kalami	Cauliflower coral #	<i>Pocillopora damcornis</i>
17	Marjane siah	Black coral	<i>Porites nodifera</i>
18	Marjane ostovanei	Cylindrical coral	<i>Porites cylindrical # #</i>
19	Marjanre baleshi	Pillow coral, False	<i>Pseudosideratrea tayamai</i>
20	Marjane narne khakestarie sabz	Grey- green soft coral ++ # #	<i>Sacrophyton trocheliophorum</i>
21	Marjane bashlegghi	Hood coral ++ # #	<i>Stylophora pistillata</i>
22	Marjane moghazzi	Brain coral	<i>Symphillia nobilis</i>
23	Marjane moghazzi	Brain coral	<i>Symphillia radians</i>
24	Marjane goldani	Vase coral & # #	<i>Turbinaria sp.</i>

Source: IOOC, 2002

Note:

Withstanding against pollution; # very slight, # # relatively high

Endurance against salinity; + 45 gr/ Lit, ++ 55 gr/ lit

A coral reef could be found so far (see Figure 4.2.2-10). In the surrounding area, NGL plant is under construction and the EIA report has been approved.



Source: Google Earth (modified by study team)

Figure 4.2.2-10 Distribution of a Coral Reef around Khark Island

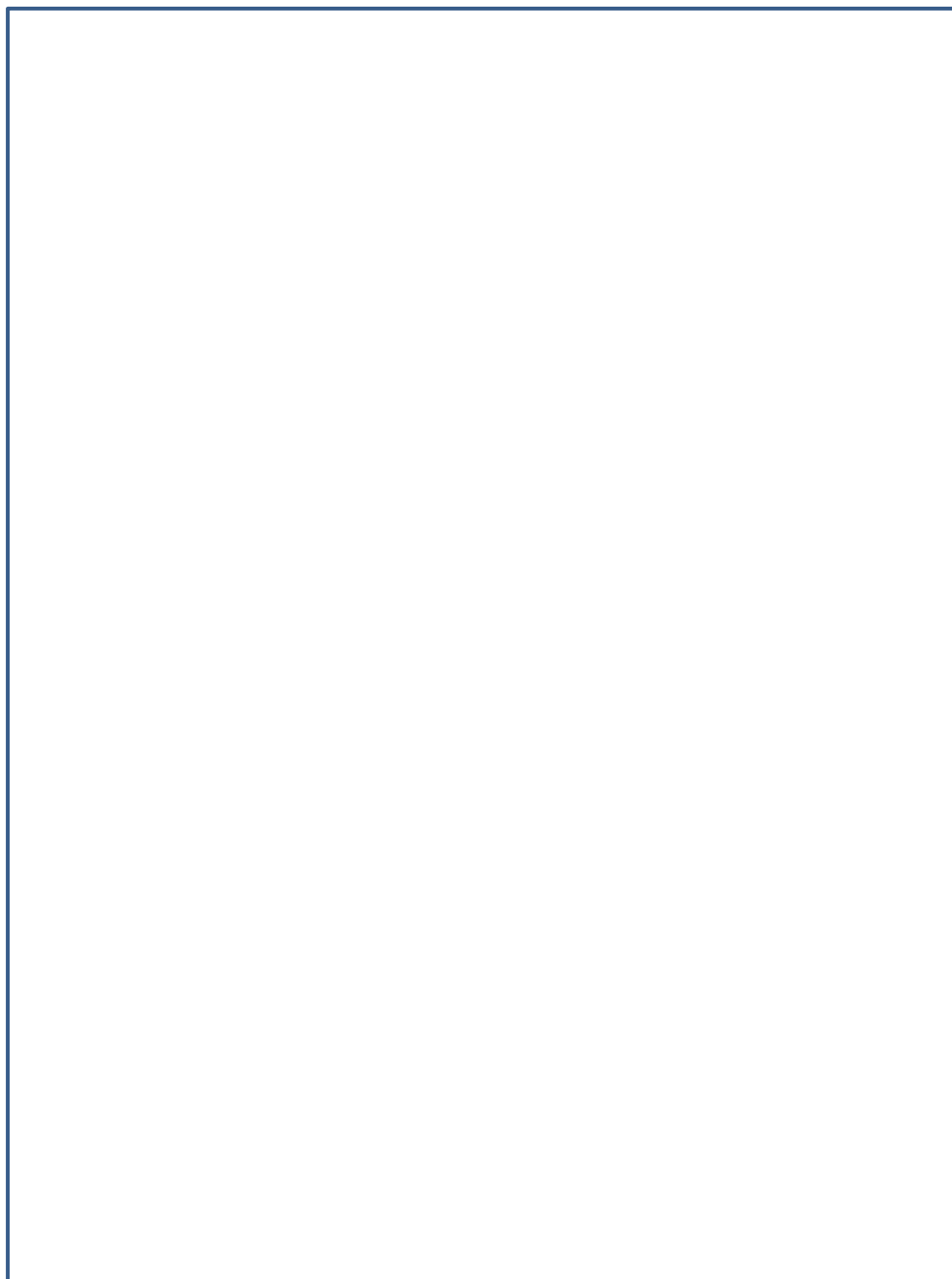
2) Protected Area

Kharko Island and the nearby larger island of Khark were designated as a Protected Region in May of 1960. The reserve was upgraded to Wildlife Refuge in the early 1970s (see Figure 4.2.2-11). But the Khark portion was de-notified a few years later, leaving only the island of Kharko protected in the Khark Wildlife Refuge (NIOC-IOOC, 2003)¹³.

The refuge is composed of the two islands of Khark and Kharko with the total area of 2,398 ha located 4km away, have sandy and coral beaches. The main plant species are reed, sedge, cat's tail, bo tree, feather grass, camel's thorn, cashew, aeluropus, and honey musquit, which is an introduced species. The most important animal species include goitred gazelle, cape hare, house crow, flamingo, gull, heron and green turtle. The region is a proper habitat for white-cheeked and bridled terns. House crow has a remarkable population in the island. Migratory birds such as great white heron, cormorant, and greater flamingo and also seasonally found in the island in great numbers (The Atlas, 2006)¹⁴.

¹³ Oil Spill Response Plan Prepared for NIOC-IOOC, Jan. 2003, NIOC-IOOC.

¹⁴ Atlas of Protected Areas of Iran, 2006, Department of Environment



Source: Google Earth

Figure 4.2.2-11 Khark Island and Kharko Island

Kharko Island is covered in sand-dun vegetation of grasses and low shrubs, fringed by a sandy beach with low strand vegetation. There are a few banyan trees near the south end of the island. Kharko island is an important site for breeding terns such as swift tern (*Sterna bergii*), lessercrested tern (*Sterna bengalensis*), bridled tern (*Sterna atenaetus*). Breeding success in the past has been severely reduced due to egg collecting by local fishermen, and the current status of the bird

population is uncertain (NIOC-IOOC, 2003)¹⁵. According to NIOC-IOOC (2005)¹⁶, migratory and native birds are found in Kharko island as Table 4.2.2-9.

Table 4.2.2-9 List of Birds in Kharko Island

Categories	Species name
Migratory Birds	<i>Ardeola Ralloides</i> , <i>Ardea Cinerea</i> , <i>Milvus Migrans</i> , <i>Arenaria Interpers</i> , <i>Calidris Minuta</i> , <i>Calidris Ferruginea</i> , <i>Calidris Alba</i> , <i>Tringa Erythropus</i> , <i>Tringa Nebularia</i> , <i>Tringa Glareola</i> , <i>Tringa Hypoleucos</i> , <i>Limosa Limosa</i> , <i>Limosa Laponica</i> , <i>Numenius Arquata</i> , <i>Numenius Tenuirostris</i> , <i>Falco Tinnunculus</i> , <i>Ammopedrix Griseagularis</i> , <i>Sterna Bergii</i> , <i>Sterna Bengalensis</i> , <i>Sterna Sandvicensis</i> , <i>Sterna Repressa</i> , <i>Sterna Anaethetus</i> , <i>Sterna Saundersi</i> , <i>Columba Livia</i> , <i>Steretopelia Decaocto</i> , <i>Steretopelia Turtur</i> , <i>Psittacula Kramri</i> , <i>Athene Noctus</i> , <i>Apus Pallidus</i> , <i>Coracias Garrulus</i> , <i>Merops Superciliosus</i> , <i>Upopa Epops</i> , <i>Caladrella Rufescens</i> , <i>Galerida Cristata</i> , <i>Motacilla Flava</i> , <i>Lanius Collurio</i> , <i>Lanius Isabellinus</i> , <i>Lanius Senator</i> , <i>Lanius Minor</i> , <i>Oriolus Oriolus</i> , <i>Sturnus Roseus</i> , <i>Acrocephalus Schoenobaenus</i> , <i>Acrocephalus Scirpaceus</i> , <i>Hipolais Pallida</i> , <i>Hipolais Cligata</i> , <i>Sylvia Borin</i> , <i>Sylvia Cimmunis</i> , <i>Sylvia Minula</i> , <i>Sylvia Althaea</i> , <i>Phulloscopus Trochilus</i> , <i>Phulloscopus Collybita</i> , <i>Muscicapa Striata</i> , <i>Saxicola Ruberta</i> , <i>Oenanthe Pleschanka</i> , <i>Oenanthe Isabellina</i> , <i>Phoenicurus Phoenicurus</i> , <i>Luscinia Svecies</i> , <i>Emberiza Calandra</i>
Native Birds	<i>Phasianus Colchicus</i> , <i>Hirundo Rustica</i> , <i>Oenanthe Oenanthe</i> , <i>Passer Domesticus</i>

Source: NIOC-IOOC, 2005 (modified by Study team)

One of the most important habitats of the sea turtles is Khark and Kharko islands. Especially, Kharko Island has better ecological condition due to secure environment, proper coasts, and most importantly, due to being far from human activities, marine and coastal pollutions caused by oil-related operations and /or industrial and urban sewages and waste waters (IOOC 2002)¹⁷.

3) Impact to Biota from the Petrochemical Zone

In the Atlas of Protected Area of Iran (2006)¹⁸ states in the article, the extensive petroleum industries and facilities in Khark Island have negatively affected the environment.

According to the interview with IOOC personnel, NGL plant in the south-west part of Khark Island is under construction and starts to operate in a few years. If NGL plant starts to operate, it is concerned that a coral reef, lives in close NGL plant, is affected by industrial wastewater from it.

According to NIOC-IOOC (2005)¹⁹, as extensive research was conducted from 1993 to 1995 that indicate mortalities of sea mammals in the Iranian waters of the Persian Gulf were caused by oil

¹⁵ Oil Spill Response Plan Prepared for NIOC-IOOC, Jan. 2003, NIOC-IOOC.

¹⁶ Waste Management Contract Persian Gulf Biological Report Khark Island Operational Area Pre FEED Document, Oct. 2005, NIOC-IOOC

¹⁷ Project on Environmental Studies of Siri, Lavan, Bahregan, Khark Operational Regions, Spring. 2002, IOOC.

¹⁸ Atlas of Protected Areas of Iran, 2006, Department of Environment

¹⁹ Waste Management Contract Persian Gulf Biological Report Khark Island Operational Area Pre FEED Document, Oct. 2005, NIOC-IOOC

slicks near the following five centers of pollution, it is concerned that marine organisms is affected by a leak and spill of oil from oil installations even now.

(5) Other Environmental Conditions (Ballast water)

International conventions and domestic relevant regulation forbid and restrict discharge of ballast water and the number of the inappropriate practice has been declined over years. The results of hearings to officials in Khark Island, however, have found that there are still ships discharging ballast water to the sea. Persons in charge at an affiliated company reports that this is chiefly due to lack of articles relating to penalty in domestic regulations, but the largest cause is insufficient port state control (PSC) of PMO. Currently, installation of a ballast water treatment facility is being considered.

4.2.3. Environmental Management

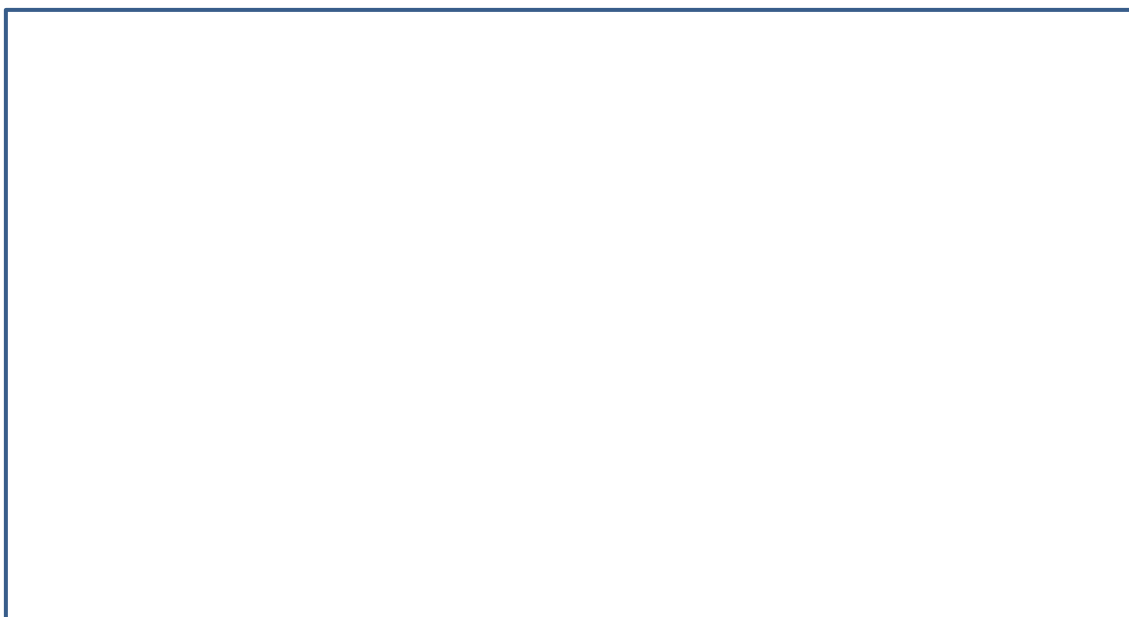
(1) HSE Management System

IOOC and IOTC under the supervision of NIOC and Khark Petrochemical Company (privatized) are operating in Khark Island area. As Khark Island is not the special zone, each company operates individually.

1) IOOC

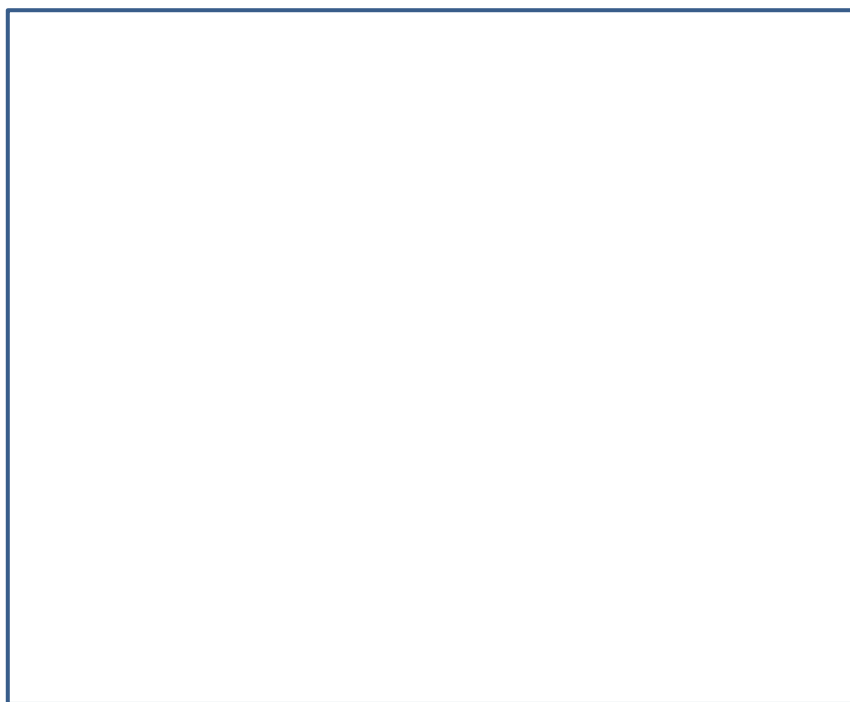
(a) Organization

As shows in Figure 4.2.3-1 IOOC Headquarters has the HSE Department which control general HSE management systems and each regional office also has its HSE Department. Figure 4.2.3-2 shows the planned organization structure of the HSE Department in IOOC Headquarters. According to the chart, it was planned to deploy one head and one expert for Environment, Work/Industrial Health and Safety and Firefighting respectively. However, the actual deployed posts in the HSE Department are Head of HSE Department, Head of Environment, Head of Work/Industrial Health and Head of Safety and Firefighting. These head experts should supervise the HSE management in all the operation fields.



Source: IOOC

Figure 4.2.3-1 Organization of IOOC



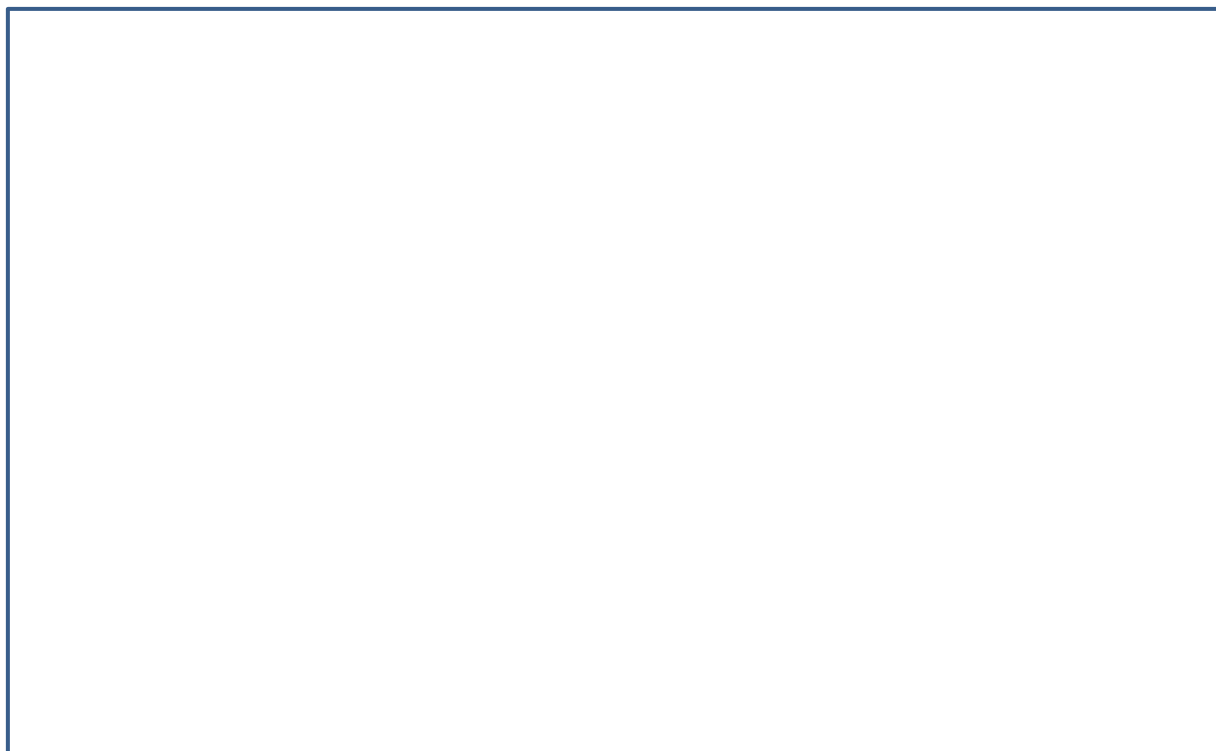
Source: IOOC

Figure 4.2.3-2 Organization of the HSE Department of IOOC Headquarters

Major responsibility of Head of Environment is management, policy making, planning, and supervision on environmental protection for the purpose of establishment of HSE management system. Major tasks for the Head of Environment are as follows:

- Assessment of current situation of environment and continuous development through compilation of regulations and instructions
- Supervision on execution of prevailing laws and regulations as well as current methods concerning environmental protection
- Assessment and prioritization of environmental studies
- Preparation of executive methods concerning environment protection
- Cooperation for creation of proper basis for environmental culture
- Compilation of assessment methods and case assessment in IOOC
- Study and research on identification of environmental pollutants
- Analysis of information and reports of environmental accidents
- Inspections according to planned programs, analysis of environmental engineering designs to assure observance of HSE criteria, and offering suggestions and application of change in the mentioned designs
- Periodical inspection of industrial and non-industrial wastewater treatment plants
- Provision and supervision of proper solutions to prevent oil spill and remove industrial pollutions, and pollution of soil, underground waters, sea water and air

Figure 4.2.3-3 shows the organization structure of the HSE Department in Khark Regional Office of IOOC. There are four (4) complexes in the Khark Regional Office area: Aboozar, Dorood, Foroozan and NGL. One environmental expert is in charge of environmental protection activities for those complexes in Khark Regional Office.



Source: IOOC

Figure 4.2.3-3 Organization of HSE Department in Khark Regional Office

(b) Management System

IOOC registered the integrated management systems (ISO 9001, ISO14001 and OHSAS 18001) and formulated the management policy. The management policy for the Khark Operational Region is as follows:

- Commitment to observe and conform to the health, safety and environment standards and regulations devised by the Iranian Ministry of Petroleum and other national and regional lawmaking authorities. In addition, commitment to requirements of contracts
- Fulfillment , maintenance and improvement of customers' satisfactions
- Prevention of environment pollution and lowering destructive or adverse environmental effects through establishment of proper infrastructures and utilizing known methods which are used for optimum consumption of energy as well as decrease in waste generation
- Commitment to prevention of injuries and illnesses which may be suffered by personnel as well as persistent improvement of safety and occupational health management
- Boosting safety capabilities of the company as well as supplying requirements of employees' health
- Using state of the art and proper technologies to improve the quality of products and

lowering operational costs

- Providing a safe and proper work environment to propagate employees' cooperation in some issues such as health safety and environment and creation of proper intra-organizational and extra-organizational communications
- Promotion of knowledge level and employees' skills by continuous training of different occupational ranks to improve the quality, safety and environment at individual level
- Commitment to continuous improvement of processes and management methods and systems in line with fulfilling customers' needs, lowering safety and health risks, preventing environmental pollution and raising efficiency

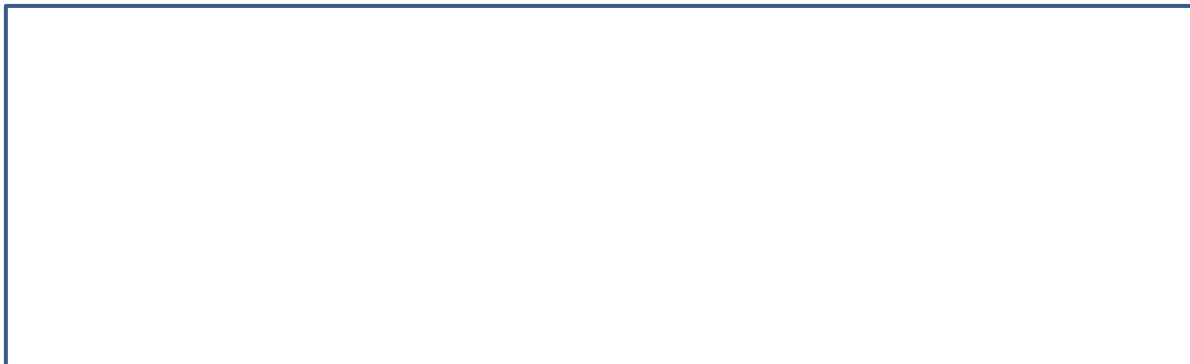
As mentioned above, the management policy includes prevention of environmental pollution and lowering destructive or adverse environmental effects. However, the environmental monitoring reports are compiled and submitted to the HSE Department of IOOC Headquarters only once a year from each operational region, while operating companies in other pilot areas report monthly. Besides, sampling for the monitoring is also carried out only once a year. The Head of Environment for the HSE Department of IOOC Headquarters should supervise the activities of more than 300 plat forms.

IOOC formulated an emergency response manual for Khark Region (IMS-PR-01), and compiled the manual of executive methods for response to accidents related to environmental pollution. In the manual, emergency conditions are classified into the following types:

- Natural disaster such as earthquake, flood, thunder and lightning, water-based obstructions and other instances
- Industrial disasters such as fire in land and sea oil establishments, and company localities in a large scale, diffusion of H₂S in oil platforms and land establishment and neighbors
- Marine accidents including fall of people or helicopters into the sea and sinking the ships
- Motor –vehicle collisions and accidents leading to wounds
- Environmental accidents such as crude oil leakage out of pipes, reservoirs, pits, dangerous chemical matter leakage and other cases

As for the environmental accidents, five (5) cases are considered as expected risks: oil leakage from land oil-carrying pipes, oil leakage through carrying pipes, and marine platform establishment, chemical matter leakage from barrels, holes at the bottom of the tanks of crude oil storages, and oil leakage from the pit wall (oil tank). The manual provides response measures for each accident. Figure 4.2.3-4 shows the structure of emergency response in Khark Region of IOOC. When an emergency occurs, crisis committee consisting of the members shown in the figure will be formed and make necessary decisions for the response. There are individual manuals for the emergency

response in the off-shore platforms (Aboozar, Foroozan and Dorood 3).



Source: IOOC

Figure 4.2.3-4 Organization of Crisis Committee for Khark Region of IOOC

2) IOTC

(a) Organization

IOTC Headquarters are located in Khark Island and six (6) environmental experts are working for environmental protection in their work fields: two (2) for headquarters, two (2) for Khark Island, one (1) for Neka and one (1) for Assaluyeh. Other information related to organization structure of IOTC has been collecting.

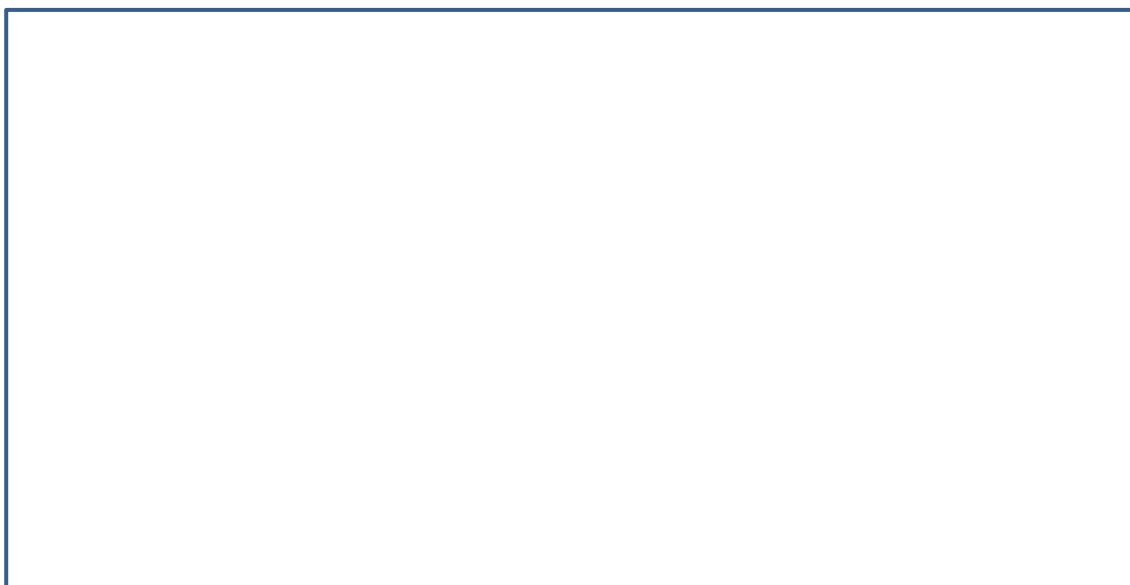
(b) Management System

IOTC prepared the local contingency plans for their work fields based on the request from PMO. Other information related to HSE management system including environmental management has been collecting.

(2) Environmental Management Technology

World trends in environmental technology

As earlier mentioned in 4.2.1 (2), in recent years, the upstream sector of petroleum industry in the world, including oil producing countries in the Persian Gulf region, have implemented some measures to increase the crude production and to maintain the oil reservoir pressure through the re-injection of surplus gases burnt out by the flare stacks and produced water (or sea water), in order to mitigate environmental impacts from the dissemination of the surplus gases into the atmosphere which is a source of the air pollution and the release of the production water into the sea. In this regard, Figure 4.2.3-5 ‘Zero Emission Concept’ has been assumed to be the final goal as mitigation measures for environmental conservation.



Source: Study team

Figure 4.2.3-5 Zero Emission Concept

Khark Island is a pilot area mainly focusing on oil field development, and it is considered to be appropriate to take the environmental measure based on this concept. In light of the trend of the industry, the following is an outline of the management technologies which could be applicable to the air contamination, water quality and wastes issues in the pilot area.

1) Air Pollution Control Technology

(a) Zero Flaring

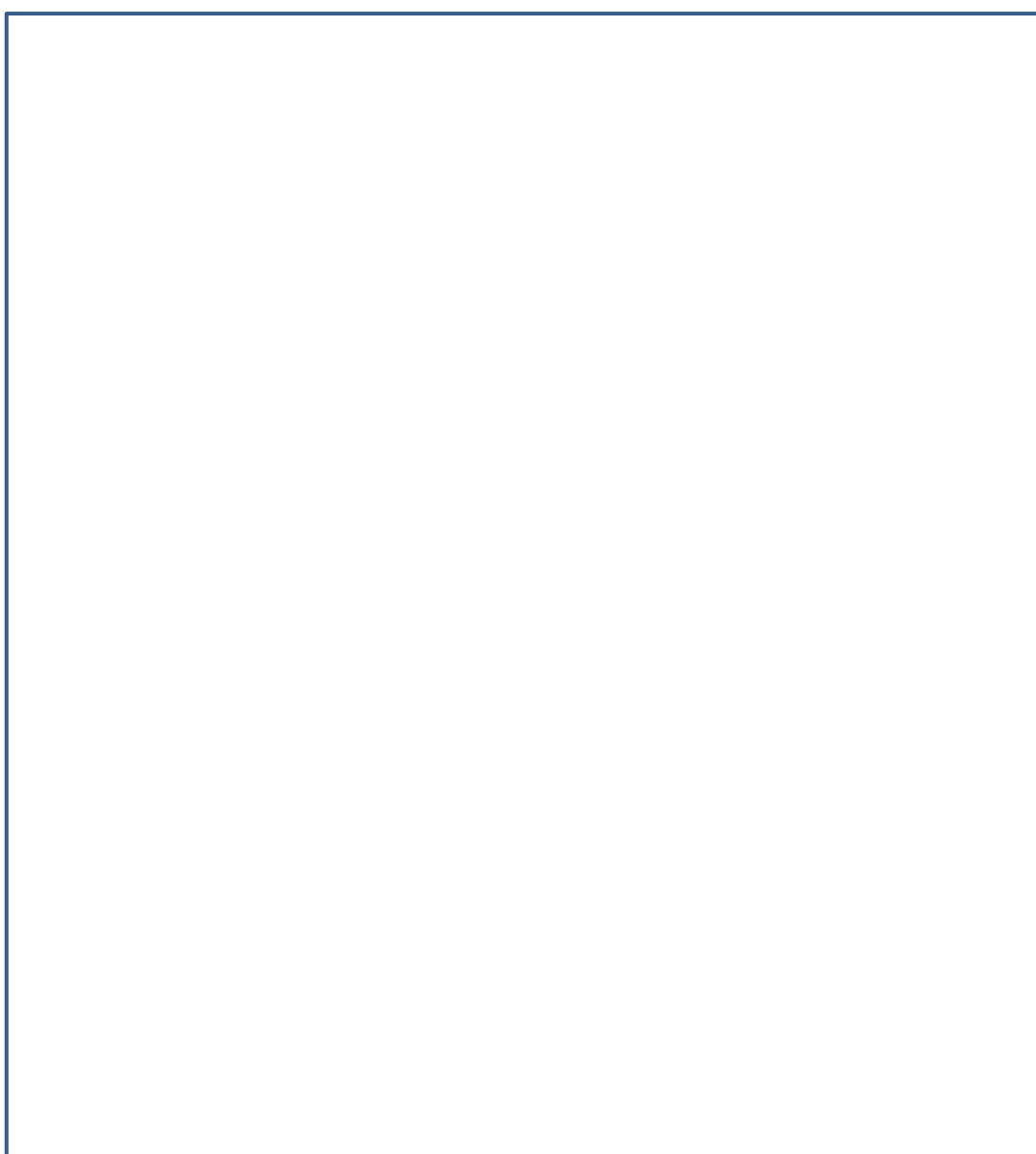
The most considerable source of the air pollution in the upstream of petroleum industry is the flare stacks. The most effective measure for this matter is ‘Zero Flaring’, which has been already introduced in some of the oil producing countries in the Persian Gulf region and started to be used widely all over the world in the past 10 years. ‘Zero Flaring’ enables to fully recover the flare gas which used to be burnt out in the atmosphere by flare stacks, and to utilize or dispose it as follows.

- Full utilization as fuel gas after eliminating H₂S (desulfurization) in the gas
- Re-injection into underground oil reservoir or gas reservoir for the purpose of increasing the recovery of crude oil and gas (EOR)
- Ultimate disposal into the underground oil reservoir or gas reservoir.

As an example from the oil producing countries in the Persian Gulf region, there are projects implemented by all the ADNOC (Abu Dhabi National Oil Company) Group companies under the supervision of the ADNOC. This is the first challenging project, which has been highly evaluated globally and followed by other Gulf oil producing countries since then.

A series of processes of Zero Flaring (before and after the implementation) in the basic crude oil production facilities is described in Figure 4.2.3-6.

The associate gas from the crude oil separated from the crude oil by the oil/gas separator to be treated as the surplus gas by the flare stack. In the Zero Flaring Project, all of this associate gas is recovered and H₂S in some part of the gas is removed through the desulfurization unit newly installed to be supplied as the fuel gas through the compressor to other facilities. The remaining gas, after being treated to remove the moisture in the gas by the dehumidifier together with the process tail gas including H₂S generated by the desulfurization unit, is re-injected into the underground oil reservoir by the high pressure compressor as the source gas for EOR.



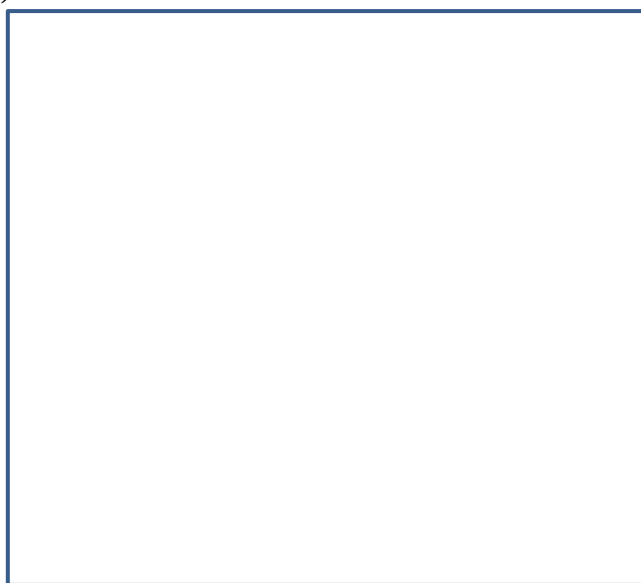
Source: Study team

Figure 4.2.3-6 Zero Flaring System: Before and after the Implementation

(b) Complete Combustion Technology of the Flare Gas

The black smoke is often observed in the flame from the flare stacks in Khark Island. This is due to the incomplete combustion of the flare gas, with some other factors such as commingled liquidity in the gas, excessive gas amount and so forth. This incomplete combustion gas includes H₂S and hydrocarbon gas, causing the air pollution. The reduction of the pollutants is required through making the flare stack to operate smokeless.

There are three methods in making the flare stacks smokeless as illustrated in Figure 4.2.3-7. Either of the methods aims to improve the mixing of the flare gas and air necessary for combustion. An appropriate selection out of them is necessary according to characteristics of the flare gas (its pressure, amount, etc.) and the location.



Source: Study team

Figure 4.2.3-7 Smokeless Flare Method

(c) Air Quality Monitoring

There are 4 air monitoring stations installed by each operation company in the Island, as earlier mention in Table 4.2.2-2. However, these 4 stations have not established the coordination mechanism, where each company has managed their monitoring data separately. Section 7.5 "Environment Monitoring" of this Study recommends consideration of the integration of the air quality monitoring systems, their accurate locations, sharing of their data, etc.

2) Water Quality Management Technology

(a) Management Technology of the Produced Water

The most considerable issue requiring environmental measures in Khark Island is a proper treatment of the wastewater from facilities including a huge amount of the produced water generated in association with the crude oil production. In the Island, as mentioned in the earlier Subsection 4.2.2 regarding the environmental current conditions, the amount of produced water has increased in Train 3 Dorood Pil Field, which has started the production in 1964, due to the aging oil field. Furthermore, the sea water injection has been implemented for the purpose of increasing the crude production, resulting in the significant increase in the amount of produced water. Its amount exceeds the capacity of the existing wastewater treatment facilities in the island. Under such circumstances, this huge amount of produced water, after being separated by the crude oil separator in the crude oil facility but without being processed, is directly released to the sea via the wastewater pond (catchment basin) (as explained in more details in 4.2.2 (2)).

In the first place, an oil operation company is supposed to formulate the production plan focusing on the crude oil production as their basic operation. Nevertheless, a lack of consideration for the treatment plan for produced water could lead to the flaw in the environmental conservation measures. As measures for this matter are required the produced water management in offshore/onshore oil fields, including the forecast of the produced water trends in each well and the reduction plans, as well as the consolidation of treatment facilities for the produced water.

This issue is presumably attributed to some factors, such as lack of mutual communication between the environmental management section and the crude production section which is in charge of forecasting increase trends of the produced water, lack of the produced water management technology, and inadequacies in the total operation plan and the environmental management system. In order to improve these factors, it is necessary to strengthen the crude oil production management system, including the forecast of the trends of increase in the produced water, and the wastewater treatment technology.

(b) Treatment of Tank Drain Water

As mentioned in 4.2.2 (2), the drain water in the crude oil tank is, without being processed, transferred directly to the wastewater pond (catchment basin) to be released together with other treated water into the sea. As to this matter, IOTC has initiated a project to establish the drainage treatment facility especially for the tank drain and to limit the oil contents concentration to less than 10 mg/L in the drainage water, and this project is on progress. If this could encourage an improvement proposal to be drafted at an earliest timing, it will expectedly lead to a preferable direction for the environmental improvements.

(c) Optimization of Wastewater Treatment System

The basic treatment system in Khark Island is a system where the wastewater treatment facility removes the contaminants such as oil contents in the wastewater and the treated water is released via the wastewater pond (catchment basin) to the sea. Likewise in the worldwide trends such as the reduction of flare gas and Zero Flare in the upstream oil industry, among these trends are the minimization of the wastewater generated by the development operation to be released to the sea and, furthermore, the movement seeking for drainage free situations.

Since 1970s in Saudi Arabia and early in 2000s in Abu Dhabi, as examples from the Gulf oil producing countries, the release of the wastewater generated from the oil production has been prohibited and the re-injection treatment (disposal) of the wastewater into underground is stipulated. Also in Kuwait and Qatar, the underground disposal of the produced water has already been implemented. Meanwhile, there are many cases utilizing the produced water, which has a tendency to increase in amount, as the source water for the pressure maintenance of oil reservoir and gas reservoir as well as EOR, achieving the drainage free.

Accompanied by aging of the existing oil fields and the increase in oil production, the Island is expected in the coming period to face the increase in the wastewater from the production facilities including the produced water, and therefore, the wastewater treatment is envisaged to become an important issue for environmental consideration. A comprehensive wastewater treatment system with a long term vision needs to be considered, taken into account the soundness of the existing wastewater treatment system and pros and cons of the wastewater pond (catchment basin).

(d) Treatment of Catchment Basin

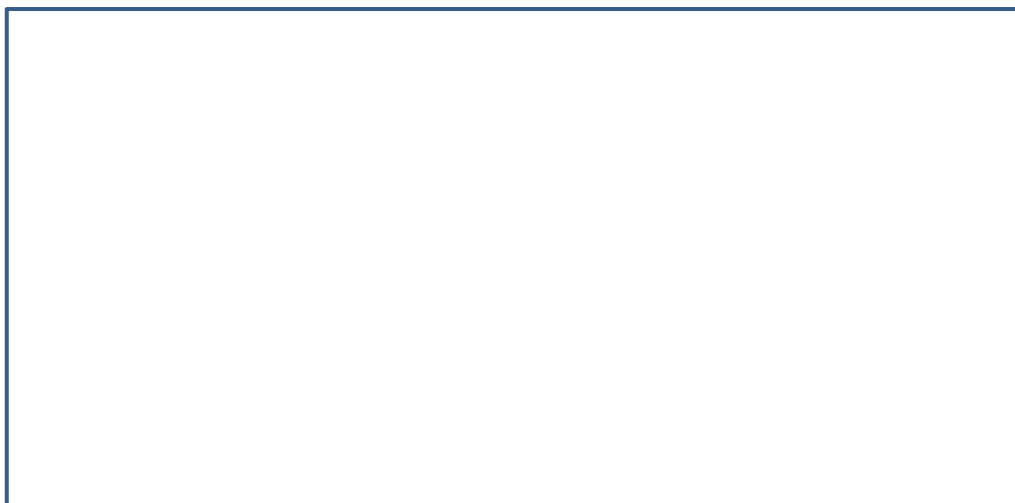
As to the treatment in the catchment basins, the two basins in the east and west managed by IOTC and one basin managed by IOOC are covered. The following methods are currently adopted or considered to treat the huge amount of oily sludge in the basin and the contaminated soil around the basins.

- Heat treatment method: Thermal desorption
- Solvent extraction
- Biological treatment

A most appropriate method or a combination of some of these out of these treatment methods is selected, taking into consideration some factors such as the amount of polluted soil to be treated, the amount of oil contents, treatment standards, treatment cost, power and fuel, facility site, hours necessary for the treatment, the treatment of the secondary wastes, locations, feasibility and so forth. In the coming period, further discussions are to be conducted with IOOC and IOTC as to the purpose and function of the catchment basins as well as utilization of these facilities after treatment.

3) Waste Management Technology

IOOC is developing a number of offshore oil fields in the offshore area adjacent to the island and the extensive areas covering from the north to the south of the Persian Gulf and constantly conducts the drilling of the wells and work-over (the rehabilitation of existing oil wells) in each oil field, where a huge amount of spent drilling mud and drill cuttings are generated during the drilling operation (see Figure 4.2.3-8).



Source: OGP related materials

Figure 4.2.3-8 Sea Disposal of the Drill Cutting

These drill cuttings normally used to be disposed in the sea during drilling operation until 1990s, while this was identified as one of the largest sea pollution sources in the offshore oil field development. Meanwhile, the drill cuttings disposed in the sea have been accumulated in the bottom of the sea. It is indicated that these drill cuttings could be a cause to damage benthonic organisms and algae in the sea area.

For protection of marine environment from the offshore oil field development, the marine environmental conservation guidelines of ROPME and the related international conventions in recent years have advocated the prohibition of disposing the oily drill cuttings and the spent oil based mud in the sea as well as the promotion of the ultimate treatment/disposal methods of drill cuttings instead of the marine disposal. Saudi Arabia, Abu Dhabi and Qatar have already prohibited the marine disposal of the oily drill cuttings for the purpose of the marine environmental protection. Furthermore in Azerbaijan and Kazakhstan, the marine disposal of the oily drill cuttings is banned in the Caspian Sea.

The following two methods are implemented for treatment of oily drill cuttings in general. The first method is implemented in Khark Island.

- (i) Land treatment (elimination or solidification (by cement, etc.) of oil content, and then ultimate disposal or the reuse)
- (ii) Underground injection (for disposal)

(a) Land Treatment Technology

For the final treatment (disposal) or reutilization of the drill cuttings and drill mud on shore, the proper treatment is required so that hazardous substances included in these wastes are removed up to a certain level stipulated by the standards applied to this area. Main hazardous substance to be treated is the oils containing in the oily spent drill mud and drill cuttings released from the underground stratum. It is said that, in general, the oil contents varies from 0% to 20% according to the type of drill mud, drilling methods and the underground stratum. Meanwhile, treatment standard to be applied varies according to the countries, areas and final treatment methods adopted. The residual oil content of less than 0.5-1.0% is generally considered to be acceptable figures (the final treatment in controlled landfill sites) in European countries.

Currently, the following technologies are adopted as treatment methods dealing with these wastes.

- Combustion method: (Incineration : Thermal combustion)
- Heat treatment: Thermal desorption/Distillation
- Solvent extraction
- Solidification / Stabilization
- Biological treatment
- Conversion to cement raw material and sub-fuels

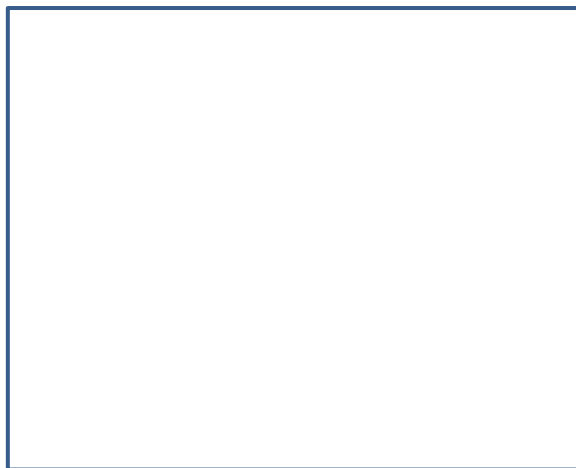
Currently in the North Sea Oil Field, the combustion method and heat treatment such as thermal desorption are often selected. Meanwhile, in Azerbaijan embracing oil fields in the Caspian Sea, British Petroleum (BP), a developer of the biggest oil and gas fields in the Sea is tackling other methods such as biological treatment and even recycling method to convert cement factories to raw material and sub-fuels, in addition the heat treatment.

(b) Underground Injection Treatment Method

In recent years, the underground injection treatment method has been considered mainly in the drilling sites of offshore oil and gas fields. This is a method to add water into the drill cuttings and to mill them into the slurry, which is injected by a pump into the special disposal well or a certain predetermined stratum via an annular of the existing production well (between casings of the well). The underground injection method in offshore oil and gas fields are generally conducted during the drilling operation on the platforms. In case of the drilling at exploration stages utilizing jack-up rigs and so forth, drill cuttings are transported to the land for the treatment.

Basic measures to be taken for the hazardous drill cuttings include the prohibition of the marine

disposal, the proper treatment and ultimate disposal of the hazardous drill cuttings after being transported to the land in accordance with a certain procedure. As an alternative of this method, instead of the normal oil base mud (OBM), Synthetic Oil Base Mud (SBM) could be utilized. The marine disposal of the drill cuttings which utilizes SBM is permitted, assuming that there are no environmentally sensitive factors such as coral reefs, etc. The following Figure 4.2.3-9 shows the typical underground injection system of the drill cuttings that are converted to be slurries.



Source: OGP

Figure 4.2.3-9 Drill Cuttings Slurry Injection System

Khark Island has currently adopted the cement stabilization method. Taken into account the future increase in the waste, however, it is required to investigate relevant technologies of the land treatment and the underground injection treatment as well as to establish an optimal waste management system.

4.2.4. Future Development Plan of Khark Island

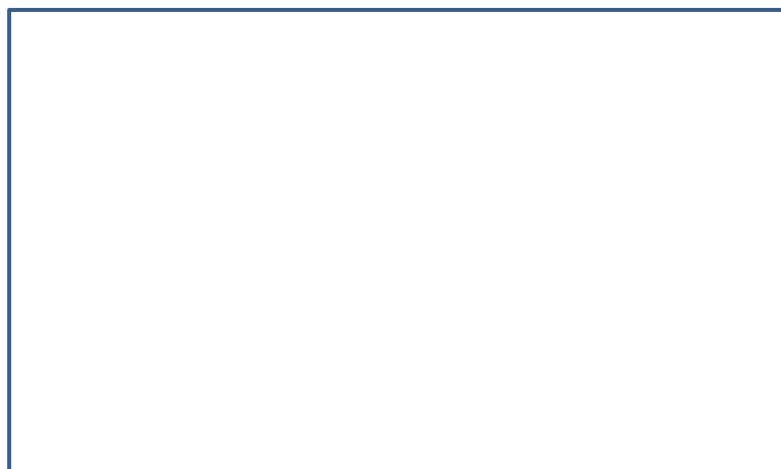
(1) IOOC

1) Offshore Associate Gas Recovery Plan

Since 2005, IOOC has proceeded a plan to recover all the associate gas (650 million cubic feet per day) which is burnt out by the flare stacks in all the offshore oil fields in the Behrgan and Khark district and to effectively utilize the natural gas resources in the fields. Effective ways of utilizing the recovered associate gas are planned as follows:

- Fuel for thermal power generation plants and raw material for petrochemical plants
- Extraction of LPG components and export as LPG product
- Extraction heavy components, liquefaction and export as condensate

Figure 4.2.4-1 provides a schematic diagram of the offshore associated gas recovery plan.



Source: IOOC

Figure 4.2.4-1 Gas Gathering Project in Khark Island

(a) Onshore Base on Khark Island

The construction of onshore base on Khark Island was commenced in 2010, then 53% of the total construction has been completed so far. Starting the operation from early 2014 is aimed at. Table 4.2.4-1 and Table 4.2.4-2 give the planned volume of associated gas to be used and the reduction volumes of CO₂, H₂S and NO₂ emissions at the onshore base respectively.

Table 4.2.4-1 Planned Volume of Associated Gas to be used at the Onshore Base (MSCFD)

Volume of associated gas recovered	Natural gas production plant (under construction)	KPC	Dorood oil field (underground injection)	Onshore base
650	505	120	18	7

Source: IOOC

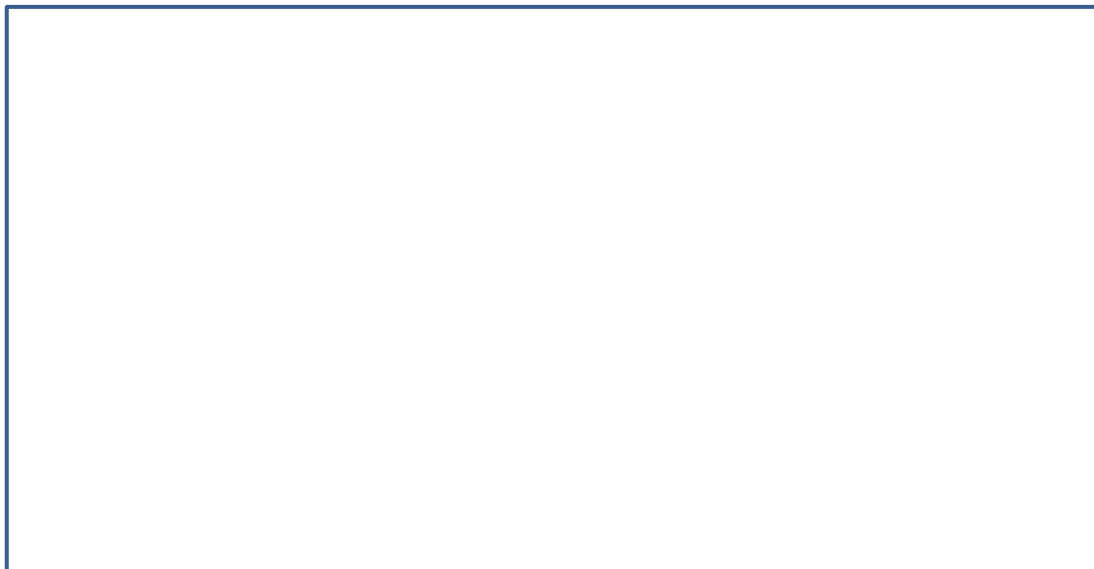
Table 4.2.4-2 Expected Reduction Volume of Emissions (ton/year)

CO ₂	H ₂ S	NO ₂
15,208,590	477,952	136,771

Source: IOOC

Associated gas recovered will be shipped from the NGL plant under construction in Khark Island as condensates of methane, ethane, propane, butane, pentane, etc.

Figure 4.2.4-2 gives a schematic diagram of the NGL plant facilities.



Source: NIOC Non Flaring Project

Figure 4.2.4-2 NGL Plant Facilities

(b) Flow of Recovered Associated Gas

➤ Hendijan Oil Field

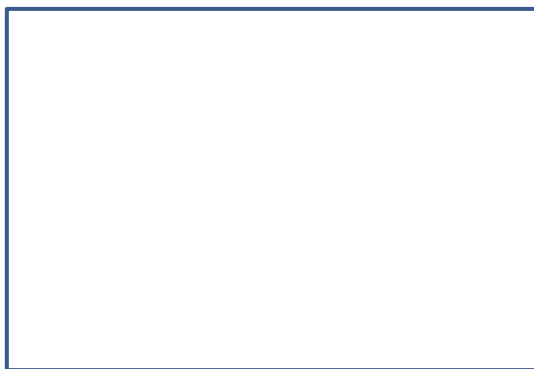
Production facilities in the field comprise 9 production platforms. The crude oil, including associated gas, is transferred to the central platform of Bahregansar Oil Field by subsea pipelines with diameters of 10 and 12 inches.

➤ Bahregansar Oil Field

Production facilities comprise 7 production well platforms and 1 central platform. The crude oil produced in this field is transferred to the central platform. The associated gas in the crude oil, together with the crude oil from Hendijan Oil Field, is separated from the crude oil by the oil-gas separator on the central platform. The treated crude oil is transferred to Bahregan Base on the main land through 16 inches subsea pipeline. Meanwhile, the plan intends to transfer the associated gas which is separated from the crude oil to the gas compressor platform in Aboozar Oil Field.

➤ Soroosh Oil Field

In this field, there is a platform complex consisting of 10 production wells, 2 produced water injection wells and an accommodation facility (see Figure 4.2.4-3). The crude oil produced is sent to the platform in Nowruz Oil Field. The plan aims at transferring the associated gas, likewise the crude oil, to Nowruz platform by a new subsea pipeline. Meanwhile, this oil field has a plan to initiate the gas injection operation.

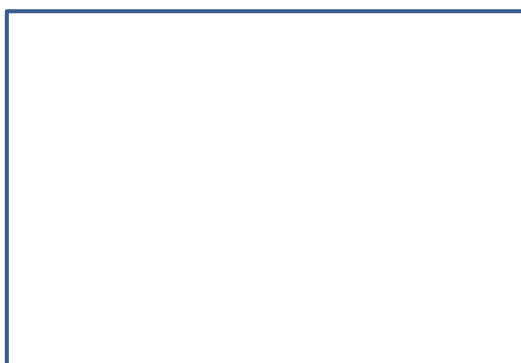


Source: IOOC Brochure

Figure 4.2.4-3 Production Platform of Soroosh Oil Field

➤ **Nowruz Oil Field**

Production facilities of Nowruz Oil Field were destroyed during the Iraq War. After the war, the foreign company of Shell presented the re-development plan of the oil field by buy-back approach based on the foreign investment inducement policy of the country and a new facility was installed in 2005. The current facility comprises a production platform including 17 production wells and an accommodation platform (see Figure 4.2.4-4).



Source: IOOC Brochure

Figure 4.2.4-4 Production Platform of Nowruz Oil Field

➤ **Aboozar Oil Field**

The field is located approximately 76km away in the southwest from Khark Island, producing 140,000 barrel/day from around 90 production wells (see Figure 4.2.4-5). According to the plan, all the associated gas recovered from the offshore oil fields will be gathered to a new platform in the field and transferred via a new subsea pipeline to the onshore base on Khark Island which is currently under the construction.

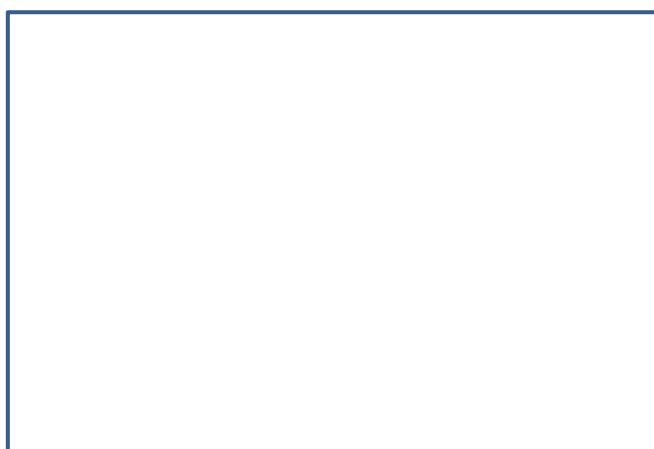


Source: IOOC Brochure

Figure 4.2.4-5 Production Platform of Aboozar Oil Field

➤ **Foroozan Oil Field**

This oil field is located around 100km away in the southwest from Khark Island, neighboring to Marjan Oil Field in the national border of Saudi Arabia (see Figure 4.2.4-6). The production amount reaches at around 100,000 barrel. The crude oil produced is transferred from the production platform to Khark Island through a 20 inches subsea pipeline. The gas recovery project intends to send the associate gas separated in a production process on the platform to the platform in Aboozar Oil Field.



Source: IOOC Brochure

Figure 4.2.4-6 Production Platform of Foroozan Oil Field

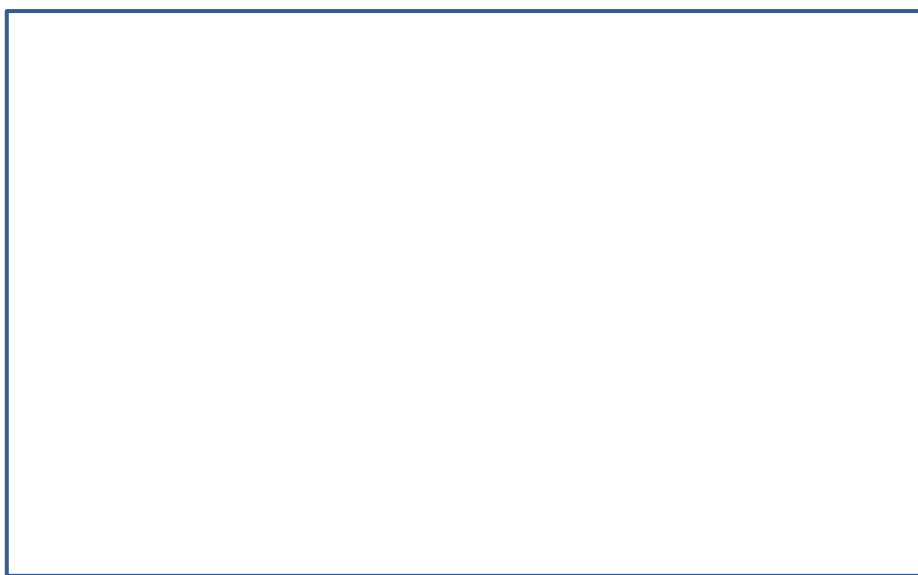
The surplus associated gas at offshore, a current pending issue, will be recovered and effectively utilized along with the completion of this project, and the amount of the flare gas, which is currently burnt out at the flare stacks in Khark Island, is reduced. Furthermore, relevant measures aiming at zero flaring need to be considered, in addition to making efforts in reducing the flare gas by the effective utilization of the associate gas in Khark Island through proper operation management at the time of initiating the operation.

(2) IOOC Projects Other Than Those in Khark Island

1) Gas Gathering Projects in Siri Island

This project aims to transfer associated gas produced in neighboring offshore fields to Siri Island, and produce NGL and condensates in NGL production facilities. The project will also reduce the amount of the flare gas emitted in the course of incineration in the flare stacks. The progress rate of the progress was 97.39% (as of September 29, 2012).

Figure 4.2.4-7 shows a schematic diagram of the project region.



Source: IOOC

Figure 4.2.4-7 Schematic Diagram of the Gas Recovery Project (off Siri Island)

The volume of associated gas expected to be recovered and the air pollution gases such as CO₂ and SO₂ under the project are shown in Table 4.2.4-3.

Table 4.2.4-3 Volume of Associated Gas Recovered and Reduction Volume of Air Pollution Gas (expected)

Volume of associated gas recovered (MSCFD)	Reduction volume of air pollution gas emission (ton/year)
140	3,164,663

Source: IOOC

2) Other Non-Flare Projects

- Non-Flare Project (Lavan)

There are plans to increase crude oil production in Resalat and Reshadat oil fields, using the gas injection method. Another project is to be launched, whereby associated gas generated in Salmon gas field will be not incinerated in the flare stack but transferred via pipelines as gas-injection gas to Resalat and Reshadat oil fields.

- Gas Refinery Plant Development Plan (Hengam)

There is a project to retrofit the Hengam gas refinery plant. The project aims to newly build gas sweetening, dewatering, gas compression and sulfur recovery facilities to bring associated gas, etc. (80 MCFD) generated in Ghesham district to the Hengam gas refinery plant. The progress rate of the project was 36.87% (as of September 29, 2012).

4.2.5. Issues

(1) Air Environment

Table 4.2.5-1 shows the issues on the air environment in Khark Island.

Table 4.2.5-1 Issues on Air Environment

Item	Present situation	Issue
Reduction in flare gas	The total amount of flare gas is estimated at about 80-150 million SFC/day. Global warming gas and air pollution substances are emitted from flare stacks.	• Reduction in flare gas emitted from the crude oil treatment facilities • Promotion of the currently ongoing projects for recovery and effective use of flare gas
Complete combustion of flare gas	Black smoke is emitted from flare stacks.	• Flare shall be made smokeless by controlling steam, air, etc. in light of characteristics (pressure and amount) of flare gas, and the location of flare stack.
Air monitoring	Four air monitoring stations exist in the island, but are not managed in an integrated manner since each company has their station.	• Integrated management of monitoring stations • Comprehensive data management • Consideration of installation of additional monitoring stations, if necessary

(2) Water Environment

Table 4.2.5-2 shows the issues on the water environment in Khark Island.

Table 4.2.5-2 Issues on Water Environment

Item	Present situation	Issue
Produced water (IOOC)	(Offshore) The amount of produced water beyond the capacity of CFU on the platforms is sent to the crude oil treatment facilities in Khark Island. (Onshore) Because of increase in produced water, the amount of discharged water from crude oil treatment facilities has been increasing over years compared to the time when the crude oil production started. As a result, some wastewater in excess of the capacity of the existing wastewater treatment facilities of IOOC is discharged to the sea without any treatment.	• Consideration of appropriate onshore treatment methods - Extension of CFU, etc. • Consideration of proper treatment at onshore - Extension of wastewater treatment plant, etc. • Consideration of underground disposal of produced water • Consideration of EOR using produced water
Drain treatment of crude oil tank yards (IOTC)	Tank drain generated is discharged after simple oil-water treatment process.	• Installation of wastewater treatment facilities
Discharged water (IOOC and IOTC)	The wastewater is likely to exceed the effluent standards of oil and COD. The wastewater discharged is also likely to contain various other chemical substances, heavy metals and NORMs (Naturally Occurring Radioactive Materials).	• Analysis of discharged water and understanding of the actual situation of contamination • Regular monitoring and following-up of the results of analysis
Wastewater pond and drainage path (IOOC and IOTC)	The soil in wastewater ponds and drainage paths of IOOC and IOTC is contaminated by oil and other substances contained wastewater.	• Analysis of the soil and understanding of the actual situation of contamination • Consideration of purification of wastewater ponds • Consideration of treatment of contaminated soil • Consideration of drawing up a plan to use the land after purification

(3) Wastes

Table 4.2.5-3 shows the issues on the wastes in Khark Island.

Table 4.2.5-3 Issues on Wastes

Item	Present situation	Issue
Wastes generated at the time of oil well drilling (IOOC)	Oily drill cuttings generated from the on shore and offshore oil well drilling sites are processed by the solidification treatment utilizing special cement inside the Island.	• Ensuring appropriate treatment (in compliance with applicable standards) • Consideration of treatment methods with an eye to an increase in wastes in future (use of SBM and underground disposal)
Wastes from the crude oil treatment plant (IOOC)	Oily solid wastes such as sludge, etc. generated from the crude oil producing facilities are treated according to the wastes management plan by IOOC.	• Onshore waste measures from the long-term perspective are needed.
Wastes from the crude oil tank yards (IOTC)	Most of the wastes generated from IOTC operation are tank sludge, but its volume is quite limited since the Company has introduced Crude Oil Washing (COW) System.	• There seem few problems at the moment.
Spent catalysts and solid sulfur (KPC)	The quantity of wastes is small since the size of the plant is small.	• Consideration of appropriate measures also covering other pilot areas is needed.

(4) Biota and Conservation

Table 4.2.5-4 shows the issues on biota and conservation in Khark Island.

Table 4.2.5-4 Issues on Biota and Conservation

Item	Present situation	Issue
Impacts of the industrial zone	The Atlas of Protected Area of Iran (2006) points out negative impacts of the extensive petroleum industries and facilities in Khark Island on environment. NGL plant is under construction in the south-west part of Khark Island and starts to operate in a few years. If NGL plant starts to operate, it is concerned that a coral reef near the plant is affected by industrial wastewater from it. From 1993 to 1995, extensive research was conducted on mortalities of sea mammals due to oil slicks in the sea near Khark Island.	• Implementation of continuous monitoring activities to promptly clarify the load of the industrial zone on environment • Consideration of measures in case the monitoring has found negative impacts on environmental • Appropriate treatment of wastewater from the NGL plant located near coral reefs

(5) Other Environmental Conditions (Ballast water)

Table 4.2.5-5 shows the issues on other environmental conditions (ballast water) in Khark Island.

Table 4.2.5-5 Issues on Ballast Water

Item	Present situation	Issue
Ballast water	The presence of ships discharging ballast water is confirmed in the sea near Khark Island.	• Lack of articles relating to penalty in domestic regulations • Execution of PSC by PMO • Installation of a ballast water treatment facility in Khark Island

(6) Future Development Plan of Khark Island

Table 4.2.5-6 shows the issues on the future development plan of Khark Island.

Table 4.2.5-6 Issues on Future Development Plan

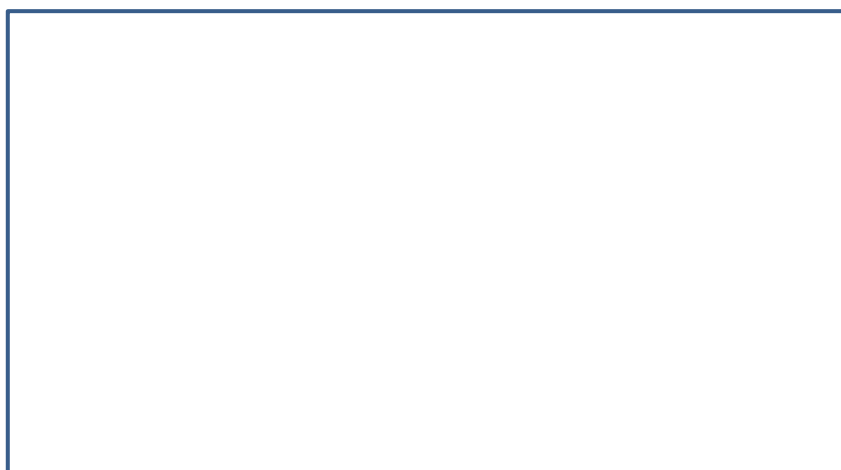
Item	Present situation	Issue
Offshore gas gathering project (IOOC)	Since 2005, IOOC has proceeded a plan to recover the entire associate which is burnt out by the flare stacks in all the offshore oil fields in the Bahregan and Khark district and to effectively utilize the natural gas resources in the fields. Under the plan, IOOC is constructing an NGL plant.	• Mitigating negative impact of construction work of subsea pipelines, etc. on environment • Appropriate treatment of wastewater from the NGL plant located near coral reefs

4.3. Assaluyeh

4.3.1. Outline of Assaluyeh Industrial Zone

Pars Special Energy Economic Zone (PSEEZ) runs a variety of natural gas refinery complex, petrochemical complexes, and related facilities including the infrastructure in the vast area of approximately 100 km² in Assaluyeh area along the Central Persian Gulf coast. Almost in the center of PSEEZ is located a gas refinery district, a petrochemical plant district in the west, a heavy/light industrial district in the east, and port facilities along the coastal area.

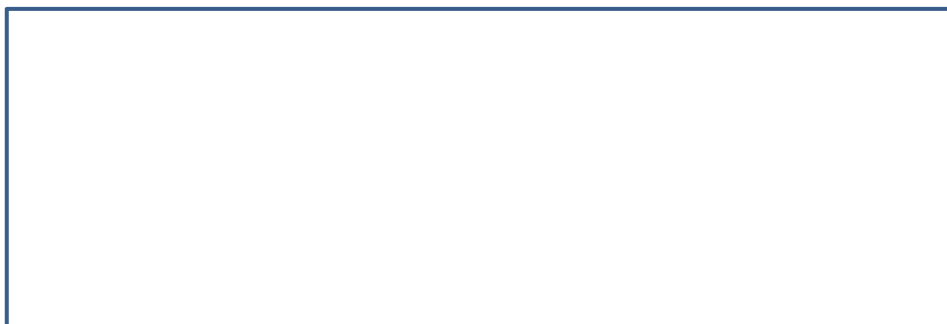
The development plan of PSEEZ is to be implemented at 27 phases in total, including the development of 12 gas refinery plants, 15 petrochemical plants, and relevant infrastructure for the heavy/light industries, road, an airport, a port, and related facilities (see Figure 4.3.1-1). These projects are to be implemented not only in Assaluyeh area, but also in Kangan area, an extended area by approximately 70 km in the west.



Source: PSEEZ

Figure 4.3.1-1 Layout of PSEEZ

Since the development has commenced in 1999, the phases 1-10 have already completed and 5 gas refinery plants and 7 companies, together with 15 petrochemical plants, are operating (see Figure 4.3.1-2). The phases 11-24 of the projects are currently on-going.



Source: SPGC

Figure 4.3.1-2 Gas Refinery Plant

The gas refinery plants, which were established during the phases 1-10, are currently operating to refine and process (to separate the condensate from the natural gas, to remove sulfur and impurities, etc.) the natural gas transferred from the offshore gas field of South Pars, as well as to produce the fuel gas, raw materials for the petrochemical plants, and condensate for export purposes.

Table 4.3.1-1 shows the projects, products and their production amounts per day for each phase.

Table 4.3.1-1 Production Amount of Gas Refinery Plants (per day)

<u>Phase 1</u> Gas Refinery Plant	• Natural gas • Condensate • Sulfur	25,000,000 m ³ 40,000 barrel 200 ton
<u>Phases 2 & 3</u> Gas Refinery Plant	• Natural gas • Condensate • Sulfur	57,000,000 m ³ 80,000 barrel 400 ton
<u>Phases 4 & 5</u> Gas Refinery Plant	• Natural gas • Condensate • LPG • Ethane	50,000,000 m ³ 80,000 barrel 400 ton 2,600 ton
<u>Phases 6, 7 & 8</u> Gas Refinery Plant	• Acid gas • Condensate • LPG	104,000,000 m ³ 170,000 barrel 5,000 ton
<u>Phase 9 & 10</u> Gas Refinery Plant	• Natural gas • Condensate • Sulfur • LPG • Ethane	50,000,000 m ³ 80,000 barrel 400 ton 4,110 ton 2,740 ton

Source : PSEEZ Book 2011

There are 15 petrochemical plants run by 7 companies and 5 related companies including power plants currently operating in the petrochemical plant district. In addition, along with the phases of PSEEZ on progress, the construction works for petrochemical plants (8 companies) of the downstream sector are currently carried on. These petrochemical plants are producing chemical

products such as methanol, benzene, urea, ammonia, olefin, ethylene, propylene, etc., utilizing the raw materials of the products from gas refinery plants (natural gas, condensate, ethane, etc.).

Gas refinery plants within PSEEZ are owned by Pars Oil and Gas Company (POGC) affiliated to NIOC, operated by South Pars Gas Company (SPGC) affiliated to NIGC. Meanwhile, in the petrochemical plant district, Pazargad Non Industrial Operation Services Company (PNOSC) affiliated to NPC is responsible for the environmental management and the supervision of the total operation lines.

The development of PSEEZ and the activities within the area are supervised and managed by the PSEEZ Management Organization under NIOC.

4.3.2. Current Environmental Conditions in Assaluyeh

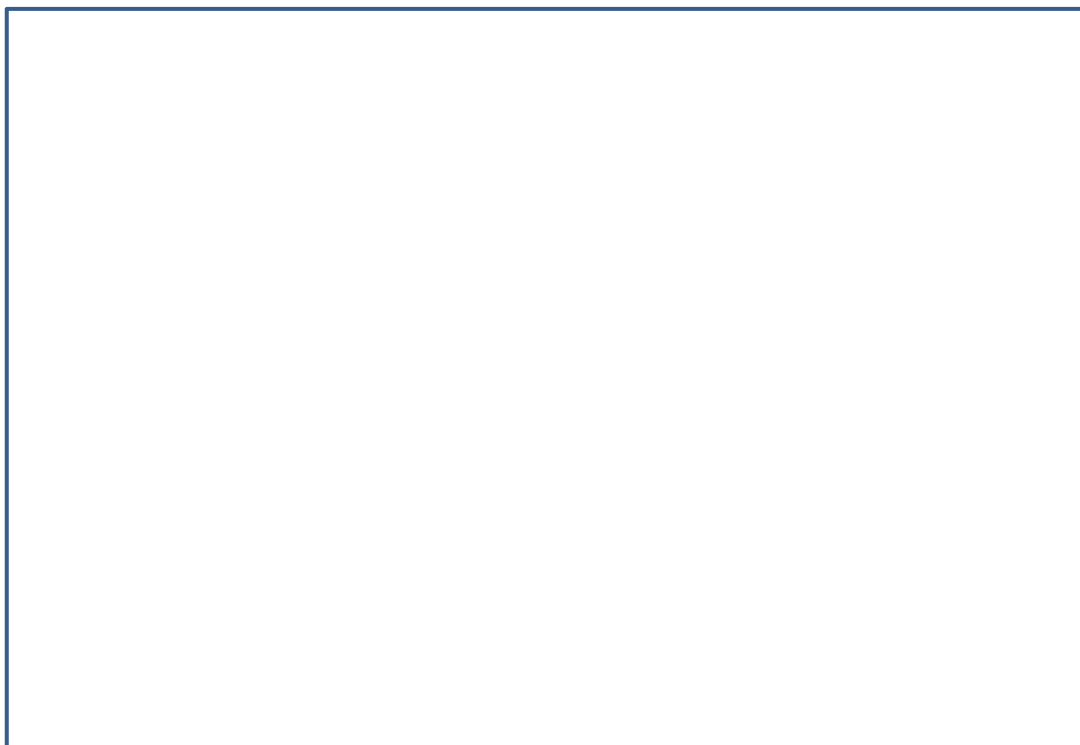
(1) Air Quality

1) Summary of Air Quality

The air pollution, due to a huge amount of emission gases containing air pollutants such as SO_x, NO_x, PM, VOC, etc. released from gas refinery plants and petrochemical plants along with the grand-scale PSEEZ development, has become one of the most considerable environmental issues in Assaluyeh Area. A number of flare stacks have been installed at the foot of a steep range of hills in the northern part of the area, some of which are causing the black smoke and big flames. A plant is forested with a lot of stacks affiliated to boilers, heat furnaces, gas turbine power generators, etc., emitting gases out of the plant to cover the area from the above with the smoky atmosphere (see Figure 4.3.2-1).

Under the circumstances, there are concerns about the impacts on health conditions of thousands employees engaged with PSEEZ and approximately 20,000 residents in the neighboring urban districts in the area.

Based on these air pollution conditions, each plant has implemented various measures in order to improve the air environment. Nevertheless, any effects have been apparent yet.



Source: Googlemap

Figure 4.3.2-1 Air Pollution in Assaluyeh Area

2) Sources of Gas Emission (flare gas)

As one of the most influential factors on the air pollution in the area, there are various gases emitted in the air from the refinery gas plants and petrochemical plants within PSEEZ. These gases and their sources are as follows.

- Flue gas from the flare stack which incinerates surplus gas, process tail/off-gas, etc. in the atmosphere
- Flue gas of the combustion equipment such as boilers, heat furnaces, incinerators, gas turbines, etc.
- Venting of gases (volatile organic compounds, including VOC) from process equipment, oil storage tanks, etc.
- Fugitive gases from process equipment, pipes, bulbs, etc.
- Accidental gas release from process plants
- Leakage of oil and gas by accident

Among these emission gases, the flare stack, installed in each plant and under the operation all the time, is considered to be the biggest source of the gases. The amount of the flare gas emitted from the gas refinery plants in PSEEZ is shown in Figure 4.3.2-2. The amount of the emission is

observed to have decreased annually because of the measures that have been taken to reduce the flare gas in each plant.



Source: SPGC Environmental Activities Report

Figure 4.3.2-2 Amount of Flare Gas in Gas Refinery Plants

The annual amounts of the flare gas emissions from the gas refinery and petrochemical plants are shown in Table 4.3.2-1. The flare gas emission volume from the former is approximately six times more than that from the latter.

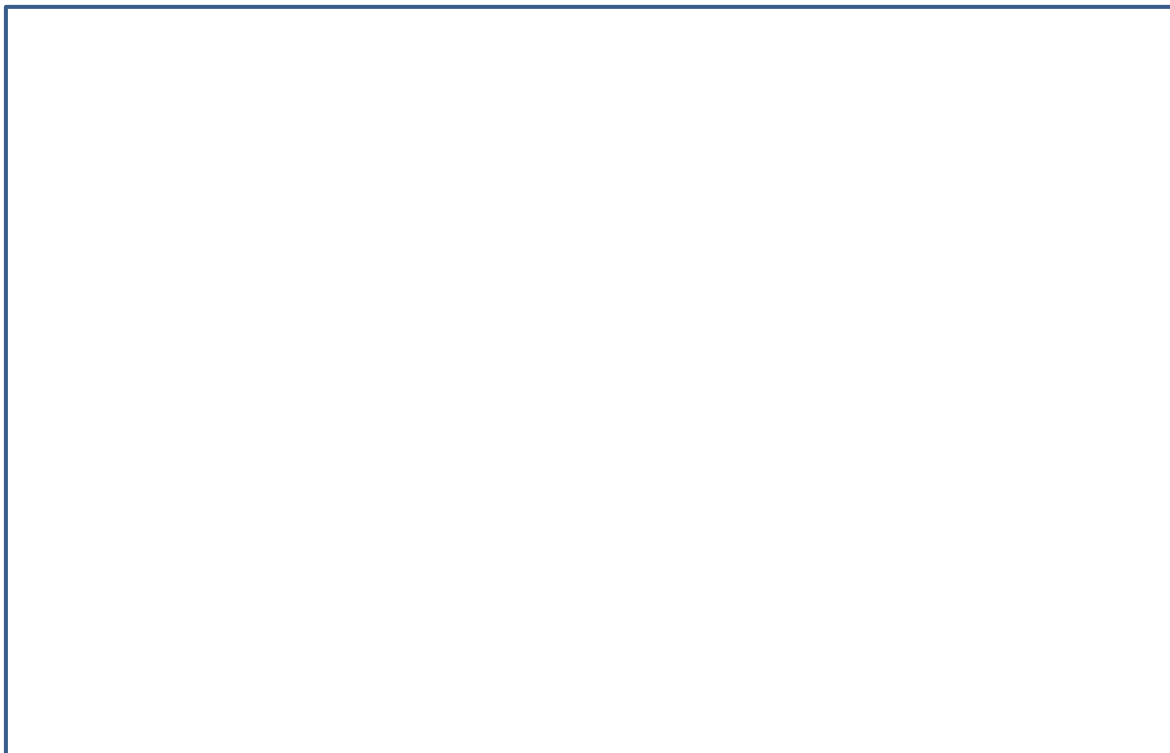
Table 4.3.2-1 Flare Gas Emissions from Gas Refinery and Petrochemical Plants

Gas refinery plants* ¹	Petrochemical plants* ²
1,253,720 ton/year	201,000 ton/year

Note: *1 Data: 2012.1.1-2012.12.31 *2 Data: 2012.3.19-2013.3.11

Source: Environmental Monitoring Data, SPGC and PNOSC

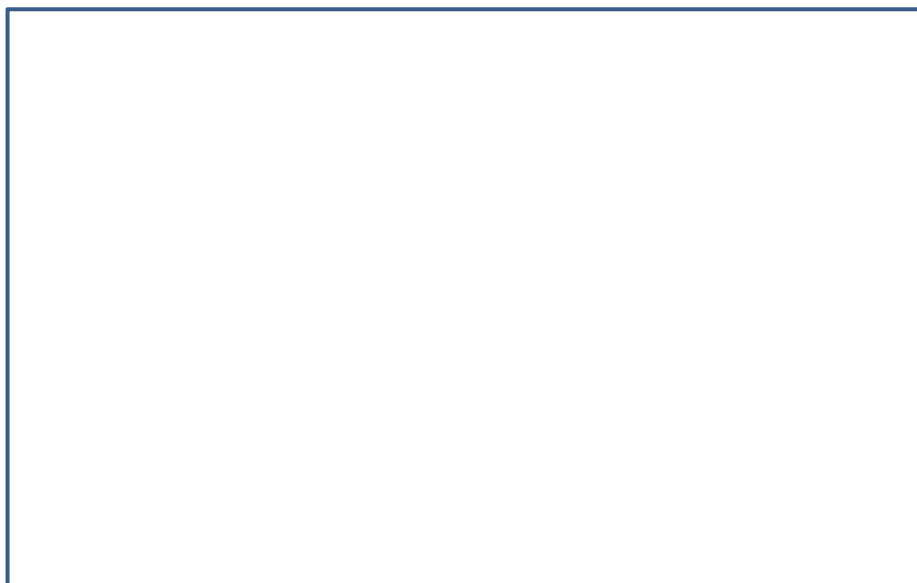
Flare gas emissions at each phase of the gas refinery plants and those from the petrochemical plants of each company are shown in Figure 4.3.2-3. This figure shows that the gas refinery plants are the primary source of the flare gas emissions from the area.



Source: Flare gas data, SPGC and PNOSC

Figure 4.3.2-3 Flare Gas Emissions from Gas Refinery and Petrochemical Plants (2012)

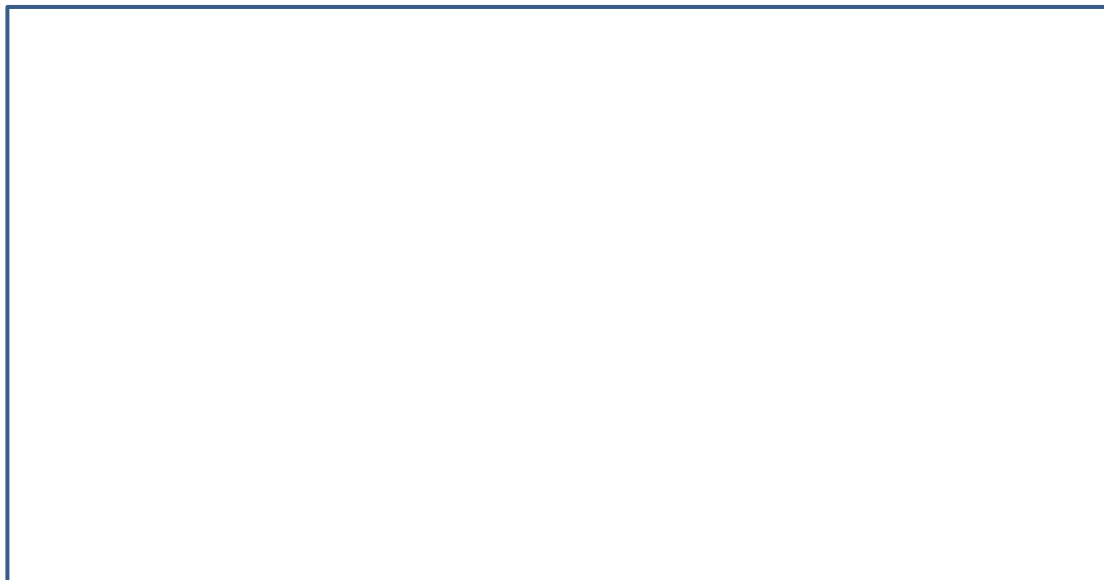
Figure 4.3.2-4 shows the flare gas rate (proportion of flare gas to gas production volume) of each phase of the gas refinery plants (based on data received from SPGC in 2012 and 2013).



Source: SPGC environmental monitoring data

Figure 4.3.2-4 Flare Gas Rate of Gas Refinery Plants

The relations between the operated year and flare rate of the gas refinery plants are shown in Figure 4.3.2-5 (where the operated year is set by April 2012).



Source: Study team

Figure 4.3.2-5 Operation periods (years) of Gas Refinery Plants and Flare Gas Rate

The figure clearly shows that the flare rate falls as the operated year becomes longer. This is attributable to the fact that as the operated year becomes longer, the plants begin to take measures to reduce the flare gas emissions. The flare rate is less than 1% at two plants out of three that has been operating for seven years or longer. The rate exceeds 2% in Phases 6, 7 and 8, and Phases 9 and 10. The rate is considered to be lowered to 1% or below within a short time if an approach to cut the flare gas emissions can be shared in phases 1-5.

If the flare rate in Phases 6, 7 and 8, and Phases 9 and 10 can be cut down to 1%, the flare gas emissions from the gas refinery plants will be able to be reduced by 45% compared to the current rate (from 1,630 MMSCM/year to 892 MMSCM/year). Moreover, if H₂S concentration of the flare gas is 5%, the amount of SO₂ emitted from the flare stack will be able to be reduced to 146 tons per day. Table 4.3.2-2 shows the results of the estimations.

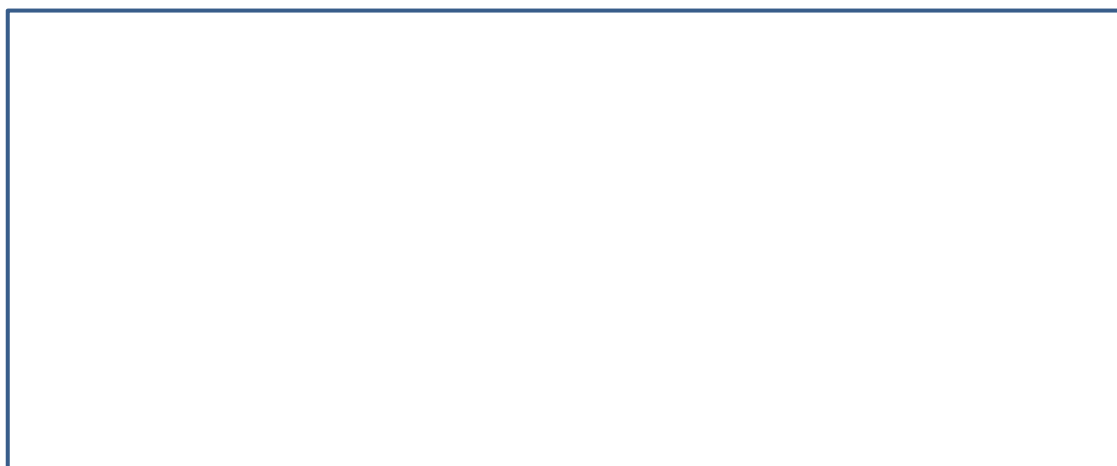
Table 4.3.2-2 Estimates of SO₂ Reductions

		Present state	After reduction
Flare gas emissions	(MMSCM/year)	1,630	892
	(ton/day)	3,434	1,880
H ₂ S in flare gas	(ton/day)	172	94
SO ₂ generated by combustion	(ton/day)	323	177
Reductions in SO ₂	(ton/day)	323-177= 146	

Source: Study team

For a better air environment and protection of gas resources in Assaluyeh area, Phases 6, 7 and 8, and Phases 9 and 10 must set out targets of the flare gas emission reductions in each fiscal year and promote further reductions by referring to the approach taken in Phases 1-5. They are also required to make an effort to reduce the flare rate in Phases 1-5 to 0.5% (The Canadian guidelines stipulate that the flare rate of plants in operation for two years or longer will be 0.5% or lower, so this value should be set as a target when proceeding with the flare gas emission reductions.) Moreover, although the petrochemical plants emit less flare gas than the gas refinery plants, they are still required to draw up a flare gas reduction plan and take measures based on it.

Figure 4.3.2-6 shows a comparison of the rates of flare gas generated in natural gas production among selected oil producing countries. The rate for Iran as a whole was 6%, higher than that of the gas refinery plants in Assaluyeh area. Iran ranked second in the comparison, followed by Nigeria which marked 17.3% of the flare rate. The figure shows that the rate of UAE and Norway was nearly zero. The parties concerned in Iran must thoroughly continue to promote reductions in the flare gas emissions.



Source: OPEC Annual Statistical Bulletin2012, NOAA satellite data

Figure 4.3.2-6 Comparison of Flare Gas Rates in 2011

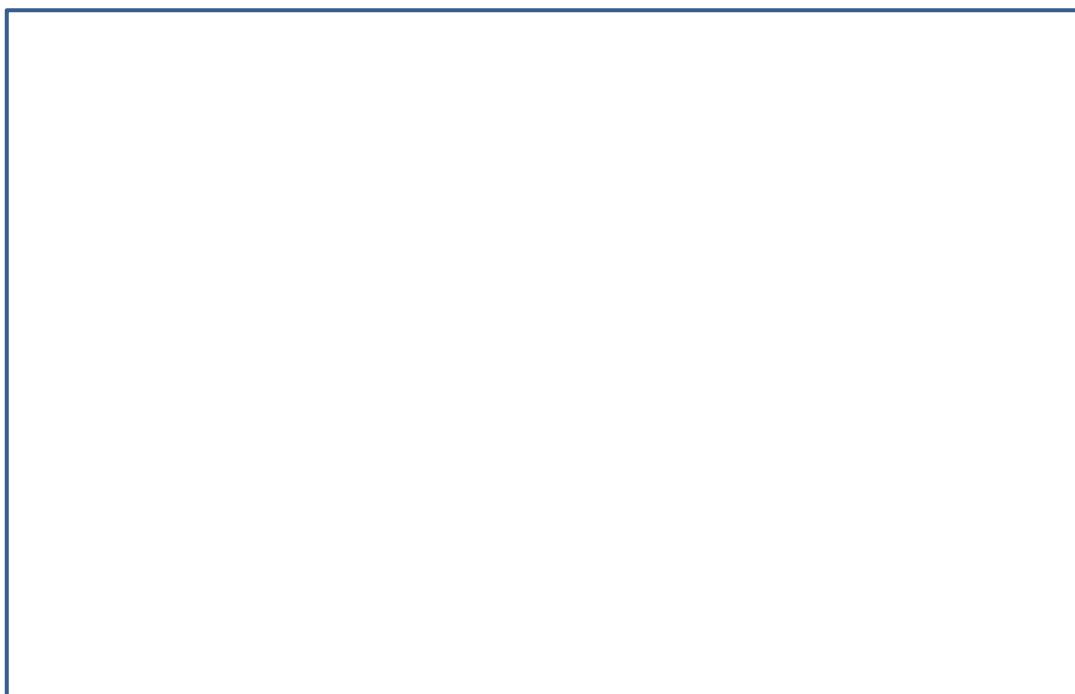
According to explanation of SPGC during site survey, the volumes of the tail gas which comprised of high H₂S discharged from sulfur recovery units (SRU) of several gas refinery plans have increased in the past years due to remarkable decline of process efficiencies of SRUs from 98.5% of original design. The increased tail gases are treated by the gas incinerators of SRUs and flue gases containing SO_x are directly emitted from the incinerators in the atmosphere in the area. It is assumed that such increased tail gas treated by incinerators is also large source of SO_x emitted in the area.

Meanwhile, Di-sulfide Oil (DSO), as bi-product, is produced from the condensate oil extracted in the gas refineries in the thermal cracking process for olefin in the petrochemical plants. The volume of produced DSO, which contains high rate (approximately 3000 ppm) of mercaptans that originated from the condensate oil, is 3-5 tons per day and it is ultimately treated in burn pits at present. This is one of the large SO_x emission sources in the area.

3) Conditions of the Air Pollution

(a) Air Quality Monitoring

SPGC has established 18 air quality monitoring (sampling) points in Assaluyeh Area as shown in Figure 4.3.2-7. Regular monitoring of the concentrations of SO₂, NO₂, BTX (benzene), PM_{2.5}, O₃, and NH₃ is implemented.



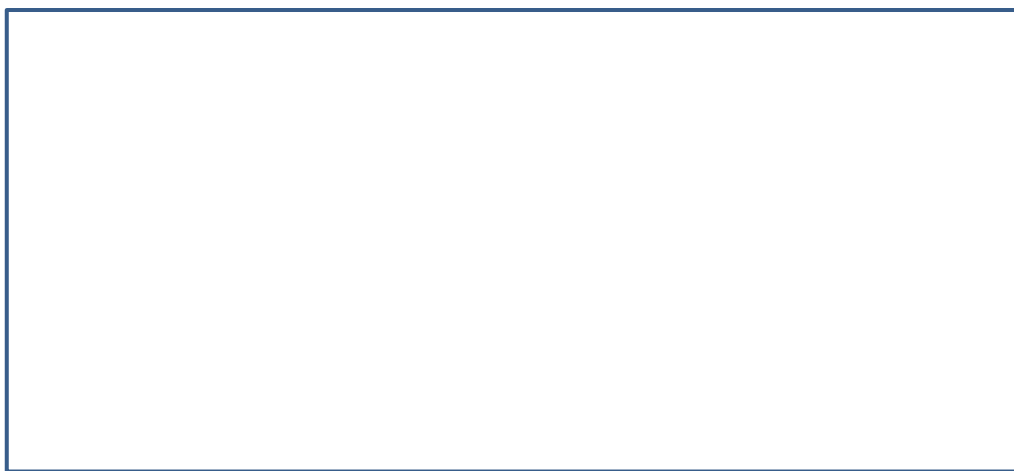
Source: SPGC Environmental Activities Report

Figure 4.3.2-7 Air Monitoring (sampling) Points

The following part shows the transition of the concentration of each harmful pollutant in the air and the concentration distribution from 2009 to 2012 in the air quality monitoring points.

SO₂ Concentration

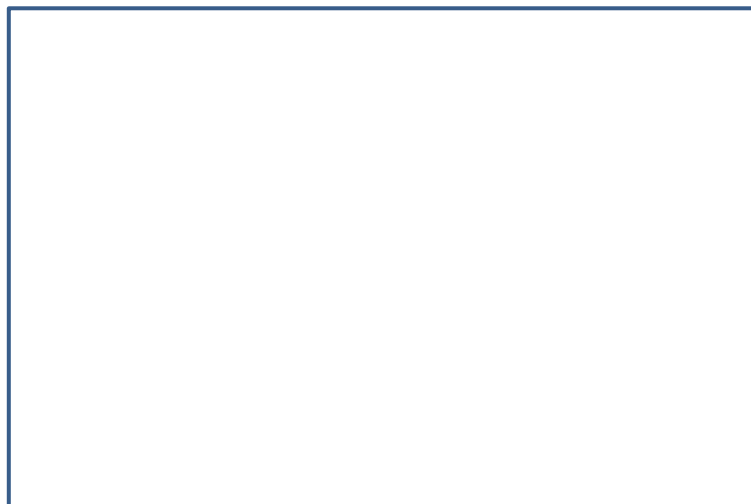
The transition of SO₂ concentration in the atmosphere in each monitoring point is shown in Figure 4.3.2-8.



Source: SPGC Environmental Activities Report

Figure 4.3.2-8 SO₂ Concentration in Assaluyeh Area

In addition, the distribution of SO₂ concentration within the area is shown in Figure 4.3.2-9.



Source: SPGC Environmental Activities Report

Figure 4.3.2-9 Distribution of SO₂ Concentration

DOE has set the concentration standards of SO₂ in the atmosphere as an annual average of 20 µg/m³ in the area. The SO₂ concentration along the southeast coastal parts in the area almost meets

the standard values, while highly concentrated SO_2 has disseminated in the northwest mountainous parts and the concentration of SO_2 exceeds the average standards in the area. These trends are found as a common feature in each year with no considerable changes.

As shown in Figure 4.3.2-2, while the discharged amount of the flare gas in the gas refinery plants has decreased year by year, there is no indication of the decline in SO_2 concentration in the atmosphere inside the area.

Assaluyeh area is characterised by the mountainous land of 1,000 m height, 5km away from the coastal lines, and the industrialized area located on the plain between them. Figure 4.3.2-10 shows the window velocity data (2005 census) along the Assaluyeh Coast. Apart from an irregular record of more than 5 m/s of the window velocity in the west-northwest direction, it is noticed that the window speed throughout the year is moderate, varying from 1~3 m/second.



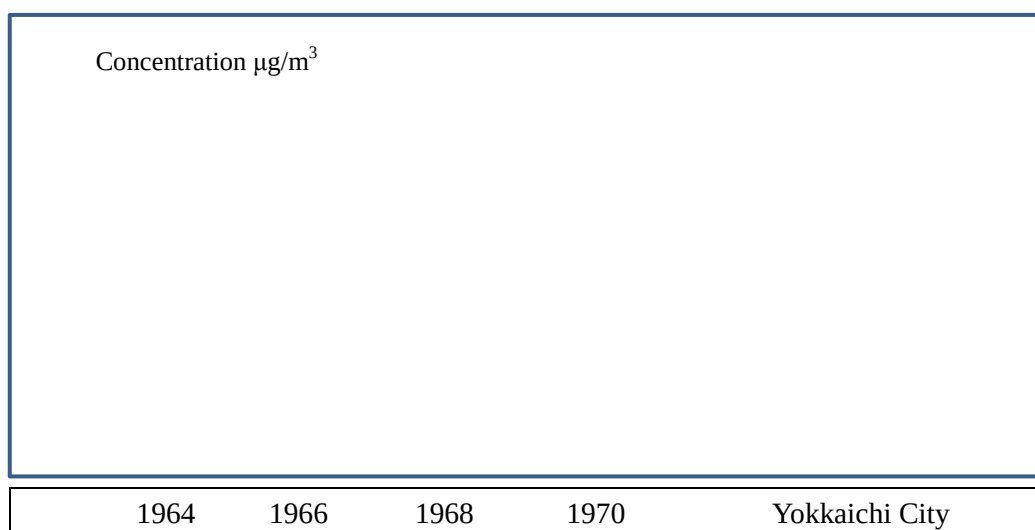
Internal 1st circle: 1~3 m/s, 2nd : 3~5 m/s, 3rd : 5~7 m/s

Source: State of knowledge of Oceanographic Parameters for Central Part of Northern Persian Gulf Coast

Figure 4.3.2-10 Wind Direction and Velocity Data in Assaluyeh Area

It is estimated that these factors, such as its geographic characteristics, influences of the weather conditions, and the nature of SO_2 which has a tendency to remain on the ground surface due to its weigh heavier than the air, have prevented the emission gas from diffusing. Instead, the gas has remained at the vicinity of the foot of the mountains, resulting in the distribution as shown in the above figure.

Yokkaichi City in Japan experienced the occurrence of the disease (Yokkaichi City Asthma) caused by the air pollution due to the harmful air pollutants such as SO_2 and so forth released from the petrochemical complex in the past. Figure 4.3.2-11 shows the comparison between the SO_2 data (1964-1970) at the time when the air pollution occurred in Yokkaichi City and the SO_2 monitoring data at the 3 points of the mountain-side in Assaluyeh (Assaluyeh mountain foot, Phase 4,5 Gallery room, Bidkhoon OIEC camp).



Source: SPGC Environmental Activities Report and Yokkaichi City

Figure 4.3.2-11 Transition of SO₂ Concentration in Assaluyeh and Comparison with the Transition of Yokkaichi City's Data at the Time of Air Pollution

Some of the figures of the SO₂ concentration in Assaluyeh are observed to have exceeded the one for Yokkaichi City at the time when the patients were diagnosed with Asthma. According to the 24 hours measurement data of SO₂ obtained from SPGC, 4 sites out of sampling points in Assaluyeh area show the record of 1,140 µg/m³ (0.4 ppm) and in other 4 sites 857µg/m³ (0.3 ppm), all of which have exceeded each standard value of PSEEZ, IPS, WHO and Japan as shown in Table 4.3.2-3. These conditions would raise concerns about possible influences by SO₂ on the health conditions of the employees and residents in the district.

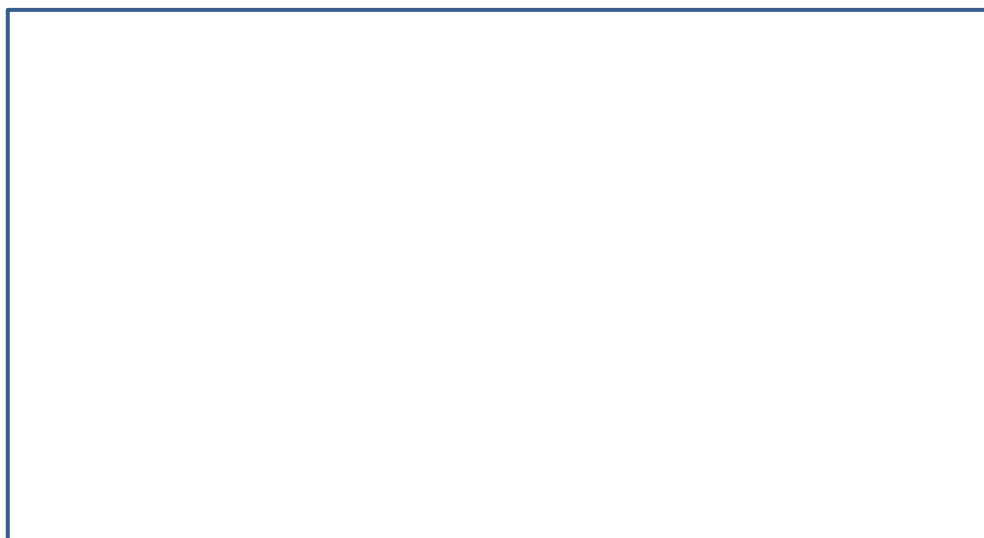
Table 4.3.2-3 Standard Values of SO₂ through 24 Hours Measurement

	PSEEZ	IPS	DOE	WHO	Japan
µg/m ³	100	340	100	114	114
ppm	0.037	0.12	0.037	0.04	0.04

Source: PSEEZ and SPGC

Benzene Concentration

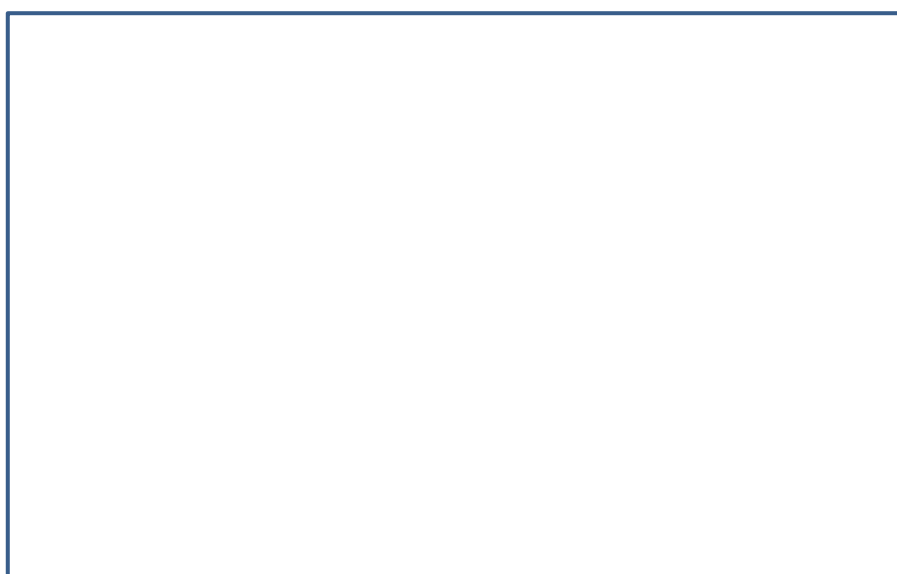
The transition of benzene concentration in the atmosphere in each monitoring point is shown in Figure 4.3.2-12.



Source: SPGC Environmental Activities Report

Figure 4.3.2-12 Benzene Concentration in Assaluyeh Area

In addition, the distribution of benzene concentration within the area is shown in 4.3.2-13.



Source:SGPC Environmental Activities Report

Figure 4.3.2-13 Distribution of Benzene Concentration

The eastern part of the area, including the coastal part, has shown almost the same as, or less than, the standard value of PSEEZ/DOE ($5 \mu\text{g}/\text{m}^3$), while the value of the northwest part of the area also exceeded the standard value like SO_2 . Especially in the monitoring point No. 10, a part of the central area, crowded by the condensate tanks, showed a quite high value recorded. These are the trends commonly observed throughout years, with no remarkable changes to be noted.

The BTX, including benzene, toluene, and xylene, are regarded as the hazardous substances (carcinogen) which directly affect on people's health conditions. Table 4.3.2-4 shows the environmental standards in Iran and the work environmental standards (exposure standards) in Japan and US.

Table 4.3.2-4 Standard Values of Benzene and ACGIH Exposure Standards ($\mu\text{g}/\text{m}^3$)

PSEEZ	DOE	WHO	Japan	ACGIH TLV-TWA	ACGIH TLV-STEL
5	5	-	3	1,600	8,000

TLV-TWA (Threshold Limit - Value Time Weighted Average): The Concentration causing effects on human body by the exposure for 8 hours/day

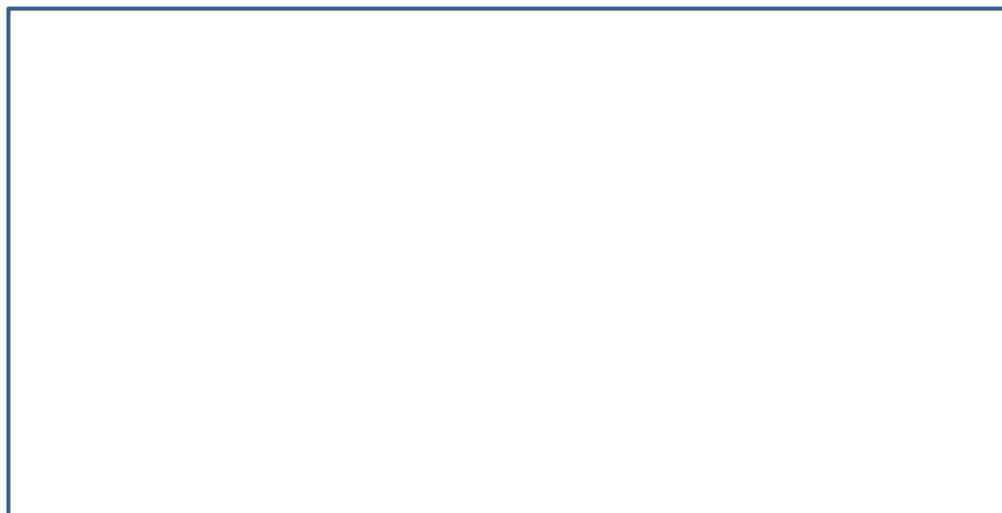
TLV-STEL (Threshold Limit Value - Short Term Exposure Limit): The concentration causing effects on human body by the short exposure for 15 minutes

Source: ACGIH (American Conference of Industrial Hygienists)

Though Figure 4.3.2-12 shows a disparity between the highest concentration of $20 \mu\text{g}/\text{m}^3$ (Phase 2, 3 fire ground: the monitoring point No. 10) and values of the work environmental standard, it is necessary, at the time of actual operation of tank sampling works, to conduct the works in windward places to avoid inhaling the liquid vapor as well as to wear the sufficient personal protection equipment (PPE) such as masks and gloves.

NO₂ Concentration

The transition of NO₂ concentration in each monitoring point is shown in Figure 4.3.2-14.



Source: SPGC Environmental Activities Report

Figure 4.3.2-14 NO₂ Concentration

According to these data, most of the monitoring points, excluding plants for Phases 4, 5 (Unit 113: the monitoring point No. 13), show almost the same as, or less than, the standard values or PSEEZ

and DOE (40 $\mu\text{g}/\text{m}^3$). In the plants of Phases 4, 5, there are power facilities equipped with the combustion facilities, such as power generators with the gas turbine engine and boilers that have caused NO_2 , resulting in a higher value than the ones in other plants.

The standard values regarding NO_2 stipulated by PSEEZ, IPS, DOE, and WHO are shown in Table 4.3.2-5.

Table 4.3.2-5 Standard Values of NO_2 ($\mu\text{g}/\text{m}^3$)

PSEEZ	IPS	DOE	WHO
40 (Annual average)	100 (Annual average)	40 (Annual average)	40(Annual average) 200 (1 hour value)

Source: PSEEZ, IPS, DOE, WHO

PM_{2.5} Concentration

Table 4.3.2-6 shows the comparison the values of PM_{2.5}, which is especially considered to have impacts on the health, among PSEEZ, DOE, IPS, WHO, and Japan.

Table 4.3.2-6 Comparison of PM 2.5 Concentration Standards ($\mu\text{g}/\text{m}^3$)

PSEEZ			DOE	IPS	WHO	Japan
Maximum	Minimum	Average				
242	91	168	10 (annual) 25(1 hour)	75	10 (annual) 25 (1 hour)	35

Source: SPGC Environmental Activities Report

PM_{2.5} is a particulate substance less than 2.5 micro meters (1 micro meter is equivalent to 1/1,000 millimeter) floating in the atmosphere. While many of the particles of 2.5-10 micro meters are natural dusts, PM_{2.5} is considered to be strongly poisonous, most of which include artificial substances emitted from exhaust gases from diesel cars and smokes of the factories. Since this particle penetrates into the depth of the lungs, without being stopped around throats, it is assumed that it could cause some diseases such as lung cancer and allergic asthma.

According the data here, it was observed that the particulate substances were more than double of the aforementioned standard value and they are considered to be affected by the exhaust gases from the flare stacks, not naturally generated dusts, leading to further concerns about impacts on the health conditions among employees and residents.

(2) Water Quality

1) Outline of Water Quality

The industrial wastewater from Assaluyeh area is released from gas refinery plants and petrochemical plants into the sea more or less according to the effluent standards, but the gas refinery plants have some problems, such as failure in appropriately recovering used neutralizer (MDEA: methyl diethanolamine) in their wastewater facilities and waste MEG (mono ethylene glycol) in the air dryers, resulting in contamination of wastewater. On the other hand, the industrial wastewater from the petrochemical plants is processed in the integrated wastewater treatment facilities, but the facilities are increasingly required to treat wastewater with high COD loads.

Another problem is incorporation in wastewater of ammonia and other harmful substances that cause troubles to biological treatment. No outstanding contamination is confirmed in the sea area next to Assaluyeh in comparison to other sea areas, but according to a report by Research Institute Petroleum Industry (RIPI)²⁰, there are samples of wastewater taken after the construction of production facilities in some parts of the sea area showed a tendency of high values of organic substances compared to other parts of the sea, suggesting a necessity to decrease the load of the drainage water given the construction is to increase in the future. It is assumed that the relative increase in the amount of organic substances, etc. in some parts of the sea area next to Assaluyeh is partially due to the influences by the wastewater from the production facilities in the area.

2) Wastewater Treatment System

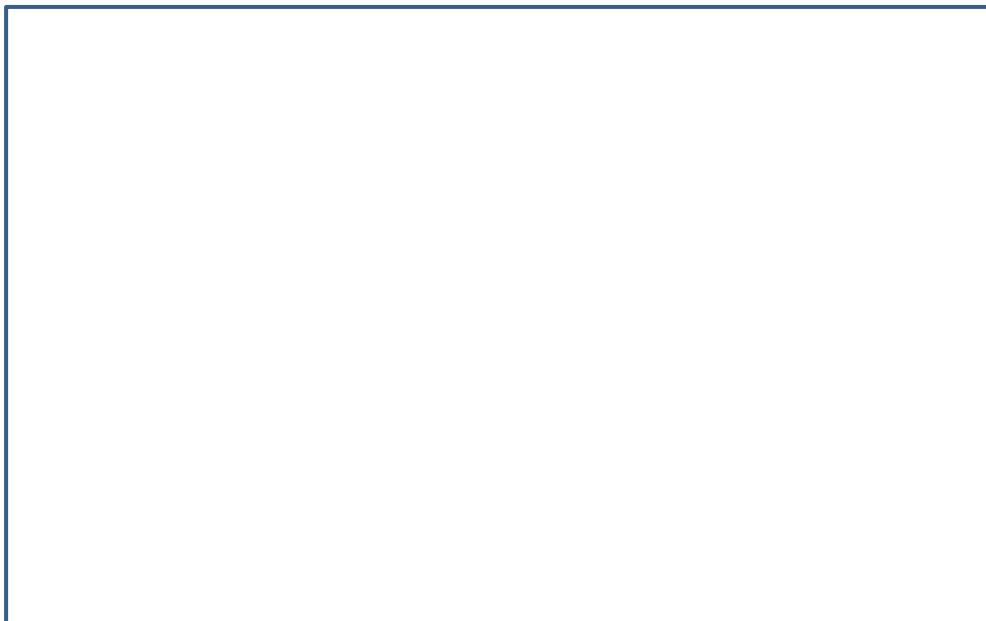
The wastewater discharged from each plant of the gas refinery plants and the petrochemical plants within PSEEZ is released to the sea, after being processed to remove the pollutants included in the wastewater by each plant or treatment facilities installed in the area. Here are the conditions of wastewater treatment in each plant district.

(a) Gas Refinery Plant

In each plant within the gas refinery plant district, wastewater treatment facilities are installed to process the wastewater generated from the process facility to release into the sea. The wastewater from the gas refinery plant includes, in addition to the oily drainage, process effluent including chemical components, cooling water effluents utilized to cool down process equipment, living drainage, rainwater drainage within the plant site, and so forth. Among these kinds of wastewater, oily effluent, process effluent and living drainage contain the pollutants and they are processed in the wastewater treatment facilities. Meanwhile, as for cooling water effluent and rainwater drainage, they are released to the sea without any treatment since they are considered not containing

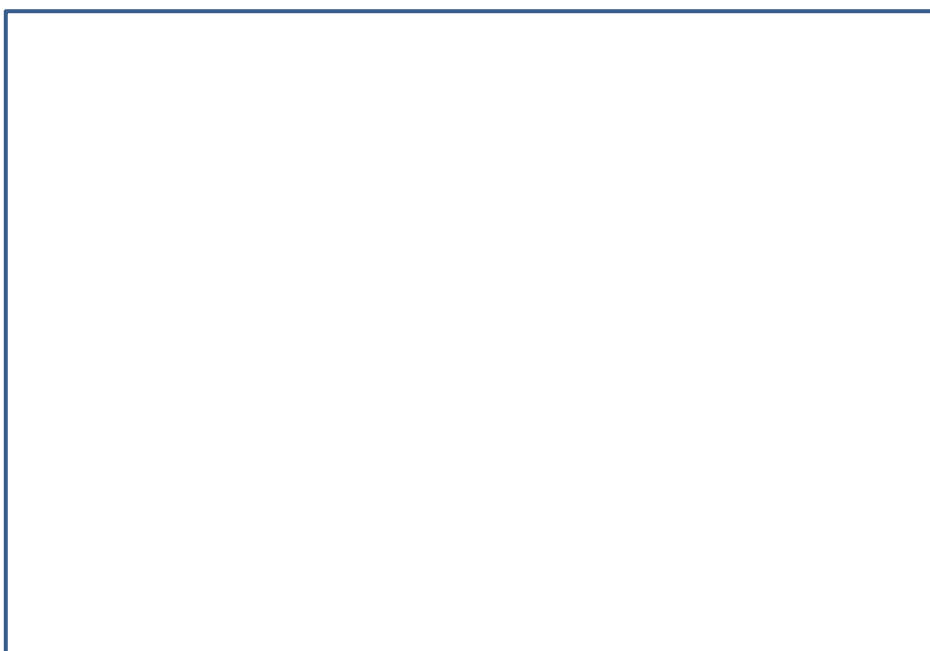
²⁰ The 2nd technical seminar "Experiences and capabilities of RIPI on pollutants monitoring and in Persian Gulf" by Mr. Fakhredin, 29th Oct. 2012

pollutants. A typical wastewater treatment system in the gas refinery plant is illustrated in Figure 4.3.2-15.



Source: Study team

Figure 4.3.2-15 Wastewater Treatment Process in the Gas Refinery Plants



Source: SPGC Environmental Activities Report

Figure 4.3.2-16 Wastewater Treatment Facilities

In the phases 6, 7 and 8, the process effluent including chemical components such as spent soda is neutralized (pH adjustment) in the neutralization unit and sent to the bio-treatment facility for

degradative treatment of the organic substances in the effluent. In other phases, the neutralized process effluent and the oil wastewater are mixed, and the oil contents in the water are eliminated through the oil floatation by API Separator and Gas Floatator. The treated wastewater after the floatation process is collected into the observation basin, and it is sent to the outfall basin and then released to the sea. In case that the water quality does not meet the standards in the observation basis, it is kept in the off-spec basin to be returned to the treatment facility for the re-treatment.

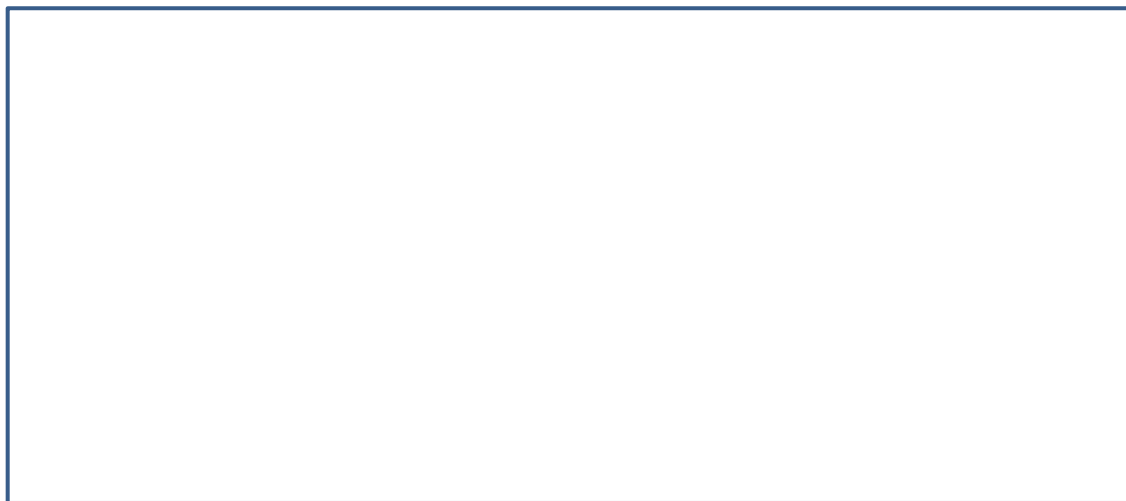
The living drainage water is processed through the activated process method and released to the sea via the outfall basin. As for the cooling water effluent, it is directly sent to the outfall basin, and then released to the sea together with other treated wastewater.

The rainwater drainage within the plant site is released to the sea through general drain ditches.

(b) Petrochemical Plant

Unlike the gas refinery plants district, the petrochemical plants district has not installed individual wastewater treatment facility in each plant, instead installed an integrated wastewater treatment facility in the utility plan operated by Mobin Petrochemical Company (Mobin PC) within the district to accept the wastewater from 15 petrochemical plants in the district and to conduct the treatment.

The process in this wastewater treatment facility is shown in Figure 4.3.2-17.



Source: Study team

Figure 4.3.2-17 Integrated Wastewater Treatment Process in the Petrochemical Plant

The industrial wastewater from each petrochemical plant is transferred to a surge basin (a reservoir tank) and its oil contents are removed by API Separator and Gas Floatator. After this treatment, its organic substances are processed through the activated sludge process in an aeration basin and

suspended solids and dissolved organic substances are removed in a clarifier basin (a settling basin) and activated coal filters respectively. The treated water is utilized either for the irrigation of the gardening inside the plant area or released to the sea via the outfall basin (the drainage tank).

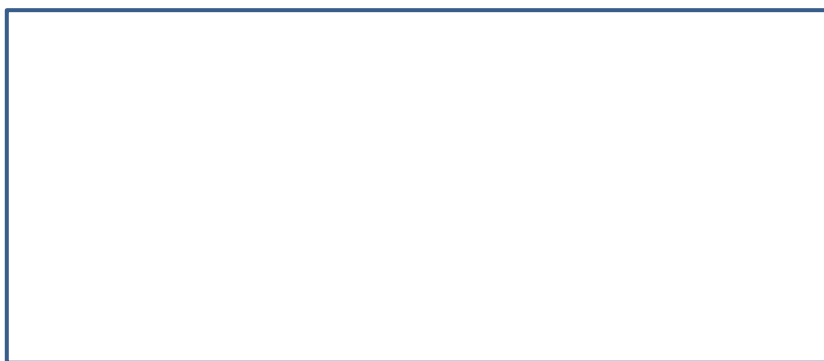
3) Water Quality Monitoring

The wastewater processed in each treatment facility in the gas refinery plants and the petrochemical plants is measured in terms of the properties of treated water and the concentration of pollutants in accordance with water quality monitoring programs of each plant.

The following table shows an example from the records of water quality monitoring in the gas refinery plants and the petrochemical plants. (Source: SPGC Environmental Activities Report)

(a) Gas Refinery Plant

Figure 4.3.2-18 shows the monitoring records of COD in an observation basin which is recorded at Phase 9 and 10 gas refinery plant.

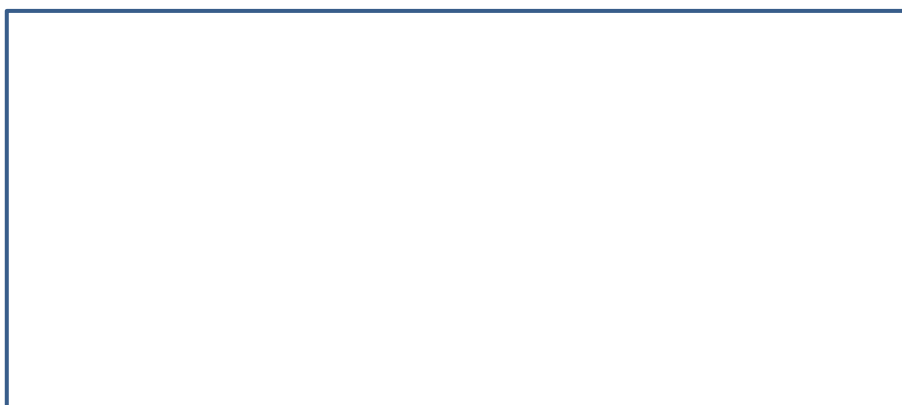


Source: SPGC, Environmental Monitoring Waste water treatment report (Nov.2011-Aug.2012)

Figure 4.3.2-18 COD in Observation Basin (Phases 9, 10)

Most of the value of COD in the observation basin varies between 1,000 and 5,000 mg/L (maximum 10,000 mg/L), exceeding the effluent standard value of 60 mg/L. The observation basin is located in an exit of the wastewater treatment facilities, meaning the measured results here are the direct assessment of the operational and functional conditions of the treatment facilities. In the first place, the measured values of COD are supposed to transit between a certain ranges. Therefore, it is noted that these considerable fluctuations in the measured values are to be attributed to the fluctuation of the loads on the treatment facilities, the malfunction or flaws of the treatment facilities and so forth.

Figure 4.3.2-19 shows the results of monitoring activities on the outfall basin in the gas plants in Phases 9 and 10.



Source: SPGC, Environmental Monitoring Waste water treatment report (Sep.2011-Jul.2012)

Figure 4.3.2-19 COD in Outfall Basin (Phases 9, 10)

Wastewater processed with the amount of COD considerably exceeding the effluent standards as stated above is diluted with cooling water, etc. in the outfall basin and discharged to the sea. In phases other than Phases 9 and 10, wastewater processed is diluted in the outfall basin and discharged to the sea.

Table 4.3.2-7 shows the number of times when the amount of COD measured in the outfall basin in each phase has exceeded the effluent standard from April to August 2012, as well as the number of monitoring activities conducted.

**Table 4.3.2-7 Number of Times When COD Amount Exceeds the Effluent Standard
(Apr-Aug, 2012)**

	Effluent standard	Phases				
		1	2, 3	4, 5	6, 7, 8	9, 10
COD	Max. 60 mg/L	4 (42)	1 (43)	3 (22)	0 (40)	17 (44)

Note: Figures in the brackets are the number of monitoring activities conducted.

Source: SPGC

The number of times when the COD amount has exceeded the effluent standard is conspicuously high in Phases 9 and 10, compared to other phases. This is attributable to the mixture of neutralizers (MDEA) used in the gas refinery plants and waste MEG and other soluble organic substances from the dryers into oily wastewater. The wastewater facilities of Phases 9 and 10 are basically designed to handle oily wastewater and have no ability of treating soluble organic substances. Therefore, if these organic substances of high concentration are contained in wastewater, the wastewater processed is likely to have such substances in excess of the effluent standards even if it is diluted in the outfall basin. This problem is observable also in some wastewater facilities in some phases other than Phases 9 and 10. On the other hand, Phases 6, 7 and 8 has had no situation where the amount of these substances has exceeded the effluent standards

(perhaps because these phases have biological treatment facilities for organic substances in processed wastewater).

Table 4.3.2-8 shows the number of times when the amounts of pH and SS measured in the outfall basin have exceeded the effluent standards.

**Table 4.3.2-8 Number of Times When pH and TSS Amounts Exceed the Effluent Standard
(Apr-Aug, 2012)**

	Effluent standard	Phases				
		1	2, 3	4, 5	6, 7, 8	9, 10
pH	6.5 - 8.5	1 (41)	0 (45)	0 (22)	1 (40)	0 (44)
TSS	Max. 40 mg/L	0 (39)	0 (41)	0 (22)	0 (40)	1 (44)

Note: Figures in the brackets are the number of monitoring activities conducted.

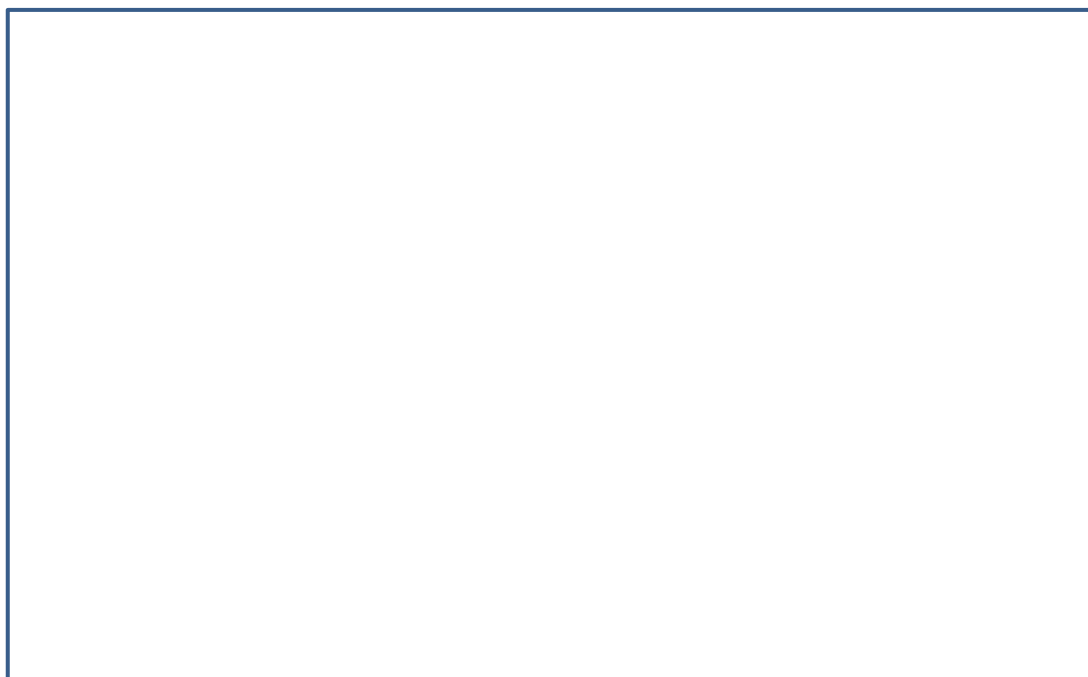
Source: SPGC

As for pH and TSS, no phase has experienced an excess of their amounts above the effluent standards more than once. Oil in wastewater is appropriately processed by the API separators and floatators and also diluted in the outfall basin in each phase, so all the phases are considered to satisfy the oil effluent standard (10mg/L or below). (Few data during the above mentioned period is available.)

(b) Petrochemical Plant

As earlier mentioned, the wastewater treatment is conducted by the integrated wastewater treatment facility operated by Mobin PC in the petrochemical plants district, which enables to manage the water quality monitoring of the wastewater together with operation of the treatment facilities in an integrated manner.

As an example, Figure 4.3.2-20 shows the water quality (COD, pH, oil and TSS) of the water discharged from the integrated wastewater treatment facility in a month between May 22 and June 21, 2012.



Source: Data from Assaluyeh Petrochemical companies

**Figure 4.3.2-20 Quality of Wastewater Treated in the Integrated Wastewater Treatment Facility
(May-June, 2011)**

During the period shown above, the wastewater exceeded the effluent standards of COD and pH only once each, but the wastewater facilities appropriately treat the wastewater. The integrated wastewater treatment facility has been, however, obliged to process an increasing amount of wastewater with a high COD load. Another problem is incorporation in wastewater of ammonia that causes troubles to biological treatment. As measures to deal with wastewater with a high COD load, Mobin PC, jointly with RIPI, puts the MBR in pilot operation, which is a treatment method to deal with high COD loads.

(3) Waste Management

1) Outline of the Waste Management

Development and operational activities in the gas refinery plants and petrochemical plants within PSEZ have generated a variety of solid wastes. These wastes include general wastes and various hazardous wastes. Construction of plants and maintenance works of equipment generate waste materials such as metal scraps and spent machinery parts, while offices and accommodation facilities dispose general wastes and living wastes, etc. There are hazardous wastes, such as lubricating oil, paint, empty container of chemicals, oily sludge. Other huge amounts of wastes include spent catalysts regularly generated from the processing equipment of the plants. The catalysts utilized in the processing plants vary in materials according to their processing purposes

and the contaminants included in the spent catalysts. Accordingly, special considerations are needed for their management and treatment.

The waste management implemented in the gas refinery plants and the petrochemical plants within PSEEZ is explained as follows.

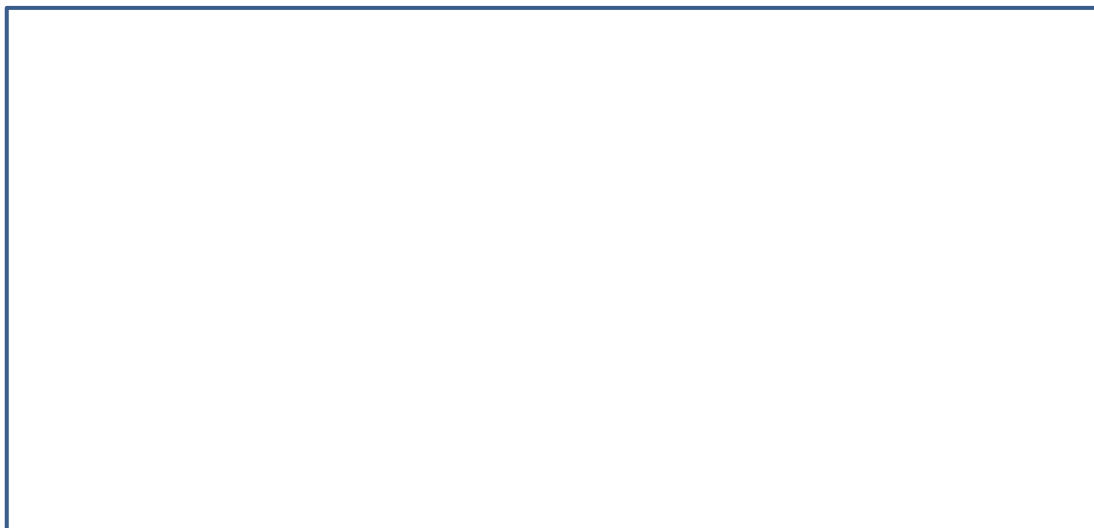
2) Waste Management System

(a) Gas Refinery Plants

SPGC in charge of gas refinery plants has formulated the waste management plan focusing on the following activities, and implemented them in each plant.

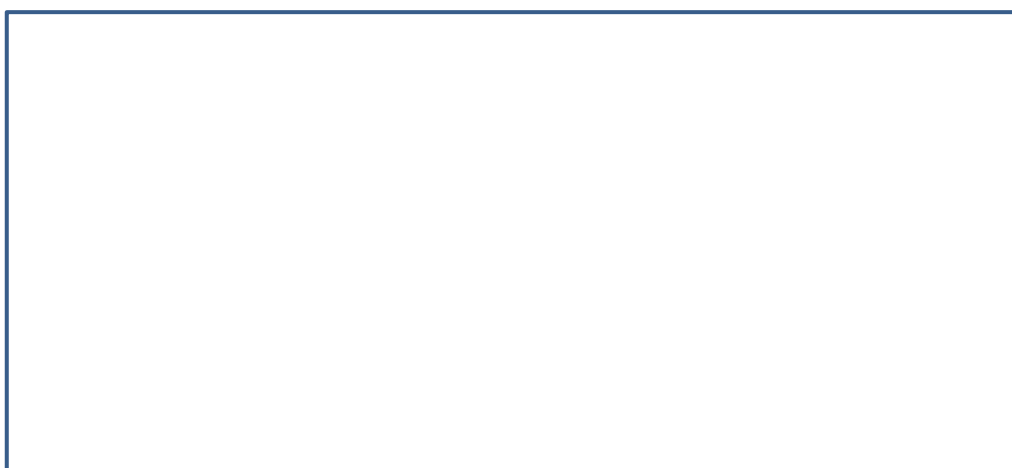
- Clarifying the responsible departments and sections for industrial wastes and living wastes
- Controlling the waste generation (the reduction of the wastes)
- Promoting appropriate classification/segregation of wastes by the wastes codes
- Inventory of the annual wastes amount
- Designating the temporary storage sites for industrial wastes
- Selling recyclable wastes to private companies (promotion of the recycling)
- Enlightenment and instruction of proper management for industrial and living wastes

In order to realize the above goals, the activities for segregation of the wastes are implemented in each plant. The segregation of wastes begins with separating into non-hazardous wastes and hazardous wastes, and non-hazardous wastes further separated into biodegradable wastes, general wastes and metal scraps (see Figure 4.3.2-21). Hazardous wastes are separated into the medical wastes and chemical wastes, while the chemical wastes are further separated into combustible wastes and corrosive/reactive wastes. For the purpose of facilitation these segregation, wastes containers with different colors for each waste type are installed in designated locations in each plant (see Figure 4.3.2-22).



Source: SPGC Environmental Activities Report

Figure 4.3.2-21 Waste Segregation Containers

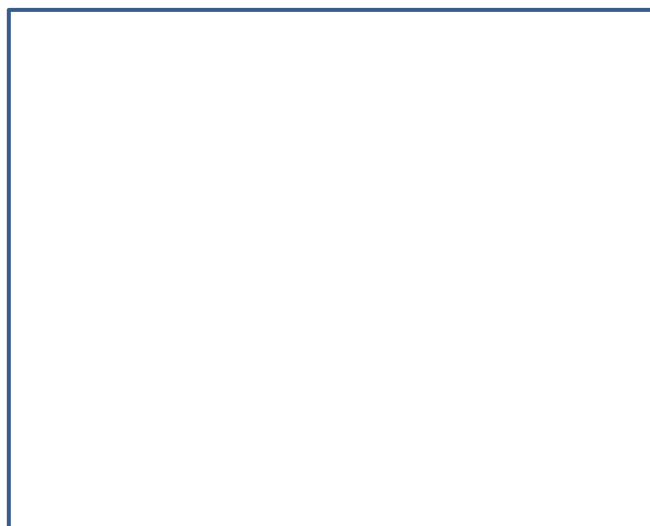


Source: SPGC Environmental Activities Report

Figure 4.3.2-22 Locations of Waste Containers (an example)

(b) Petrochemical Plants

Each petrochemical plant within PSEEZ has conducted the management activities based on the waste management system of NPC. Basic procedures for the soli wastes management are shown in Figure 4.3.2-23.

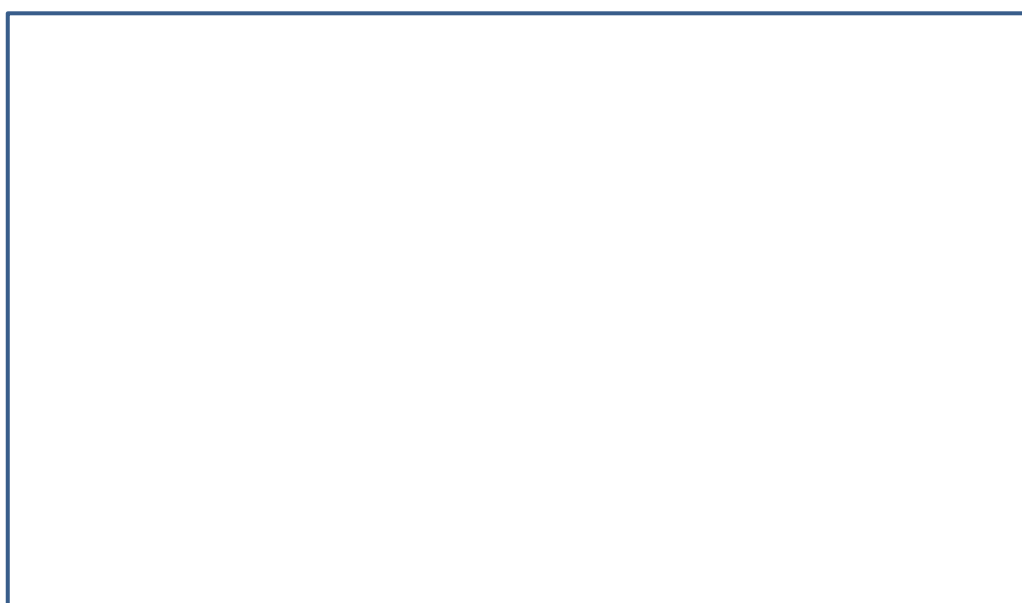


Source: NPC Waste management system

Figure 4.3.2-23 Waste Management Process in the Petrochemical plant

This process includes, as a necessary process for the waste management covering from the waste generation up to the final disposal, a series of procedures from the segregation by coding, labelling, mentioning the manifest (management slips), collection, transportation, processing, recycling, and the landfill for the ultimate disposal as well as environmental monitoring at the disposal sites.

The wastes discharged from each plant are coded and, according their codes, the process from the wastes generation up to the final disposal is managed and controlled by the form shown in Figure 4.3.2-24.



Source: NPC Waste management system

Figure 4.3.2-24 Waste Management Form

The progress of the monthly wastes management and its achievements are recorded on this form, which keeps the relevant records such as kinds and numbers (weights) of discharged wastes, treatment/disposal methods of each waste (recycling, sale, incineration, landfilling, temporary storage), their numbers, remained amounts of the wastes under the process. This form is filled in based on the data of the manifest system which records a series of processes for each waste.

The annual amount of the wastes discharged from 10 petrochemical plants in the district and the processed/disposed amount are shown in Table 4.3.2-9.

Table 4.3.2-9 Annual Amount of the Processed Wastes in the Petrochemical Plants (ton)

Generated Amount	Recycled	Sold	Incinerated	Land filled	Temporarily stored
8,226	115	5,071	6,010	2,475	1,846
Percentage	0.1 %	33 %	39 %	16 %	12 %

Source: Assaluyeh Petrochemical Companies

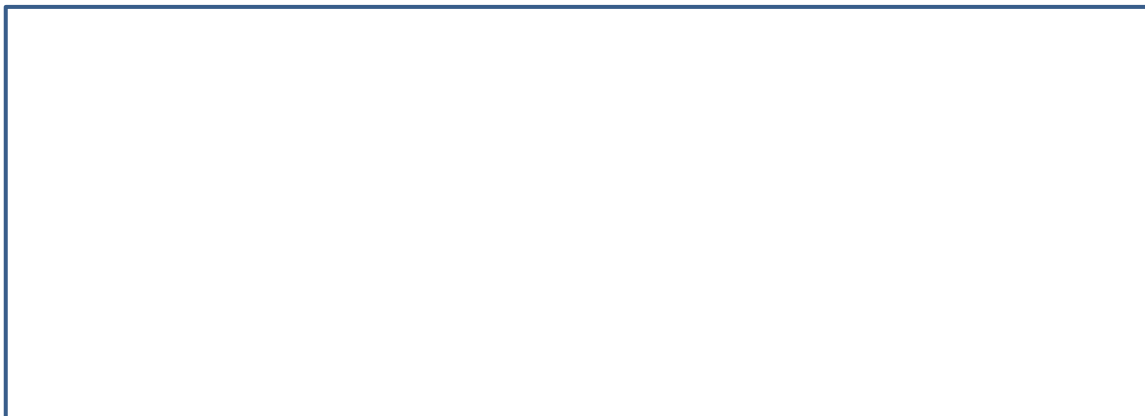
(c) Spent Catalysts

Spent catalysts are the most considerable amount of hazardous wastes discharged from each plant within PSEEZ. The catalysts are utilized for process facilities such as reactors and thermal crackers, etc. of the gas treatment and petrochemical plants. They vary in types according to processing purposes and process fluid to be treated. It is required that these catalysts are to be replaced regularly due to the deterioration in its function along with the plant operation. In that case, the used catalysts are discharged from the process equipment as spent catalysts.

There are various types of spent catalysts. Many of them contain hazardous substances such as oil contents, sulfur, heavy metals depending on the kinds of process fluid and their purposes, and therefore, they are categorized as hazardous wastes. Some catalysts contain precious metals and rare metals (i.e. zinc, nickel, cobalt, platinum, copper, tungsten, etc.) as additive (active elements) according to their purposes, many of which are considered to be expensive.

Therefore, spent catalysts as valuable wastes, in general, are widely regenerated by catalysts manufacturers for recycling, or the precious metals and rare metals in the catalysts are recovered in specialized factories.

As a management method of these spent catalysts, PSEEZ has designated a joint temporary storage facility (compartment) for the special wastes including the spent catalysts inside the territory in order to separate these wastes from other wastes (Figure 4.3.2-25). The storage period here is fixed for up to 6 months, and each plant company responsible for the wastes is obliged to take relevant disposal procedures such as regenerating the spent catalysts by catalyst manufacturers and selling the wastes to private specialized companies.



Source: Study team

Figure 4.3.2-25 PSEEZ Wastes Temporary Storage Facility (compartment)

(4) Biota and Conservation Area

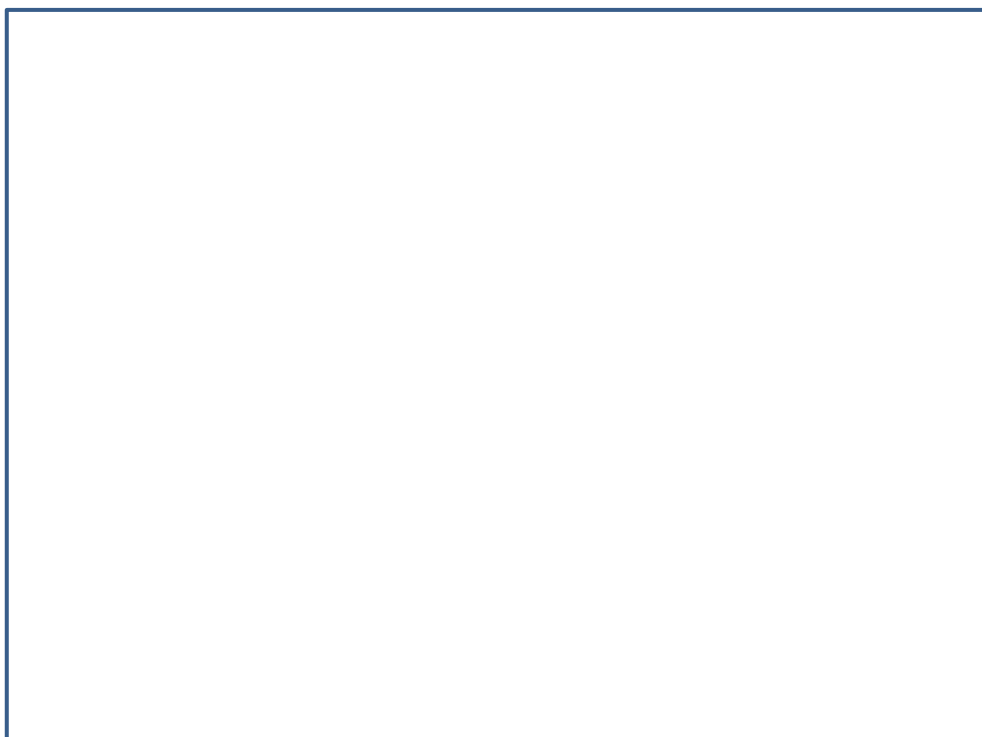
1) Present Situation

In this area, mangrove tree is growing around industrial zone and the protected area (see Figure 4.3.2-26). During the field survey, JICA study team found that the color of some parts of mangrove trees, especially in the far end north of the protected area closer to the PSEEZ, was brown while the color of the mangrove trees in other area was green. Since the recognition was from a long distance, it might be a misunderstanding due to light reflection. Depletion of mangrove in the adjacent area, however, was reported in a presentation on the meeting between JICA study team and HSE managers, although the cause of the phenomena was not clarified. Some adverse impact may be happening to the mangrove area.

Even in the green-colored mangrove trees, an environmentalist of the JICA study team recognized some leaves showed unhealthy condition (refer to an example shown in Figure 4.3.2-27) which sometimes leads to dying of the tree.



Figure 4.3.2-26 Distribution Area of Mangrove Tree in Assaluyeh Area



Source: JICA Oman project

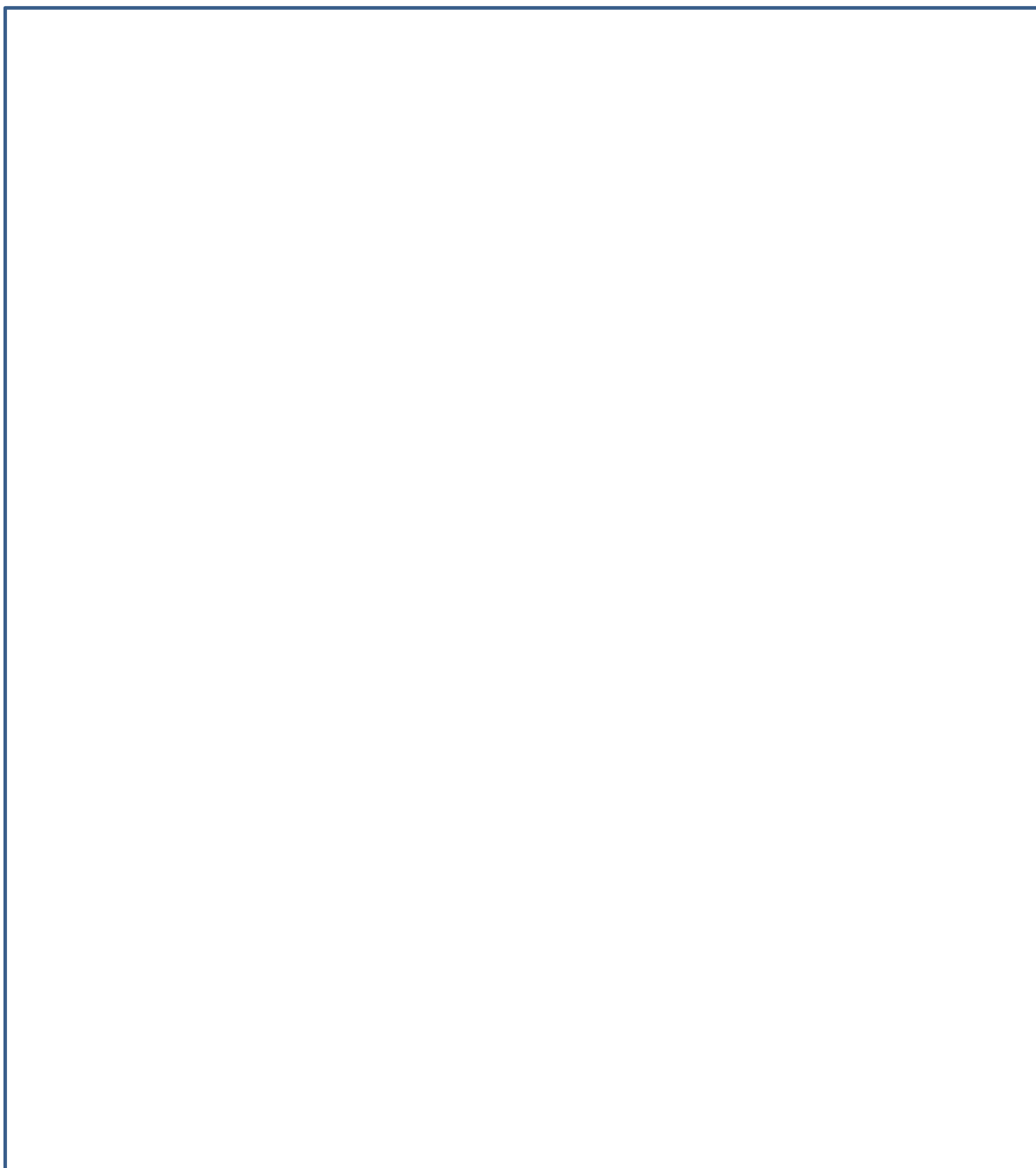
Figure 4.3.2-27 Example of Healthy Mangrove Tree (left) and Unhealthy Mangrove Tree (right)

2) Protected Area

Mangrove protected area starts from just south edge of PSEEZ. The mangrove area spreads toward south in patch and leads to the Naiband National Park.

Northern part of the mangrove protected area is surrounded by fence.

Naiband National Park is designated as the first marine national park in 2004, combining Naiband protected area, Hara Naiband area and a part of Persian Gulf (see Figure 4.3.2-28). The national park has 49815ha and consists of coral reefs, sandy beaches, mangrove forests and land area. Sandy beaches provide the nesting area for turtles. Major plants in the park are Avicennia, Cashaw, Bo tree, Nubk tree, Acacia, palm tree, Swallow wort, banyan, rosinweed, astragal, Deervetch, saltwort and medic. The main animal species are Jebeer gazelle, caracal, Brandt's hedgehog, Indian crested porcupine, Cape hare, Indian gerbil, wild boar, wolf, Houbara bustard, Greater cormorant, Dalmation pelican, Gary heron, Gray partridge, Bonelle's eagle, various buzzards, kestrel, hoopoe, saker, falcon, little bittern, marsh frog, Western green toad, False cobra, saw-scaled viper and fish species such as Javelin grunter, Jhon's snapper, Bigeye croaker and rosy goat fish (The Atlas, 2006).



Source: Atlas of protected area

Figure 4.3.2-28 PSEEZ and Naiband National Park

A booklet²¹ for birds of the Naiband National Park lists 122 land birds and 84 marine birds. Out of them, 2 species are designated as endangered, 3 species as vulnerable and 4 species as near threatened by IUCN Red List of Threatened Species. And 33 species are protected by Iran.

Naiband Bay is a primary protected marine area and the most important coastal ecosystem of the south. It supports a rich habitat for coral reefs, rocky coasts, real creeks and creek estuaries of

²¹ Mosfafa Moazeni , Birds of Naiband National Park, March, March 2011, PSEEZ

Harra tree forests. According to surveys, Naiband Bay is recognized as one of the most diverse coastal regions supporting larvae (27 fish families). Dolphins and whales wander nearer shore close to Naiband Bay (NIOC-IOOC 2005)²².

3) Impact to Biota from the Petrochemical Zone

On the discussions and interviews, impact to biota from PSEEZ was not confirmed.

However, the atlas concludes that extensive human interventions, harsh climatic conditions, military practices and industrial developments in and around the park have dramatically affected the wildlife of the park.

Therefore it is considered that continuous monitoring for biota is important.

One of concerns is influence of thermal/cooling water discharge to Naiband National Park. It is said that turtles are coming to Naiband National Park for spawning. Turtles use to eat sea grass, which grows at shallow sandy-bed area. Figure 4.3.2-29 shows a distribution map of sea grass.

Shallow sandy-bed area spreads at the north part of Naiband National Park according to a sea chart. Moreover the existence of coral reef at north part of Naiband National Park in the interview. Those habitats are vulnerable to high temperature. Although the distance between PSEEZ and north part of Naiband National Park is about 10km, possibility of reaching of discharged thermal/cooling water to vulnerable area cannot be denied due to formulation of thermocline, which occasionally limits vertical mixing between different water mass such as sea water and discharged water. Figure 4.3.2-30 shows an image of thermocline and dispersion of discharged water. For the protected area, the ocean currents and seawater temperature in the bay must be surveyed to clarify any impact of warm wastewater and the presence of any contaminants.



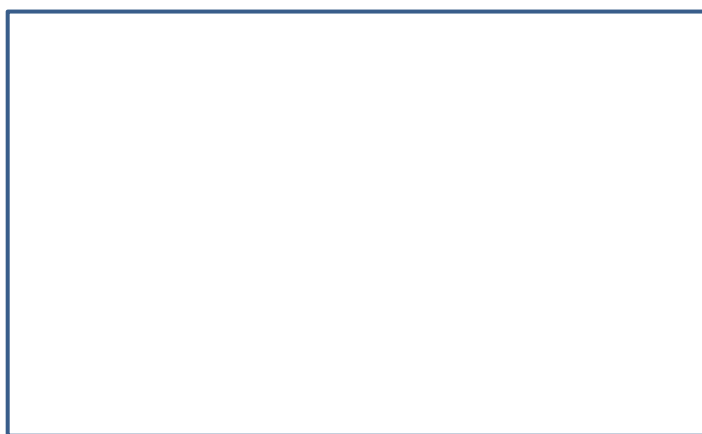
Source: Google Earth

Figure 4.3.2-29 Sea Grass in Naiband Bay

²² Waste Management Contract Persian Gulf Biological Report Khark Island Operational Area Pre FEED Document, Oct. 2005, NIOC-IOOC

A thermocline (sometimes metalimnion) is a thin but distinct layer in a large body of fluid (e.g. water, such as an ocean or lake) in which temperature changes more rapidly with depth than it does in the layers above or below. In the ocean, the thermocline may be thought of as an invisible blanket which separates the upper mixed layer from the calm deep water below.

(Source: <http://en.wikipedia.org/wiki/Thermocline>)



Example of Thermocline

Source:
[http://msue.anr.msu.edu/news/
the_thermocline_a_summer_p
henomenon_in_michigan_inla
nd_lakes](http://msue.anr.msu.edu/news/the_thermocline_a_summer_phenomenon_in_michigan_inland_lakes)

Example of dispersion of
discharged cooling water
from a power plant.

Source:
[http://www.sur.co.jp/corp_i
nfo/environmental/water/wa
ter_2.html](http://www.sur.co.jp/corp_info/environmental/water/water_2.html)

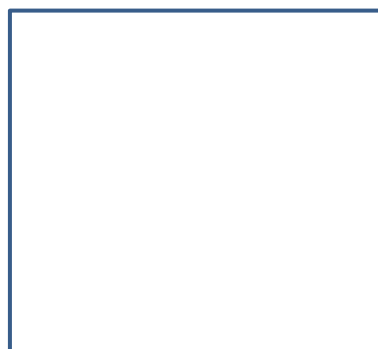


Figure 4.3.2-30 Image of Thermocline and Dispersion of Discharged Water.

4) Future Plan

No information about future plan on preservation of biota in the area was obtained: it is desirable to conduct regular surveys on the ocean current and seawater temperature within Naiband Bay, as well as the distribution of contaminants.

(5) Other Environmental Conditions

No critical environmental issue other than the above stated conditions has been observed in Assaluyeh.

4.3.3. Environmental Management

(1) HSE Management System

Areas for gas refining and petrochemical has been started its operations in PSEEZ, Assaluyeh. PSEEZ Organization manages the activities in the special zone. South Pars Gas Complex Company (SPGC), under the supervision of NIGC), operates the complexes in the gas refining area. Owner of the complexes is Pars Oil and Gas Company (POGC) under supervision of NIOC. Pazargad Non Industrial Operation Services Company, under the supervision of NPC), manages operations of complexes in the petrochemical area. HSE management in the petrochemical complexes is executed by each petrochemical company. Each operating company follows the management systems of the company group which the company belongs to. There is no integrated management system which all the operating companies join in PSEEZ (see Figure 4.3.3-1).

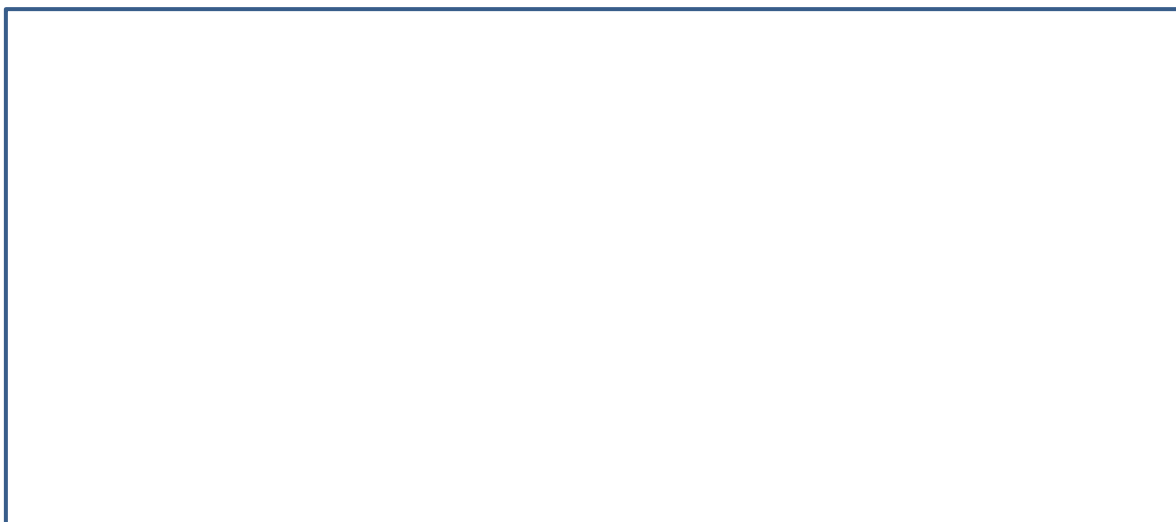


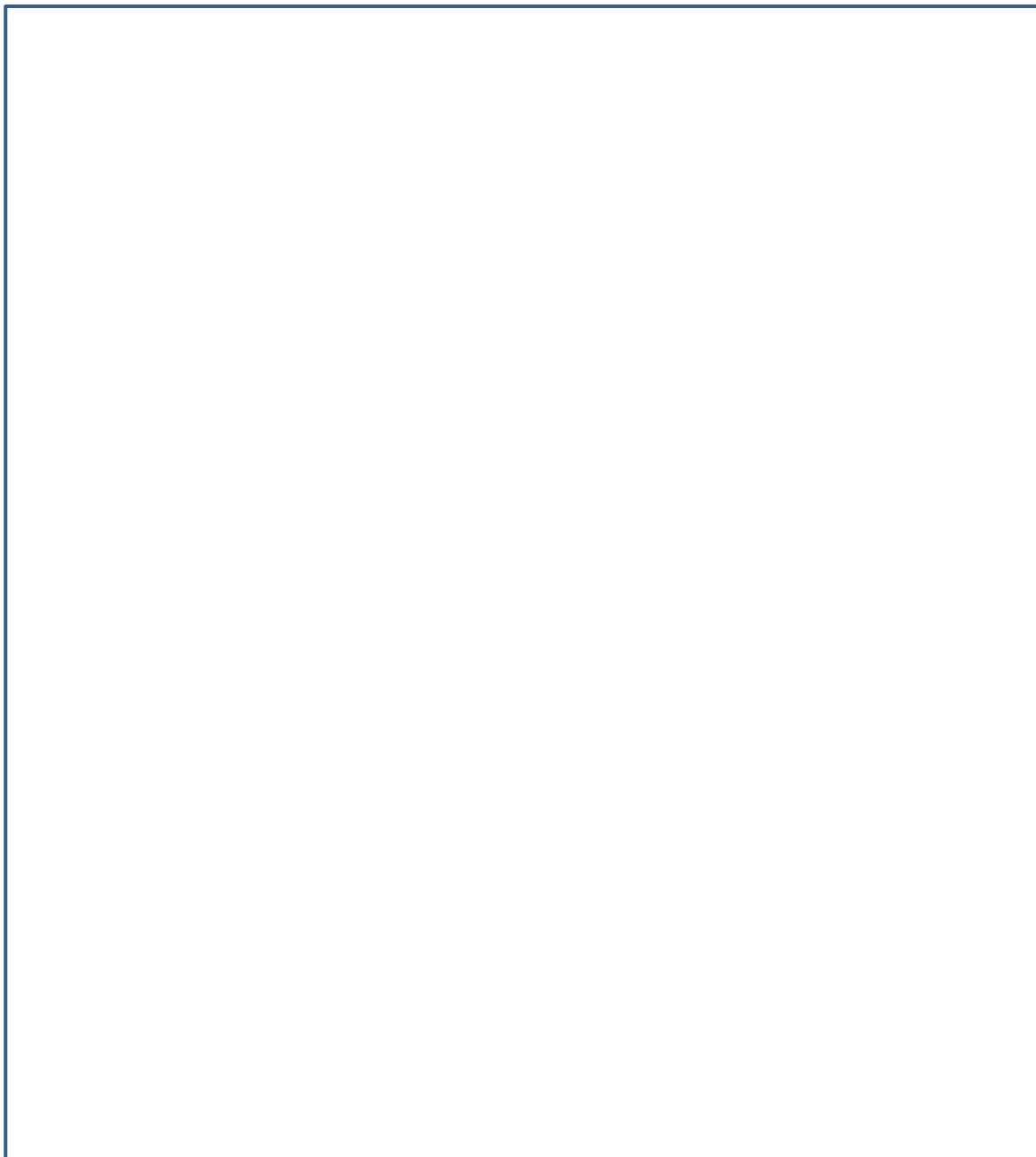
Figure 4.3.3-1 Main Companies Operating in PSEEZ and its Company Group

1) PSEEZ

(a) Organization

PSEEZ Organization is a service company for management of PSEEZ in Assaluyeh. The area of responsibility is Pars 1, Assaluyeh, in which operations have been started and Pars 2, Kangan located in the western side of Assaluyeh, in which development has been commenced. Figure 4.3.3-2 shows the organization structure of the HSE Department of PSEEZ Organization. According to the planned chart, one head and one expert are deployed to each section. However, the organization deploys five (5) environmental experts including the Head of Environmental Protection for Environmental Protection Section and three (3) including the Head of Laboratory for

Laboratory Section. The operation companies take responsibility for the environmental management for the complexes of gas refinery and petrochemical plant within their own compounds respectively. Therefore, the environmental protection section of HSE-PSEEZ has monitored the environmental condition of boundaries between each complex as the environmental management.



Note: Figures in bracket shows the number of experts deployed.
Source: PSEEZ Organization

Figure 4.3.3-2 Organization of HSE Department of PSEEZ Organization

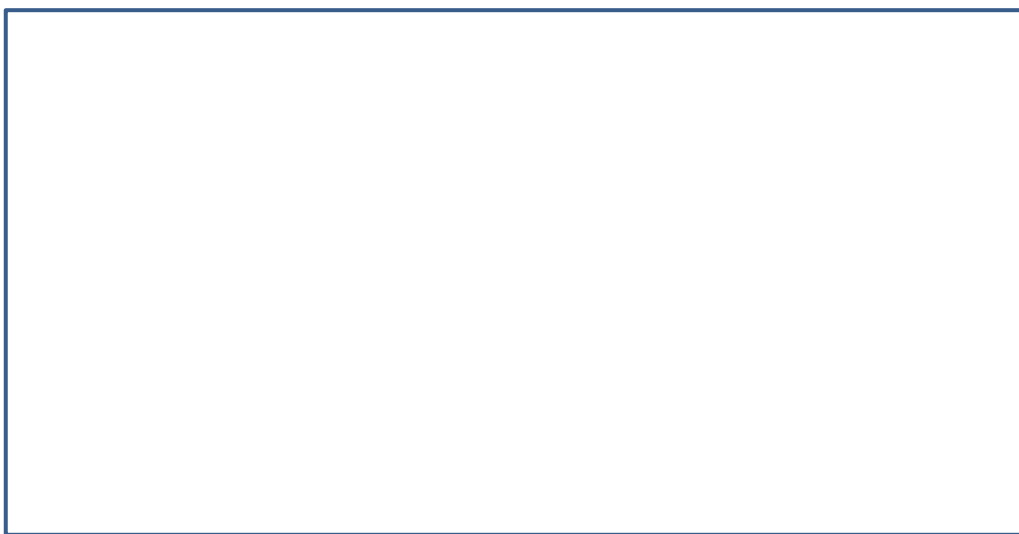
(b) Management System

Information related to environmental management and emergency response followed by PSEEZ Organization has been collecting.

2) Pazargad Non Industrial Operation Services Company (PNOSC)

(a) Organization

Pazargad Non Industrial Operation Services Company falls under NPC and controls general HSE management in the petrochemical area of PSEEZ. Figure 4.3.3-3 shows the organization structure of the HSE Department of the company. Main responsibility of the person in charge of environmental protection in the HSE Department is to monitor activities of the petrochemical companies, pollutants, industrial waste management, and industrial wastewater and sanitary wastewater treatment and to establish comprehensive management system & environmental monitoring in the region. Only one environmental expert is deployed in the company and the expert should take care of all the activities related to environmental protection in the petrochemical area of PSEEZ.



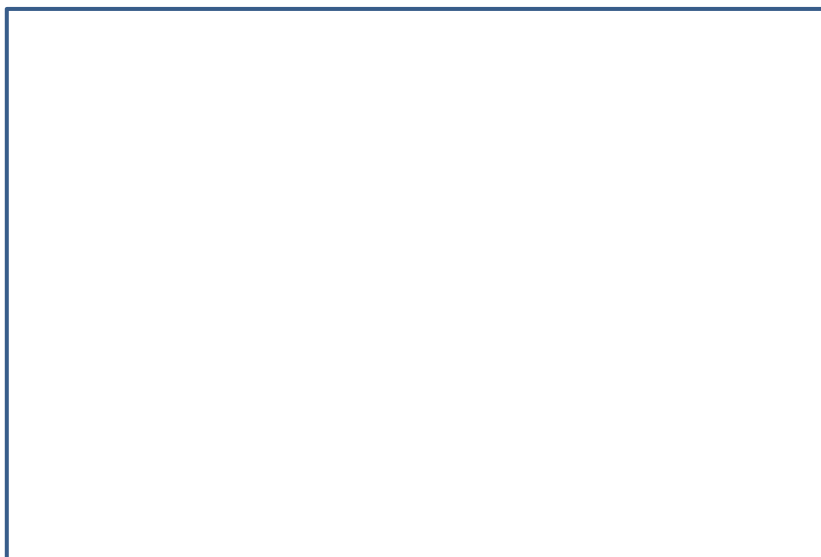
Source: NPC

Figure 4.3.3-3 Organization of the HSE Department of Pazargad Company

(b) Management System

As PSEZ Company does, the petrochemical companies including Pazargad Non Industrial Operation Services Company, which operate in the petrochemical area of PSEEZ, should follow the NPC's management systems. The information related to the management policy of Pazargad Non Industrial Operation Services Company has been collecting. The crisis management in the

petrochemical area of PSEEZ is based on the NPC's systems for crisis management. The organization structure in Assaluyeh is shown in Figure 4.3.3-4.



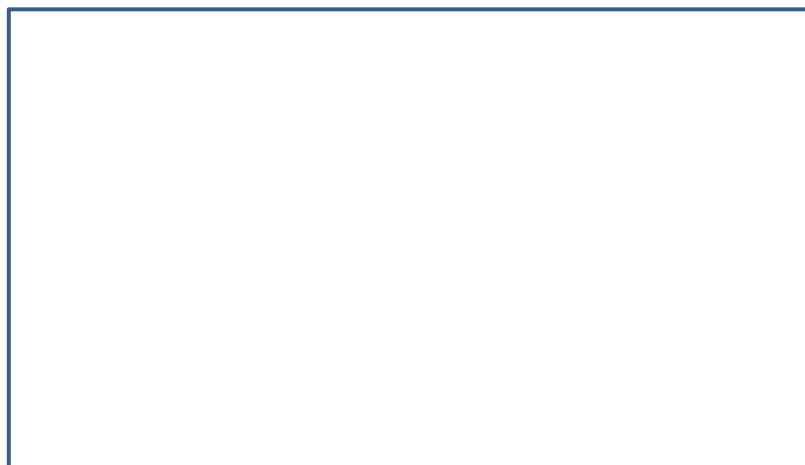
Source: NPC

Figure 4.3.3-4 Organization of Crisis Management Committee in Assaluyeh

3) SPGC

(a) Organization

SPGC is responsible for operations of refining complexes in the gas refining area of PSEEZ. Figure 4.3.3-5 shows the organization structure of the HSE Department of the company.



Source: SPGC

Figure 4.3.3-5 Organization of the HSE Department of SPGC

Major responsibilities of the Environmental Section are as follows:

- Supervising execution of prevailing regulations and methods in the field of environment in the Company
- Collecting and adapting environmental standards with operations of the Company
- Studying, improving, and developing the environmental status through formulation of regulations and instructions
- Adapting environmental methods and instructions for controlling the air, soil and water pollutants
- Conducting research, reviewing and formulating instructions for neutralizing and disposal of the Refinery's chemical wastes
- Analyzing the environmental incidents and providing countermeasures to prevent reoccurrence of them
- Reviewing and prioritizing the environmental studies and researches to improve the environmental condition of the Refinery
- Supervising the changes in the process in order to decrease or eliminate pollution sources through requiring changes and modifications in the machinery and distinguished environmental activities

(b) Management System

SPGC has established its environmental management and crisis response systems which are led by the Environmental Section. The section engages in environmental management through monitoring, waste management and other activities, under which a number of committees for improvement of wastewater treatment, waste management and so on are being established and starting their activities.

SPGC has prepared manuals for "Accidental Chemical spillage", "Site Emergency Response Plan" and other manuals as its implementation system for crisis response. It is necessary to prepare and appropriately manage these manuals and share information with parties concerned.

(2) Environmental Technology

1) Atmospheric Environment

(a) Current Situation

Assaluyeh area has a critical problem of air pollution caused by the massive emissions of the gases from the large scale operation of petrochemical complexes in the region, which contain hazardous components such as SO_x, NO_x, PM, VOC, etc.

Under such situation, a very high SO_x content in the atmosphere in the residential area adjacent to the PSEEZ as well as the working places is assumed as one of the most serious problem that must

be addressed accordingly.

(b) Emission Sources

There are various and many emission sources in the petrochemical complex. The typical emission sources in the complex are listed below.

- Flaring (burning out of process tail/ off-gas, excess gas, vent gases, etc.)
- Flue gas of combustion equipment (turbine, boiler, furnace, engine, incinerator, etc.)
- Venting of VOCs (tank vent, routine release of process gases, etc.)
- Fugitive gases
- Emergency gas release
- Accidental release (process gases/ liquids)

(c) Pollutants in the Gases emitted

The typical pollutants included in the gases emitted from petrochemical plant are listed below.

- SOX, NOX, Particle mater (PM), Ozone
- H₂S
- Volatile organic compounds (VOCs) and semi-volatile organic compound (SVOC)
- Ozone Depleting Substances (ODS)
- Others

(d) Concept for Emission Control

In general, four (4) emission control concepts are suggested as follows:

- Reduction of the total volume of the gases to be emitted into the air
- Minimum generation of pollutant in the flue gases to be emitted
- Elimination of pollutants in the gases prior to release to the air
- Effective dispersion of the gases in the air

(e) Emission Control Methods

Typical applicable emission control methods to the above concepts are considered, but not limited to, as follows.

- Reduction of the total volume of the gases
 - Maximum recovery of usable gas from flare gas
 - Reduction of off-gas/ tail gas for production process (high efficient treatment process e.g. sulfur recovery unit)
 - High efficient combustion equipment (for reduction of fuel consumption)
 - Reduction of vent gases from process/ equipment (i.e. seals of floating roof tanks)
 - Maximum recovery of vent gases

- Reduction of fugitive gases by proper design and maintenance of equipment
- Minimum emergency/ accidental release of process gases by proper process operation
- Minimum generation of pollutant in the flue gases
 - Employment of high efficient flare burner
 - Elimination of liquid hydrocarbon (oil mists) from the gas to be flared
 - Introduction of low-NO_x burners
 - Use of high quality fuel (low sulfur)
- Elimination of pollutants in the gases
 - Treatment of flue gases (elimination of SO_x, NO_x, PM)
- Effective dispersion
 - Proper design (height) of flare stack
 - Proper location considering dominant wind flows

(f) Probable Causes of the Air Pollution

In accordance with the findings through site survey and information provided by the operational companies, it is assumed that the major SO_x emission sources in the gas refinery complex is likely to be the flue gases discharged from incinerators for treatment of the tail gas with extremely high H₂S generated from sulfur recovery units (SRU) in each gas refinery plant. Similar to the volume of tail gas, flue gas volume is also dependent on the efficiency of SRU. The specific efficiency of each SRU in the complex is 98.5% originally. However, the complex at present is confronted by significant efficiency decline of the SRU due to process deterioration. Immediate remediation of such situation will not only improve and ensure stable operation of the complex, it will also cause reduction of harmful flue gas emission in the air.

A study for the installation of tail gas treatment units for the reduction of H₂S in the tail gas discharged from SRU is now in progress by the company.

On the other hand, the petrochemical complex produces olefin from the condensate extracted in the gas refinery plants. The olefin plants also produce di-sulfide oil (DSO) containing approximately 3,000 ppm of mercaptan as bi-product (3~5 tons/day). The DSO having no market for its usage is treated continuously in the burn-pit in the complex. Accordingly, the flue gas from DSO burning which produces high SO_x content is considered to be one of the largest SO_x emission source in the complex.



Source: Google Earth

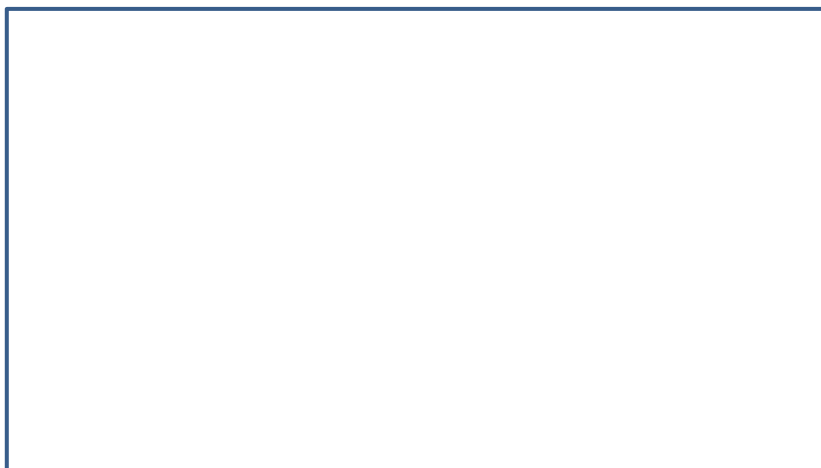
Figure 4.3.3-6 Flare Stacks in PSEEZ

Flare stacks in the gas refinery complex burn out continuously in the atmosphere surplus gas and various off-gas from the process plants and they are located in the northern area of the complex along the hills.

Especially, the flare stacks of gas refineries release much larger flames with smokes in the atmosphere comparing with the same petrochemical plants. The records of flare gases treated by the flare stacks of both complexes show that the volume emitted from the gas refineries are excessively large, which could be attributed from the excessive sweeping gas supplied to flare stacks for maintaining stable combustion of flare burner.

It is considered that the surplus gas in flare gas is generated due to un-balanced material masses between the feed gas from upstream offshore gas field and the demands for treatment in the refineries for deliveries to downstream including petrochemical plants and gas pipe lines. Currently, flaring of surplus gas is well controlled in the gas refineries and no surplus gas is released in the flare gas system. However, should flaring of the surplus gas be necessary, since the surplus gas to be treated by flare stack contains high concentration of H_2S similar to the raw natural gas, surplus gas burning could become the largest source of SO_x emission into the atmosphere of the region.

In addition, the figures of SO_x emission inventory presented by the HSE representative of PSEEZ in the 1st Technical Seminar held in Tehran, showed that the SO_x emission from the facility using heavy fuel oil in phase 2 & 3 plants is enormous (852,900 gr/h) as compared with the other sources (818-1,089 gr/h) in the complex (See Figure 4.3.3-7). Such emission source seems to be the flue gas from steam generators (boilers) burning heavy fuel oil with high concentration of H_2S in the utility plant. However, the SO_x emission has been reduced since the utility plant has now replaced heavy oil containing high sulfur with natural gas for its fuel.



Source: 1st technical seminar

Figure 4.3.3-7 Inventories of the Pollutant Emissions

Furthermore, the air quality monitoring records taken by SPGC indicate higher concentration of Benzene than the standard in the area at several monitoring points and the figure is extremely high at the condensate storage tank farm. BTX (benzene, toluene, and xylene) are recognized as harmful materials which directly affect human health (causing cancer), especially the workers exposed to such environment in the area. The probable cause of such phenomenon is the fugitive gases and condensate containing BTX components from the facility/ equipment in the plants. The leakage of BTX is perhaps attributable to incomplete sealing of the floating roof of the condensate storage tank or inadequate design standards of the tank. The design standards and points leaking the gases must be investigated again and the following measures considered and taken.

- (i) Improvement in plant operation (for inhibition of volatilization of BTX components)
 - Decrease of vapour pressure of BTX by alteration of condensate extraction process
- (ii) Improvement in roof seals
 - Preventing leaks of condensate vapor from roof seal device by replacement with double seal system

The air qualities of the Assaluyeh area is characterized in such a way that the points with the highest concentration of SO₂ and Benzene are distributed mainly in the north-west side of the area and low concentration in the coastal and south-east areas. This phenomenon is considered to be due to the natural feature of the land at the site (high mountains behind the site, only 5 km from the coast) as well as the less dominant wind in the region. The states of emissions and dispersion of air pollutants should be clarified promptly in reference to the regulatory system of air pollution in Section 7.3.3 “Introduction of the Total Volume Control System”.

(g) Consideration on Cumulative Impact

The PSEEZ development is ongoing in accordance with the long term development plan (consisting of 24 phases) and the plants so far constructed in 10 phases are now operational. The remaining phases of construction are planned in the coming decades subsequently.

The various gas emission sources in the respective plants are distributed in the large area of the complexes. It is considered that the current air pollution problem in the area is the result of the accumulated impacts of the pollutants emitted from such many sources in the area. Upon completion of more projects in the future, further degradation of environmental quality in the area is expected due to additional environmental loads in the same area.

Therefore, the effective strategy and measures for remediation of the degraded environment resulting from the current plant operations shall be discussed dedicatedly together with effective mitigation measures that will reduce the additional environmental impacts arising from the future development to ensure the conservation of the healthy environment in the area.

(h) Air Emission Controls

● Gas Refinery Complex

Under the above situation, the South Pars Gas Company (SPGC), operator of the gas refinery plants, has initiated several environmental activities for protection and/or mitigation of the impacts of the air quality in the region. The environmental activities undertaken and undertaking currently are as follows.

- Air pollution monitoring
 - Emission of flue gases from flare system and other combustion sources in the complex
 - Acid gases incinerated
 - Air quality monitoring (BTX, SO₂, NO₂, NH₃, H₂S, PM) at 20 sampling stations in the complex area (since 2009)
- Air dispersion modeling study
- Reduction of flare gas
 - Modification of Mercaptan Recovery Unit
 - Installation of Tail-Gas Treatment Units (TGTU) for Sulfur Recovery Unit (SRU)
 - Improvement of efficiency of SRU
 - Reduction of generated gas to be supplied to acid gas treatment equipment (reduction in gas emissions to the flare system)
 - Total maintenance for improvement of operational performances for SRU, Condensate Stabilization Unit, off-gas compressors
 - Periodical calibration of flow meters in flare gas network
 - Transfer and reinjection of surplus gas to Aghajari oil field (Phases 6, 7 and 8)

- Reduction of SO_x in flue gases of combustion equipment
 - Fuel conversion of steam generators from heavy fuel to natural gas
- Reduction of NO_x in flue gases of combustion equipment
 - Introduction of Low-NO_x type burners for steam generators, furnaces, etc.
- Study on guidelines for design of effective flare system and network for emission reduction

In spite of these efforts of the operating company, the obvious effects of the measures undertaken have not been evident in the environmental monitoring records so far.

● Petrochemical Complex

The Pazargad Non Industrial Operation Services Company (PNOSC), the organization in charge of management of the petrochemical companies in the zone, are tackling several activities to control the emission of gases from the petrochemical plants in order to improve the degraded conditions of the area as the most serious issue. The efforts dealing with the issue are as follows.

- Audit for environmental management and activities of each petrochemical companies (16 companies) in the area
- Enhancement of the environmental laboratory of the organization (procurement of advanced measurements and analysis instruments)
- Air quality monitoring at the specific locations (onsite and offsite of the plants, residential areas including workers camps, construction sites, jetty, and offshore)
- Assessment of air quality impacts
 - Estimation of energy consumption of the area
 - Inventory of flare gases and flue gases
- Mitigation measures undertaking
 - Identification of the issues for environmental management to be improved based on the findings of the audit
 - Studies on reduction of gas emissions
 - Promotion of smoke-less flaring

2) Water Environment

(a) Current Situation

The outcomes of previous investigations of marine environment of Assaluyeh area show that, the qualities of seawater and sediments in the area have not been affected significantly by the activities of the development projects. However, the investigations show a little sign of pollution in water and sediment due to the discharge of waste water from the huge gas refinery and petrochemical plants along the coast.

(b) Water Quality Controls

● Gas Refinery Complex

In each plant within the gas refinery plant district, wastewater treatment facilities are installed to process the wastewater generated from the process facility to release into the sea. The wastewater from the gas refinery plant includes, in addition to the oily drainage, process effluent including chemical components, cooling water effluents utilized to cool down process equipment, living drainage, rainwater drainage within the plant site, and so forth. Among these kinds of wastewater, oily effluent, process effluent and living drainage contain the pollutants and they are processed in the wastewater treatment facilities. Meanwhile, as for cooling water effluent and rainwater drainage, they are released to the sea without any treatment since they are considered not containing pollutants.

To prevent discharge of the treated wastewater exceeding the effluent standards, the wastewater facilities are equipped with a tank (off-spec basin) to temporarily store the treated wastewater for retreatment. The qualities of the treated wastewater are monitored regularly at the observation basin and outfall basin in the process in accordance with the company's monitoring program.

SPGC well recognizes the current situation of the Wastewater treatment system of the plants and points out the problems to be discussed for improvement as follows.

- The wastewater facilities of some plants have the capacity of dealing with oily wastewater only and are not equipped with facilities processing MEG, MDEA or other pollutants in wastewater.
- Malfunction of the neutralization unit of spent caustic

SPGC has already launched the plans for improvement of the existing wastewater treatment systems in each plant, which consist of following activities.

- Basic engineering for improvement of WWT units for all refinery plants
- Study on improvement of oily WWT unit in the Refinery 2 (completed by RIPI)
- Environmental assessment of discharging wastewater from the plants

● Petrochemical Complex

There is a centralized utility plant operated by Mobin PC in the petrochemical zone. The utility plant supplies electric power, steam, industrial water, etc. necessary for operation of the petrochemical plants in the zone, and receives both industrial wastewater and sewage water discharged from 15 plants for proper treatment. And the majority of the treated water in compliance with the standards is reused for the gardening and other purposes in the zone and the remaining treated water are released to sea.

On the other hand, this integrated wastewater treatment facility processes wastewater from each plant according to the wastewater volume and concentration of pollutants initially designed. But the

load is now much greater than the one initially designed, causing various issues on the management and operation. To deal with this, Mobin PC has a plan to improve the wastewater facilities to deal with an increased load due to an expansion and increase in production of the existing petrochemical plants within the complex. It also considers the treatment of process wastewater containing ammonia and other substances of the volume exceeding the capacity of the existing facilities. For these improvement plans, Mobin PC must seek for not just an enhancement of the capacity of the facilities but also thorough discussions with each manufacturing company that emits wastewater so as to set out appropriate standards of the quality of wastewater to be accepted, the wastewater treatment cost and the operation and maintenance of wastewater monitoring activities.

PNOSC promotes proper controls of wastewater from the plants. The activities include:

- Audit of wastewater management of the petrochemical plants (16 companies)
- Enhancement of environmental laboratory of PNOSC (i.e. procurement of advanced measurement instruments and analyzers)
- Inventory of wastewater discharges
- Monitoring of water qualities of the wastewater and rain water outfall channels (6 channels)
- Mitigation measures undertaking
 - Identification of the issues for environmental management to be improved based on the findings of the audit
 - Studies on proper quality control for wastewater with rain water

In Assaluyeh, individual entities independently engage in waste water management, such as PSEEZ, the highest ranked organization of the complex; SPGC, a company in charge of O&M of the gas refinery plants; PNOSC, the managing body of the petrochemical plants; and Mobin PC, the operator of the integrated wastewater treatment facility in a petrochemical plant district. It is necessary, however, to establish operation, improvement, monitoring and audit system from the comprehensive viewpoint.

3) Waste Management

The operations of the plants in PSEEZ generate various types of solid wastes including hazardous and non-hazardous wastes. The wastes discharged from the plants are treated and disposed in accordance with the relevant laws /regulations of Iran and the waste management plans (WMP) prepared by the operating companies of the plants.

The WMP defines the procedures for proper management consisting of material coding and segregation depending on the feature and properties of the wastes, storage, transportation, manifest and ultimate disposal by landfill as well as environmental monitoring of the landfill sites.

The spent catalysts are considered as the most significant hazardous solid waste generated from the plans by periodical replacement. The recyclable and reusable spent catalysts are temporarily stored

in the designated intermediate storage site managed by PSEEZ for future transfer to the manufacturers or factories for regeneration.

The PSEEZ organized the waste management committee among the companies in the zone. The committee launched a promotion program for implementation of proper waste management in the zone. The highlighted activities include:

- Identification of the wastes generated from each plant
- Waste minimization
- Proper segregation and coding
- Estimation/ inventory of annual generation of wastes
- Selling out of the valuable wastes to private sector for recycle
- Instructions for proper management of the industrial and urban wastes

Waste management in this area is made in new plants, so it is relatively well managed. Since the volume of waste increases further in future. MOP and NPC will be required to reassess waste management with the focus on (i) surveys on contamination of places to store waste and (ii) plans to further promote 3R.

4.3.4. Future Development Plan of Assaluyeh

(1) Future Development Plan

Developing Assaluyeh area, together with Kangan Area, is planned, in parallel with a series of the offshore gas field development plans, which are Part 1: South Pars offshore gas field, Part 2: North Pars offshore gas field and Part 3: Golshan offshore gas field.

These development plans envisage 27 phases, while phases 1-10 have already completed (5 gas refinery plants). Designing and constructing the plants for phase 11-24 are currently in progress. These undergoing development plans include, along with the development offshore gas fields and the production increase of natural gas, the addition/expansion of gas refinery plants and the construction of LNG plants utilizing the refined gas as raw material. The plans are summarized in Table 4.3.4-1.

Table 4.3.4-1 Plant Construction Plan for Assaluyeh & Pars Kangan District

	District	Plant
Phase 11	Pars Kangan	Gas refinery plant, LNG plant
Phase 12	Pars Kangan	Gas refinery plant, LNG plant
Phase 13	Pars Kangan	Gas refinery plant, LNG plant
Phase 14	Pars Kangan	Gas refinery plant, LNG plant
Phases 15&16	Assaluyeh	Gas refinery plant
Phases 17&18	Assaluyeh	Gas refinery plant
Phase 19	Pars Kangan	Gas refinery plant
Phases 20&21	Assaluyeh	Gas refinery plant
Phases 22,23&24	Pars Kangan	Gas refinery plant

Source: PSEEZ Book 2012

- **North Pars**

North Pars project is related to the plan for development of North gas fields.

North Pars gas field is 16,000ha in size and has the capacity of 47.2 trillion cubic feet. Golsham, Ferdowsi and Farzad A&B gas fields are located in this area and are to be developed in future.

The current gas production volume and future processing volumes are presented in Table 4.3.4-2 and Table 4.3.4-3 respectively.

Table 4.3.4-2 Current Production Volume in Gas Refinery Plant

Product	Assaluyeh Phases 1-10
Refined gas	282.3million m ³ /day (9,965million feet ³ /day)

Source: PSEEZ Book 2012

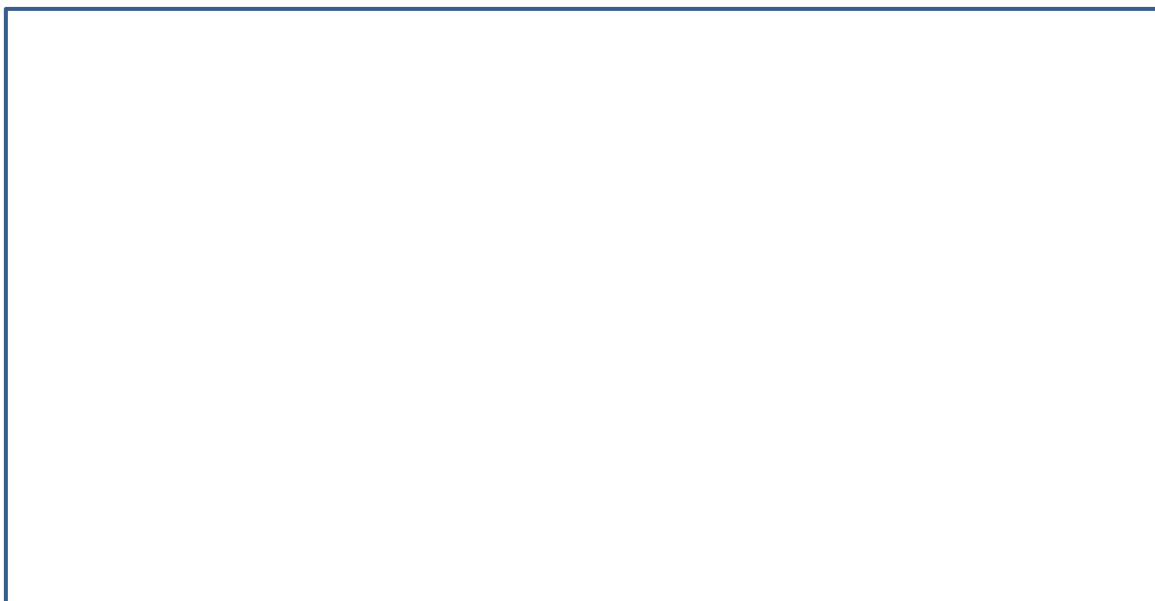
Table 4.3.4-3 Future Treated Gas Volume

	Assaluyeh district (million m ³ /day)	Pars Kangan district (million m ³ /day)
Phase 11	-	56
Phase 12	-	84
Phase 13	-	56.6
Phase 14	-	56.6
Phases 15&16	56.6	-
Phases 17&18	56.6	-
Phase 19	-	56.6
Phases 20&21	56.6	-
Phases 22,23,24	-	56.6
Total	169.8 (5993.9 million ft ³ /day)	366.4 (12933.9 million ft ³ /day)

Source: PSEEZ Book 2012

The natural gas (refined gas) produced in these gas refinery plants are currently supplied as fuel for each plant and raw material for petrochemical plants within the area, and for the re-injection into the offshore oil fields. And in the coming phases, the gas which is to be increased by the development project is planned to be supplied not only to the petrochemical plants in the area, but also LNG plants. It is also expected to be utilized to raw material of GTL plants and reinjection into the oil reservoir, while the excess part is to be supplied for domestic demands including the power stations via a domestic gas pipeline network.

In the petrochemical plant district in the area, 15 petrochemical plants and 1 power plant of 7 private companies are currently operating. In addition, projects to construct and expand the 26 petrochemical plants and downstream petrochemical plants are planned, many of which have already been proceeded (see Figure 4.3.4-1). These projects are to enable to produce some chemical products such as methanol, butane, ethylene, olefin, propylene, polypropylene, various glycol, ammonia, urea, styrene, butadiene, and the export of these products to foreign markets is to be promoted.



Source: NPC Projects-Petrochemical Industry 2012

Figure 4.3.4-1 Petrochemical Plant Project

In the meantime, the heavy/light industries district in the eastern part of the area, taking advantage of its affluent fuels and power supply, it has planned to attract new industries through the introduction of domestic and foreign investment. In this regard, related infrastructure improvement projects, including site preparation, expansion of port and harbor, improvement of roads, water supply and sewerage systems, are planned and implemented.

(2) Environmental Impacts

Currently, the air pollution due to the emission of various gases accompanying the operation of gas refinery plants and petrochemical plants has been a significant issue. Especially, there are concerns about health of neighboring residents and operation workers within the plants to be subject to SO₂ and PM contained in a huge amount of combustion gas released in the air from a number of flare stacks of these plants as well as hazardous substances such as benzene, etc. leaked from plant facilities. In the meantime, the wastewater from these plants is discharged to the sea, after being processed following the water quality standards stipulated. Currently, outstanding impacts of the industrial wastewater on the water quality and the bottom sediments have not been observed yet in the sea neighboring this area, while some sort of trends of environmental impacts by the wastewater are identified in the vicinity of some outfalls.

The processing facilities of each plant generate a huge amount of spent catalysts as wastes. The spent catalysts as hazardous wastes are separated from other wastes, part of which is temporarily stored in a designated storage yard for the purpose of recycling and reutilization partially. Yet, the implementation of its proper treatment has not been achieved.

As mentioned above, the area, for the coming period, has plans to additionally construct a number of gas refinery plants and petrochemical plants based on the development plan. The construction work has already been started. It is easily expected once these numerous planned plants start to operate, a huge amount of gases, wastewater and wastes will be discharged from the plants, which will lead to further environmental loads in the area and cause more critical environmental pollutions.

Based on the current conditions that the air pollution has already been a considerable issue and the marine pollution is also concerned in the area, still on its way to achieve the development, the existing plants have considered some environmental measures to be taken and some of them have already been implemented. However, no clear effect has shown yet.

For the purpose of realizing fundamental environmental measures in the area, it is required, in addition to the assessment of environmental impacts accompanying the operation of all the existing plants in the area, to consider basic environmental directions and effective measures to be taken based on the assessments of the cumulative environmental impacts by the additional operations of the planned plants in the area as a whole.

4.3.5. Issues

(1) Air Quality

Table 4.3.5-1 shows the issues on the air quality in Assaluyeh.

Table 4.3.5-1 Issues on Air Environment

Item	Present situation	Issue
Air pollution	The air pollution, due to a huge amount of emission gases containing air pollutants such as SO_x, NO_x, PM, VOC, etc. released from gas refinery plants and petrochemical plants, has become one of the most considerable environmental issues. • SO_x It assumes that the major source of SO₂ emissions in Assaluyeh is gas refinery plants, which take measures to reduce the flare gas, so the emissions have been reducing over the years. The amount of SO₂ emissions in the northwestern area near the mountainous area exceeds the standards. • Benzene The value of the northwest part of the area also exceeded the standard value like SO₂. Especially in a part of the central area, crowded by the condensate tanks, showed a quite high value recorded. • NO₂ In the plants of Phases 4, 5, there are power facilities that have caused NO₂, resulting in a higher value than the ones in other plants. But the amount in the region as a whole satisfies the standard values. • PM_{2.5} Values exceeding the standard values were observed.	• Strengthening of air pollution monitoring • Accurate grasping of production gas and emission gas volumes • Reduction of the total volume of the gases - Maximum recovery of usable gas from flare gas - High efficient combustion equipment - Employment of high efficient flare burner - Improvement of the existing facilities (to prevent leakage) - Recovery of gas released to the air • Minimum generation of pollutant in the flue gases - Improvement of the existing facilities (Employment of high efficient flare burner) - Use of high quality fuel (low sulfur) • Elimination of pollutants in the gases - Installation of facilities to process pollutants in the gases • Sound dispersion and dilution of gases - Proper design of flare stack - Selection of the location of flare stack

(2) Water Environment

Table 4.3.5-2 shows the issues on the water environment in Assaluyeh.

Table 4.3.5-2 Issues on Water Environment

Item	Present situation	Issue
Seawater	Some samples of wastewater taken in some parts of the sea area showed a tendency of high values of organic substances compared to other parts of the sea. One possible cause is the impact of wastewater from the production facilities in the region.	• Appropriate treatment of wastewater from the production facilities and reduction of organic substances in the water emitted
Gas refinery plant	The wastewater treatment facilities at each phase has the capacity of adjusting pH level and removing oil but no functions of processing dissolved organic matters such as MEG and MDEA contained in wastewater. Because of this, the amount of COD exceeding the standard value is conspicuous. The waste treatment facilities at Phases 6, 7 and 8 have the functions of adjusting pH level and removing oil and also bio-treatment facilities to remove COD, so conduct appropriate treatment.	• Consideration of COD treatment and implementation of countermeasures - Separate treatment of MEG and MDEA - Introduction of COD processing facilities at phases other than Phases 6, 7 and 8
Petrochemical plant	Mobin PC accepts the wastewater from 15 petrochemical plants in the district and appropriately processes it with its integrated wastewater treatment facility. Since it started to accept wastewater with high COD burden, however, it now has to process it appropriately. Another issue is inclusion of substances such as ammonia harmful to bio treatment in wastewater.	• Consideration of measures for an increase in raw water burden, and implementation of the measures • Consideration of measures for wastewater containing ammonia, and implementation of the measures • Coordination and thorough discussion over the implement of wastewater treatment between Mobin PC accepting wastewater at its integrated wastewater treatment facility and each production company (the similar issue exists in Mahshahr. The issue will be examined under the same concept.)

(3) Waste Management

Table 4.3.5-3 shows the issues on the waste in Assaluyeh.

Table 4.3.5-3 Issues on Waste

Item	Present situation	Issue
Waste management	The waste management plan has been formulated and implemented at each gas refinery plant. Petrochemical plants engage in management activities according to the NPC waste management system. The waste managements of the both types of plants are relatively well developed.	- Thorough and continuous commitment to appropriate management procedures such as classification/segregation of wastes by the wastes codes, ultimate disposal by landfill and environmental monitoring of the landfill sites - Pollution study of the waste storage site - Reassessment of waste management in light of promotion of 3R by MOP and NPC
spent catalysts	A large amount of spent catalysts is waste from the plans by periodical replacement. The recyclable and reusable spent wastes are temporarily stored in the designated intermediate storage site managed by PSEEZ for future transfer to the manufacturers or factories for regeneration.	Formulation of specific measures to be taken including recycling and recovery of valuable metals.

(4) Biota and Conservation Area

Table 4.3.5-4 shows the issues on biota and conservation area in Assaluyeh.

Table 4.3.5-4 Issues on Biota and Conservation Area

Item	Present situation	Issue
Impact from the petrochemical zone	The Atlas of Protected Area of Iran (2006) states that extensive human interventions, harsh climatic conditions, military practices and industrial developments in and around the Naiband park have dramatically affected the wildlife of the park.	- Continuous monitoring of biota - Consideration of measures in the case that the monitoring has found any negative environmental impact
	One of concerns is influence of thermal water discharge to Naiband National Park on biota (turtles, coral, etc.)	- Survey on the ocean currents and seawater temperature in the bay - Survey on impact of warm water discharged and contaminants

(5) Future development plan

Table 4.3.5-5 shows the issues on the future development plan in Assaluyeh.

Table 4.3.5-5 Issues on Future Development Plan

Item	Present situation	Issue
Gas field development	Gas field development plan comprises 27 phases, of which phases 1-10 has been already completed and plant designing and construction under phases 11-24 are currently in progress.	• Assessment of environmental impact of the present plan and the operation, as well as assessment of cumulative environmental impact of the construction of plant under planning on the entire region • Consideration of measures based on the assessment of the cumulative environment impact

4.4. Institutional Issues of the Pilot Sites

(1) Variation of the Management Systems

The subsidiaries follow their mother company's policy. Basically, they developed the HSE management systems based on the OGP's guidelines. Each national company group has its own management systems. One company's management systems do not therefore always suit another company because the work field varies from upstream to downstream. Besides, the Iranian Government promotes privatization process. Some companies have been handed over to the private sector and others have been privatized as a shareholding company. The private sector is not subject to rules and regulations governing the state companies. It may be assumed that the relationship between the national companies and the privatized companies would get weaker.

As the oil and gas development plans are promoted, the number of stakeholders operating in the development areas will increase. Even though each company meets the environmental standards, the operations could cause deterioration of the environmental conditions as air pollution has occurred in Assaluyeh. Accordingly, it is necessary to examine institutional framework that covers the whole area for the environmental protection and promotes the inter-organizational coordination and collaboration for the environmental protection.

(2) Methods of Environmental Monitoring

Each company group has its own unified monitoring formats and data management systems for the environmental management and it contributes to reducing the burdens of the environmental experts on data entry and compiling. However, they have not utilized the monitoring records to analyze change in the environmental condition across the ages. The monitoring records that are collected by the operating companies are not shared because the operating companies' concern about the environmental protection is usually limited to the pollution on their premises. In addition, to

address emergencies and initiate collective actions for the environmental protection in an industrial zone, a tool such as a map that shows the location of emission and discharge sources and types of pollutants is needed. However, the zone management companies do not have such a tool to identify the pollution sources and assess the environmental risks in the zones. This means that, currently, the zone management companies do not sufficiently fulfill the responsibility to control the environmental protection activities in the zones. Therefore, the environmental monitoring systems in an industrial zone should be reorganized. Roles and responsibilities of related organizations on environmental monitoring should be also clarified.

(3) Weak Authority of Zone Management Company

Currently, even though the zone management company finds that an operating company does not conform to the environmental regulations and standards in the industrial zone, there is no system to impose a punishment on the company. The zone management companies issue a warning to the company through its mother company or the MOP for more serious case. Such warning does not have legal power to make the company remedy a fault or improve the operations/facilities. This is caused by the weak authority of the zone management companies. As discussed in the previous sub-section, the privatization process may weaken the relationship between the privatized companies and national companies. This may also weaken the coordination and collaboration with the private sector on the environmental protection activities and narrow the range of control by the zone management companies. Therefore, it is necessary to rationalize the environmental management structure in one industrial zone and redefine the authority of zone management companies.

5. Oil Spill Emergency Response System

5.1. Legal Frameworks on Oil Spill Emergency Response System

5.1.1. Prevention of Emergencies

The national laws and regulations related to the oil pollution prevention of marine environment caused by exploration and operations of the petroleum industries in the country are listed below.

Table 5.1.1-1 National Laws and Regulations related to the Oil Pollution Prevention of Marine Environment

Title	Brief Description	Issue Year
Oil Law	Requires MOP to ensure environmental protection during oil exploration and production operations	1987
The Law of Iranian Marine Areas of the Persian Gulf and Oman Sea	Defines the basic requirements for preventing the pollution of marine waters in the Persian Gulf	1993
The Law of Sea and Border Rivers Protection against the Oil Pollution Regulation for Construction & Exploitation of Facilities in the Continental Shelf & Iranian Special Economic Zone	Issues comprehensive regulations on marine pollution aspects based on the Law of Iranian Marine Areas of 1993	1996
Act on Protection of Seas and Navigable Rivers against Oil Pollution	The protective measures to be provided by all ships and oil facility for drilling, production, transmission of oil including platforms, pipelines, etc. in the sea and rivers in the territorial area.	2010

Source: Study team

The Act on Protection of Seas and Navigable Rivers against Oil Pollution established in 2010 stipulates protective/ preventive measures to be undertaken by the responsible institutes and operators of all ships and oil facility in the territorial waters of Iran, which include:

- Insurance against the damage to environment by oil pollution or financial statement for compensation of such damage
- Inspection of ships and oil facility by PMO
- Immediate notification of oil pollution to PMO and the local authority of DOE
- Prevention for entry of single-hull oil tanker into the territorial water
- Penalties for violation

5.1.2. Response to Accident

(1) Regulatory Authority

The government of Iran ratified the international convention of Oil Pollution Preparedness, Response and Cooperation (OPRC) 1990 in 1997, which provide the framework for international cooperation in combating major incidents of marine pollution by oil spills. As a part of the OPRC Convention (Article 3), Iran is to develop an oil pollution emergency plan for ships, offshore units, as well as ports and oil handling facilities; and as a minimum, this plan should include the designation of:

- Competent national authority,
- National operational contact point,
- A national contingency plan.

Accordingly, the Port and Marine Organization (PMO) was nominated legally as the National Responsible Authority for the OPRC convention. Then, the PMO have subsequently developed the National Oil Spill Contingency Plan (NOSCP) as per requirement of the convention.

(2) Liability for Accidental Oil Spill

For accidental oil spill, the Act on Protection of Seas and Navigable Rivers against Oil Pollution established in 2010 stipulates the response actions to be taken by the ships and oil facility concerned in the event and PMO as well as the relevant authorities including the military and police forces.

The Act defines the civil liability of the owners, exploiters and officials for all the damages caused by the pollution. The liability shall cover all the costs of protection of spilled oil, elimination and recovery of the impacts, and environmental monitoring, including the materials, equipment and work forces mobilized for the response operations.

5.2. Regional Cooperation Scheme and International Conventions on Oil Spill Emergency Response System

5.2.1. Regional Cooperation Scheme

(1) Regional Cooperation in the Gulf Area (Kuwait Convention)

In 1978, the eight governments of the Gulf Region; Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates, adopted the Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution (Kuwait Convention) and Action Plan. The Plan mainly covers programme activities relating to oil pollution, industrial wastes, sewage and marine resources.

The regional Organization for the Protection of the Marine Environment (ROPME) (<http://www.ropme.com/index.html>) was created in 1979. The objective of the ROPME is to coordinate the Member States efforts towards protection of the water quality in ROPME Sea Area and protect the environment systems as well as marine living and to abate the pollution caused by the development activities of the Member States.

The Kuwait Convention has related five (5) protocols that were developed in accordance with the recommendations of the Legal Component of the Kuwait Action Plan. These protocols include the Protocol concerning Regional Cooperation in Combating Pollution by Oil and Other Harmful Substances in Cases of Emergency (1978), which provides the provisions concerning emergency response and contingency planning.

(2) Marine Emergency Mutual Aid Centre (MEMAC)

In conformity with the provisions of the 1978 Protocol, the Marine Emergency Mutual Aid Centre (MEMAC) was established in Bahrain and started functioning in March 1983. All ROPME member states, including Iraq, participates in MEMAC.

MEMAC is working closely with its Member States. This work can be briefed as follows:

- Revising National Contingency Planning and providing experts and observers during the course of revision and exercise.
- Revising laws, regulations and different Conventions related to marine pollution.
- Providing information with regard to technology, researches, methods and techniques in relation with combating or related matters. Besides, MEMAC has issued a list of Experts and Companies, who are available regionally and worldwide and working in the field for emergency.
- Reporting all the incidents in the Region and follows up activities such as cleaning, etc.

(3) ROPME Sea Area Regional Oil Spill Contingency Plan

MEMAC has prepared the ROPME Sea Area Regional Oil Spill Contingency Plan, which provides procedural and operational information and guidelines for the ROPME Contracting States when requesting regional assistance in oil spill incidents.

The essence of the oil spill response planning framework of the ROPME Sea area is that each Contracting State shall have its own National Contingency Plan and resources to respond to marine oil spills in the waters and on the coast under the jurisdiction.

(4) Indian Ocean Memorandum of Understanding (MoU)

Port State Control (PSC) is the inspection of foreign ships in other national ports by PSC officers (inspectors) for the purpose of verifying that the competency of the master and officers on board, and the condition of the ship and its equipment comply with the requirements of IMO and international conventions (e.g. SOLAS, MARPOL, STCW, etc.) and that the vessel is manned and

operated in compliance with applicable international law.

Since 1981, when the IMO adopted the resolution on procedures of PSC, IMO has encouraged the establishment of regional PSC organizations and agreements on PSC and Memorandum of Understanding (MOU) have been signed covering all of the world's oceans.

In accordance with the above international scheme, the Indian Ocean Memorandum of Understanding (IOMOU) on PSC in the Indian Ocean region was signed in October 1997 by the nineteen (19) countries including Iran along the coasts of the Indian Ocean. The IOMOU commits the maritime authorities of the member countries to a unified system of port state control measures and to intensify cooperation and information exchange on issues concerning PSC.

PMO, the responsible governmental authority for the PSC, adopts the same PSC to all the ports and marine terminals in the Persian Gulf, too.

5.2.2. International Conventions

In order to combat the marine pollutions and protect the natural environment, it is important that international cooperation and common management strategies are well established.

The International Maritime Organization was established in 1948 as the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships.

IMO has been introducing various kinds of international cooperation measures through the international conventions. In the field of the marine environment protection from oil pollution, measures are classified according to the three categories; a) Pollution Prevention, b) Pollution Response, and c) Liability and Compensation.

Among these conventions, the following conventions and annexes play primary roles in the oil spill response planning:

- International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)
- Annex I : Prevention of Pollution by Oil
- International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC 1990)
- Civil Liability and Fund Convention (1992 CLC, 1992 Fund and 2003 Supplementary Fund Protocol)

Major requirements of these conventions are summarized in the Table 5.2.2-1. Each State who ratifies these conventions shall provide the national legislations to implement the necessary actions to be taken, or even if not ratifies, the State is still require to prepare its own domestic rules and legislations corresponding to the issues.

Table 5.2.2-1 Requirements of IMO Conventions

Adapt. year	IMO Conventions	Amendments	Requirements
a) Pollution Prevention			
1978 1983	MARPOL 73/78 (Annex I/II)	1991 Amendments	• Shipboard Oil Pollution Emergency Plan (Vessel) • Port State Control • Special Areas
b) Pollution Response			
1990 1985	OPRC 1990	HNS Convention 96	• <u>Oil Pollution Emergency Plan</u> - Seaports - Oil handling facilities - Offshore unit • <u>National Contingency Plan</u> • Multi-national / Regional Contingency Plan
2008	Bunker Convention		• prevention, reduction and control of pollution by ships bunkers and guaranteeing sufficient and timely compensation
c) Liability and Compensation			
1969 1975	CLC Convention 69	92 CLC	• Insurance by Ship Owners (P&I Club)
1971 -	Fund Convention 71	92 Fund 2003 Fund	• Fund by Oil Receivers (IOPCF)

Source: Study team

In addition to the above IMO conventions, the United Nations adopted the *United Nations Convention on the Law of the Sea (UNCLOS)* in 1982. It lays down a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources.

The Convention provides the general framework for international cooperation in case of pollution incidents and emergencies at sea. Each state is further required jointly to develop and promote contingency plans for responding to marine pollution incidents.

The status of adoptions of the related international conventions by Iran is as follows.

<u>Conventions</u>	<u>Year of adoption</u>
MARPOL 73/78	2002
OPRC 1990	1997
OPRC-HNS	2011
Bunker Convention	In progress
CLC Convention 92	1996
Fund Convention 92	1996

5.3. Review of Overseas' Oil Spill Emergency Response System

5.3.1. Relevant International Guidelines

(1) IMO Manual on Oil Pollution

The Marine Environment Protection Committee of the International Maritime Organization (IMO) published the Manual on Oil Pollution, which provides guidance on oil pollution emergencies, taking into account the International Convention on Oil Pollution Preparedness, Response and Corporation, 1990 (OPRC). The Manual consists of the following sections:

Section I	Prevention (revision under consideration)
Section II	Contingency Planning (1995 Edition)
Section III	Salvage (1997 Edition)
Section VI	Combating Oil Spills (2005 Edition)
Section V	Administrative Aspects of Oil Pollution Response (2009 Edition)
Section VI	Guidelines for Sampling and Identification of Oil Spills (1998 Edition)

Section II Contingency Planning provides guidance to governments on ways and means of establishing a response organization and preparing contingency plans, which are prescribed in article 6 of the OPRC Convention.

Authorities responsible for development and operation of a plan at Government level are:

- Defence Department
- Maritime Transport (Civil) Department
- Environment Protection Department
- Coast Guard
- National Committee.

There are two planning approaches: the operational concept of tiered response and governmental organizational framework at the national, multi-national/regional and international levels. (See Figure 5.3.1-1.)

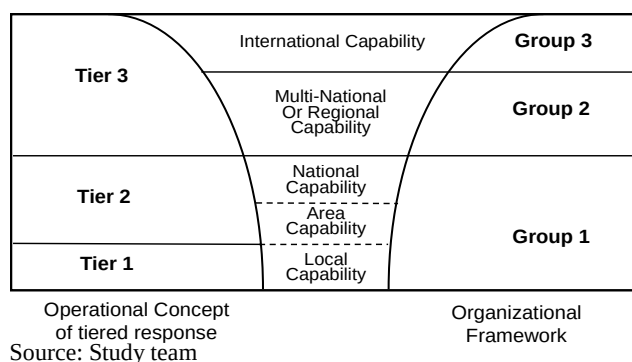


Figure 5.3.1-1 The Global Framework for Pollution Response

Tiered response is a widely accepted operational concept that provides a convenient categorization of response levels and a practical basis for planning. Tiered response recognizes three levels.

- **Tier 1:** a small spill within the capacities of an individual facility or harbor authority. Seven hundred tons is often cited as the upper limit of Tier 1; however, the circumstances of the spill and the surrounding environment will determine the actual level of response.
- **Tier 2:** a spill that requires the co-ordination of more than one source of equipment and personnel.
- **Tier 3:** a major spill requiring the mobilization of all available national resources and, depending upon the circumstances, will likely require the mobilization of regional and international systems.

Governmental arrangements may be grouped as follows:

- Group 1: entire national response system, including local/areal and national oil pollution emergency plans.
 - A minimum of two response levels should be established : a national level and a local level which will address responses to geographic subdivisions.
 - Those entities that are potential source of a pollution incident should also have an established response system and a corresponding oil pollution emergency plan:
 - Vessels: Regulation 26 of Annex I of MARPOL 73/78
 - Seaports, oil handling facilities, offshore unit: Article 3 of OPRC Convention
- These plans should maintain compatibility with the national response system, lines of authority and reporting procedures.
- Group 2: any bilateral or multilateral response plans or agreements with other countries as well as regional response bodies. Multilateral agreements are developed by governments or the UNEP Regional Seas Programme.
 - Group 3: the network of inter-regional plans or agreements, including the IMO Oil Pollution Co-ordination Center and relationships.

Organization for response

- The response organization should be large enough and sufficiently funded to deal with a pollution incident of a specified size and nature.
- The response organization should be authorized to co-ordinate the activities of other agencies and capable of controlling substantial numbers of personnel and a variety of equipment.

Section V *Administrative Aspects of Oil Pollution Response* presents that the priorities of each of the related personnel are as follows:

- the master of the casualty vessel should take immediate action to ensure the safety of the

crew and the preservation of the ship and cargo and will make arrangements, if necessary, for salvage operation;

- The salvager should salvage the casualty vessel successfully; and
- The Administration should ensure protection of the coastal environment and commercial resources.

It is important that the National Contingency Plan contains provisions for co-operation between the authority, the ship and cargo owner and the salvager to resolve any conflicts and to clarify responsibility.

(2) IPIECA - Oil Spill Preparedness and Response Report Series

1) IPIECA Reports

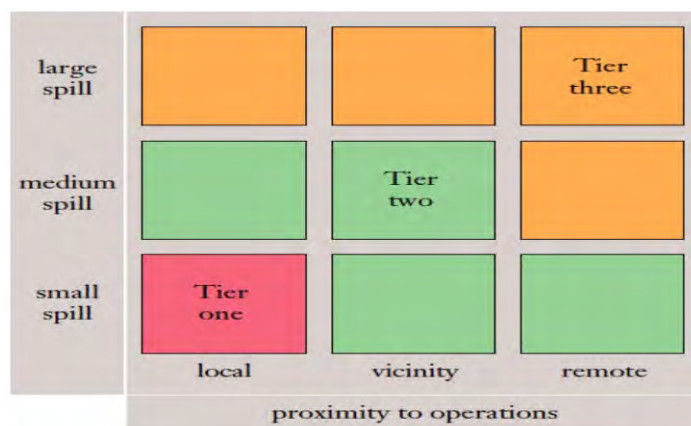
International Petroleum Industry Environmental Conservation Association (IPIECA) has published various oil spill preparedness good practice guidance, oil spill preparedness and response report series, as follows;

1. Guidelines on biological impacts of oil pollution, 1991
2. A guide to contingency planning for oil spills on water, 1991 (2nd edition 2000)
3. Biological impacts of oil pollution: coral reefs, 1992
4. Biological impacts of oil pollution: mangroves, 1993
5. Dispersants and their role in oil spill response ,1993 (2nd edition 2001)
6. Biological impacts of oil pollution: saltmarshes, 1994
7. Biological impacts of oil pollution: rocky shores, 1995
8. Biological impacts of oil pollution: fisheries, 1997
9. Biological impacts of oil pollution: sedimentary shores,1999
10. Choosing spill response options to minimize damage: net environmental benefit analysis, 2000
11. Oil spill responder safety guide, 2002
12. Guidelines for oil spill waste minimization and management, 2004
13. A guide to oiled wildlife response planning, 2004
14. Guide to tiered preparedness and response, 2007

2) Tiered Response

Volume 2- A guide to contingency planning for oil spill on water prescribes the details of oil spill response planning, based on the IMO basic concept of “Tiered Response”. (See Figure 5.3.1-2.)

The Tiered Response is the basic concepts for oil spill response.



Source: IPIECA "A guide to contingency planning for oil spill on water"

Figure 5.3.1-2 Tiered Response

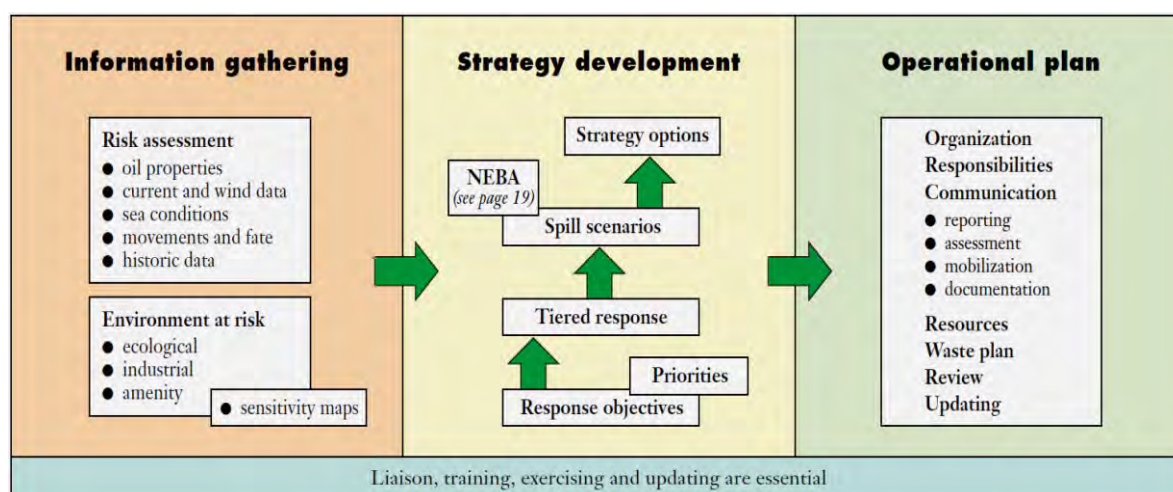
- **Tier 1:** operational-type spills that may occur at or near a company's own facilities, as a consequence of its own activities. An individual company would typically provide resources to respond to this type of spill.
- **Tier 2:** a larger spill in the vicinity of a company's facilities where resources from other companies, industries and possibly government response agencies in the area can be called in on a mutual aid basis. The company may participate in a local cooperative where each member pools their Tier 1 resources and has access to any equipment that may have been jointly purchased by a cooperative.
- **Tier 3:** the large spill where substantial further resources will be required and support from a national (Tier 3) or international cooperative stockpile may be necessary. It is likely that such operations would be subject to government controls or even direction. (It is important to recognize that a spill which could require a Tier 3 response may be close to, or remote from, company facilities.)

3) Procedures

An oil spill contingency plan should comprise three parts:

- **Strategy section:** scope of the plan including the geographical coverage, perceived risks, roles/responsibilities of those charged with implementing the plan and the proposed response strategy
- **Action and operations section:** the emergency procedures that will allow rapid assessment of the spill and mobilization of appropriate response resources
- **Data directory:** All relevant maps, resource lists and data sheets required to support an oil spill response effort and conduct the response according to an agreed strategy.

The contingency planning process is shown in Figure 5.3.1-3.



Source: IPIECA "A guide to contingency planning for oil spill on water"

Figure 5.3.1-3 Contingency Planning Process

5.3.2. Regional Trends of Oil Spill Response

Status and trends of preparedness of oil spill response in the countries in the Gulf region are described hereinafter.

Most of countries within the region have some form of national oil spill contingency arrangements in place. In some countries, where major oil companies are operating, the company's contingency plan serves as national contingency plan and is exercised with some regularity.

There is a governmental agreement among the Gulf countries for mutual co-operation for emergency response to massive oil spill. The Marine Emergency Mutual Aid Center (MEMAC), formed under the legal framework of the Kuwait Action Plan and funded by the member countries, coordinates governmental activities in the field of oil spill response and promotes mutual assistance. Each member country has response equipment that can be used by MEMAC members and emergency response efforts can be coordinated centrally at the expense of the requesting country.

In addition to regional initiatives, the Petroleum Association of Japan (PAJ) has significant response equipment stockpiles located in Abu Dhabi in the United Arab Emirates (UAE) and Saudi Arabia. This non-profit trade association has a number of stockpiles strategically located along the tanker route from the Middle East to Japan. The equipment is available free of charge.

Progress with regard to implementation of regional and international conventions over the past decade has been promising. The countries within the region have signed the Kuwait Convention promoting regional co-operation. As of April 2012, six of eight countries have ratified the Civil Liability Convention (CLC) and four countries have signed FUND 92.

The status of preparation of national oil spill contingency plans, tiered response plans and related conventions signed within the Gulf region is summarized in Table 5.3.2-1.

Table 5.3.2-1 Status of Preparedness and International Conventions in Gulf Region

Gulf Countries	National OSCP	Clean-up Resources		CLC 69	CLC 92	FUND 92	Super Fund 03	OPRC 90	OPRC HNS	Bunkers 01
		Tier 1	Tier 2							
Bahrain	1993	Yes	Yes							
Iran	2001	Yes	Yes		X	X		X	X	X
Iraq	Note 1									
Kuwait	Yes	Yes	Yes	X	X					
Oman	1995	Yes	Yes		X	X		X		
Qatar	Yes	Yes	Yes		X	X		X		
Saudi Arabia	1991	Yes	Yes	X	X			X		
United Arab Emirates	Note 2	Yes	Yes	X	X	X				

Note 1 Under preparing

Note 2 OSCPs of major oil companies cover the function of National OSCP.

Source: ITOPF HANDBOOK 2012/13

5.4. Technical Examination on Oil Spill Emergency Response System in Iran

Various petroleum activities are extensively developed in the marine and coastal areas of Iran. Such activities include exploration of offshore oil and gas fields, operation of offshore oil and gas production facilities, refining of the produced crude oil and gas and export of the products as well as tanker operations in the territorial waters.

Those petroleum related activities always accompany some potential risks of unexpected accidental oil spill other than fire/ explosion.

The spilled oil, if it occurred unexpectedly, is possible to impact on marine and coastal environment and on the social/ economical activities in the surrounding sea area. In case of a large oil spill, it is expected easily that the spilled oil will traverse the boundaries of the neighboring countries depending on the sea currents and winds, and furthermore, oil slicks may be diffused widely in the whole of the Gulf, if no proper response and timely actions are taken.

This section will review the current preparedness of oil spill response in Iran as well as potential risks and probable impacts of oil spill.

5.4.1. Current Oil Spill Emergency Response System

(1) Potential Oil Spill Risks in Petroleum Industries

1) Offshore Oil and Gas Development

The offshore oil and gas development is associated with drilling of exploration wells and

production wells, construction of production facilities and subsea pipelines and operation of the production facilities. The oil spill caused by offshore oil and gas development activities can directly and rapidly affect the marine environment in the field, even if it is just a small spill.

The potential sources and causes of oil spill accompanying the development activities in the respective development phase are considered as follows.

【Exploration Phase】

<u>Spill source</u>	<u>Cause</u>
• Drilling rig	- Well blowout - Defective well testing equipment and pipe - Defective fuel storage tank, supply system
• Service/ supply boat	- Collision, grounding, sinking

【Construction Phase】

• Construction vessel/boat	- Collision, grounding, sinking - Spill of fuel from storage tank or piping

【Operation Phase】

<u>Spill source</u>	<u>Cause</u>
• Well/ Production platform	- Defective well casing, wellhead, flow line, manifold, etc. - Defective production equipment, pipe, valve, fitting, etc. - Malfunction of control/ safety devices - Failure of operation - Fire/ explosion - Damage by natural disaster or third party
• Subsea pipeline	- Defective pipe (e.g. corrosion) - Damage by natural disaster or third party
• Service/ supply boat	- Collision, grounding, sinking

2) Petrochemical Industries

The petrochemical plant as well as refinery plant located in the coastal area adjacent to shore line has potential risks of impact on marine and coastal environment caused by probable accidental spill of oil and its intermediate process fluid or product in its operation.

The potential sources and causes of spill are shown below.

<u>Spill source</u>	<u>Cause</u>
• Process equipment	- Defective equipment, pipe, valve, fitting, etc. - Malfunction of process control and safety devices - Failure of operation - Fire/ explosion - Damage by natural disaster, third party
• Storage tanks	- Defect of tank material (e.g. corrosion) - Failure of operation - Damage by natural disaster, third party
• Pipeline	- Defective pipe material (e.g. corrosion) - Damage by natural disaster, third party

The petroleum liquid handled by petrochemical and oil and gas refinery plants are crude oil, natural gas and gas condensate, and petroleum products such as intermediate process and chemical products in petrochemical plant and naphtha, gasoline, kerosene, diesel and heavy fuel. And many of petrochemical products are accounted as hazardous noxious substances (HNS), which heavily affect marine environment, if it is released in water.

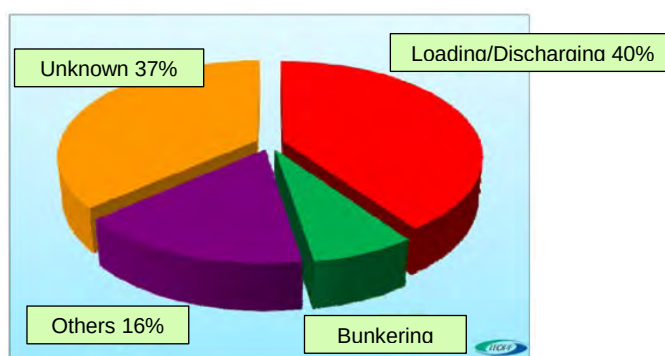
However, since almost all of the facilities of the plant are installed onshore with bund walls or other containment facility around the plant area, it is assumed that the spilled liquid, if occurred, will not directly reach to the shoreline, except for the spill from pipeline laid offsite of the plant.

3) Petroleum Export Terminals and Tanker Operation

The International Tanker Owners Pollution Federation Limited (ITOPF) issued the annual analysis report for the causes of oil spill from tanker operation in the world since 1970 on the following spill sizes.

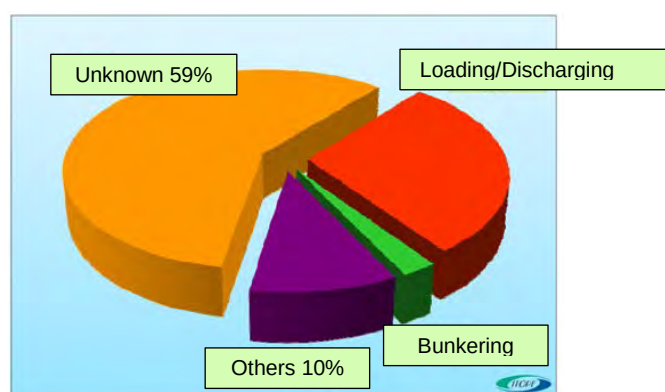
- Small size: less than 7 tons oil
- Medium size: 7-700 tons oil
- Lager size: more than 700 tons oil

Most of oil spill accidents are the result of a combination of actions and circumstances, all of which contribute in varying degrees to the final outcome. The following analysis explores the accident of spills of different sizes in terms of operation at the time of the spill. (See Figures 5.4.1-1, 5.4.1-2 and 5.4.1-3.)



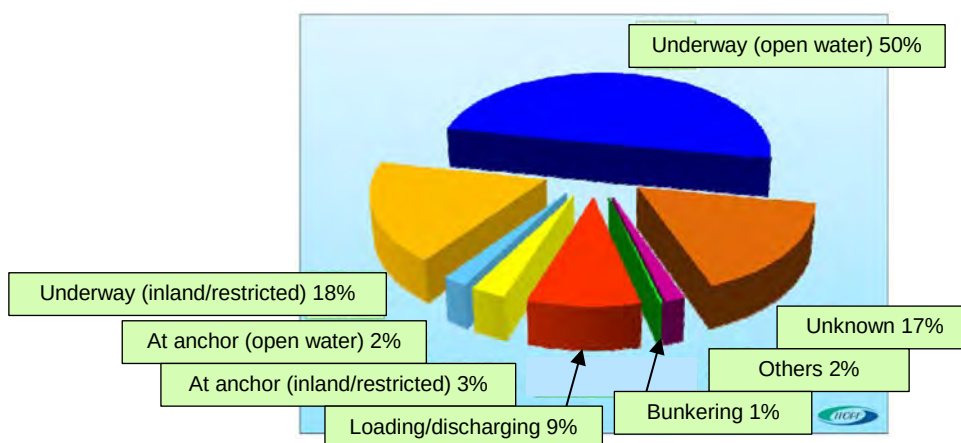
Source: ITOPF Statistics 2011

Figure 5.4.1-1 Small Size of Oil Spills less than 7 tons by at Time of Incident



Source: ITOPF Statistics 2011

Figure 5.4.1-2 Medium Size of Oil Spill on 7-700 tons by at Time of Incident



Source: ITOPF Statistics 2011

Figure 5.4.1-3 Large Size of Oil Spill on more than 700 tons by at Time of Incident

It is apparent from the above figures that:

- The largest numbers of small and medium spills from tankers are the result from terminal operations such as loading, discharging (offloading) and bunkering which normally occur in ports or at oil terminals.
- Around one third of the total large oil spills are the result from operations including anchoring and loading/ discharging in coastal areas and at the terminals.

The potential sources and causes of oil spill accompanying the export terminal operation are considered as follows.

<u>Spill source</u>	<u>Cause</u>
• Loading facility	- Defective petroleum product loading equipment - Defective loading pipeline or hose, valve, fitting, etc. - Defective bunkering/ fueling equipment, - Malfunction of control devices - Defective mooring devices - Fail of operation - Collision of tanker or support boat - Fire/ explosion - Natural disaster, third party
• Tanker and support boat	- Collision to loading facility or other boat - Defective tanker hull, tank, pipe, fitting, etc. - Grounding - Fire/ explosion

(2) Oil Spill Prevention Measures

Integrity of the facility of petroleum development and production and its operation is heavily related to the prevention of the incident accompanying oil spill. It is an outcome of proper design, construction, maintenance and operating practices. It is achieved when the facility is structurally and mechanically sound and performs the processes and produces the products for which they were designed. The sound operation of the facility is secured by dedicated implementation of appropriate management system and procedures including the management for potential risks in the operation. It is supported by the functional organization with competent and capable management and operational personnel.

1) Facility Integrity

The Ministry of Petroleum (MOP) of Iran established the Iranian Petroleum Standards (IPS) as a national engineering standards of Iran in 1990's with reference to related international standards

and guidelines which were practically applied to the petroleum industries in the world. The IPS is comprised of various categories such as engineering, design, construction, maintenance, inspection, safety, environment, etc. required for construction and operation of the petroleum related facilities. The IPS is reviewed and updated frequently in accordance with the changes of requirements of worldwide petroleum sector.

All the petroleum facilities in Iran are required to be designed, constructed and operated properly in compliance with the applicable IPS. Therefore, proper safety provisions including preventive measures for the incident associated with oil spill shall be implemented in the design and operation of the facility by the operators.

Quality of the facility and equipment gradually declines due to exhaustion, corrosion and deterioration of the materials comprising the installations. The degradation is directly related to the reliability of the steady and safe operation. For example, the major cause of the small oil spill from subsea pipeline, which is one of the most serious issues in the offshore oil production, is considered to be caused by interior or external corrosion of the pipe.

Therefore, for prevention of such probable incident, proper inspection and maintenance of the facility are essential in order to ensure the quality of the existing facility and equipment involved in the operation.

A series of standards for periodical inspection of the mechanical, electrical, instrument and control equipment comprising the facility are specified in the Iranian Petroleum Standard (IPS) for diagnosis of condition of the equipment in order to prevent the defective operation or incident including oil spill.

2) Management of Facility Operation

Safe and steady operation of the facility is achieved by proper implementation of the operational procedures specified in accordance with the purpose, characteristics of the facility and the condition of the site as well as the accompanying potential risks.

The concrete operation management system supported by documented operational procedures and manuals as well as safety procedure for emergency cases shall be in place at the respective facility for the purpose. The operational procedures shall be developed reflecting the outcomes of risk assessment for potential incident or major accident accompanying the facility operation.

Proper implementation of such operation management is also essential for mitigation of the potential risks and prevention of probable incident which may cause oil spill.

3) Personnel

Personnel stand above all facility/ equipment, operation and management. Human factors, such as when individuals interact with each other, with facility and equipment, with operations, and with the management system, share the large weight for assurance of operation integrity. The human

factors and interaction will depend on the competences and capabilities of the personnel involved in the management and operations of the facility as well as nature of the individuals.

For enhancement of competence, capability and HSE awareness of the personnel involved in the operation, a comprehensive technical and management training and education plan shall be provided in the company and each operation unit at site. The plan shall consist of the specific sources subject to all levels of the organization.

4) Control of Ships

Safety of tanker sailing in the regional sea area and entering and leaving the port/ terminal is supported by proper navigation control system of marine traffic control station in the region and the specific berthing and un-berthing procedure of the facility. In addition, the safe tanker operation is also secured by competency of the master and officers on board, conditions of the ship and its equipment as well as proper operation which complied with the requirements of international conventions and laws.

Port State Control (PSC) is the inspection of foreign ships in national ports to verify that the condition of the ship and its equipment comply with the requirements of the international regulations and that the ship is manned and operated in compliance with these rules. In this regard, the PMO has commenced a series of efforts to guarantee safety of navigation and protect the marine environment in the waters under the jurisdiction of Iran. Under the agreement in the Indian Ocean Memorandum Agreement (IOMOU), which was signed among the countries facing the Indian Ocean, PMO undertakes to implement the PSC at all the ports and crude terminal in the territorial waters of Iran including Persian Gulf.

(3) Emergency Response Scheme in Iran

1) General Oil Spill Response Scheme

(a) Responsible Organization

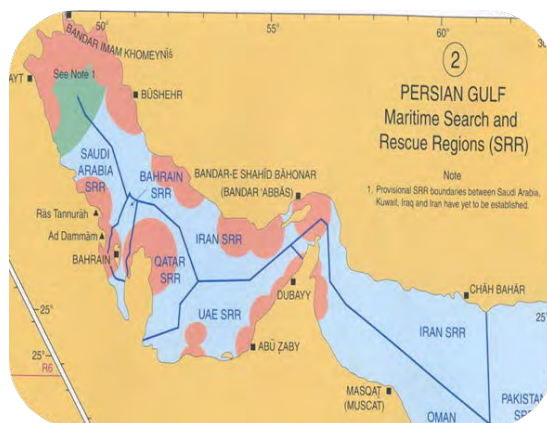
The government of Iran ratified the international convention of Oil Pollution Preparedness, Response and Cooperation (OPRC) 1990 in 1997, which provide the framework for international cooperation in combating major incidents of marine pollution by oil spills.

Accordingly, the Port and Marine Organization (PMO) was nominated legally as the National Responsible Authority for the OPRC convention. Then, the PMO subsequently developed the National Oil Spill Contingency Plan (NOSCP) as per requirement of the convention. The section in charge of development and implementation of NOSCP is the Department of Safety and Marine Environment Protection of PMO. The department is also responsible for emergency rescue of human at any disaster at the sea area.

(b) Coverage of PMO

The area covered by PMO is the marine region of Persian Gulf and Gulf of Oman. See Figure 5.4.1-4. The area includes major sea traffic lanes having approximately 44,000 vessels sailing per year including 17,000 oil tankers, oil and gas development fields and special environmental protected area designated by the international convention.

The oil spill sources to be dealt by PMO are ship and oil tanker, all fixed or floating crude and gas production, storage and loading/ unloading facilities including platforms, artificial islands, oil reservoirs, and subsea pipelines in the coasts or waters.



Source: PMO presentation material

Figure 5.4.1-4 NOSCP Coverage Area

(c) Oil Spill Response Strategy

The primary strategy for emergency response operation is in the form of a “Tiered Response” consisting of three (3) tiers depending on the scale of the oil spill/ probable extent of marine pollutions as follows.

	<u>Tier</u>		<u>Spill volume</u>	<u>Responsible organization</u>
•	Tier 1	Small oil spill	(less than 50 tons)	Operator (company)
•	Tier 2	Medium oil spill	(50~500 tons)	Provincial PMO branch
•	Tier 3	Large oil spill	(above 500 tons)	PMO with MEMAC

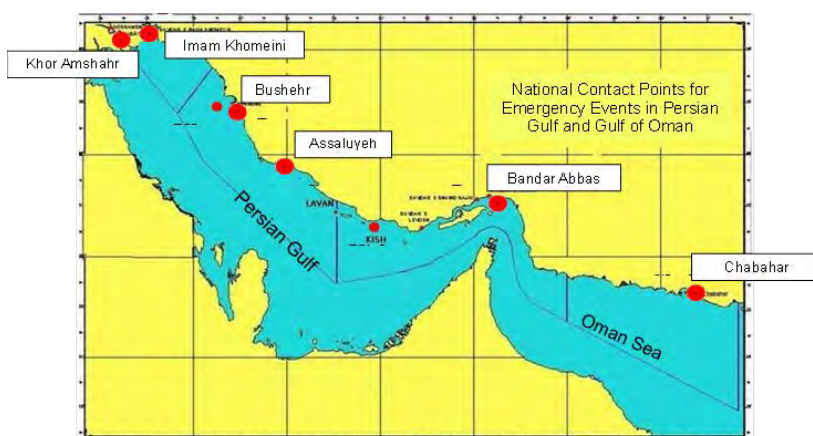
The operator of the facility (spill source) shall respond with his response resources for Tier 1 small oil spill (less than 50 tons). The regional OSR team headed by the provincial PMO shall take necessary response actions for Tier 2 medium oil spill (50~ 500 tons) with his resources together with the operator.

In case of Tier 3 large oil spill, the oil slicks could be extended widely and invade the territorial waters of the neighboring countries. For this tier, the response team of PMO shall carry out

protective works with the support of MEMAC in accordance with the procedure predetermined in the regional mutual aid program among Gulf countries.

(d) National Contact Emergency Points

PMO sets up five (5) national contact points for emergency events that could occur in the territorial waters in the Gulf and one (1) contact point in the Gulf of Oman. The operation of these contact points is the responsibility of the provincial offices of the Department of Safety and Marine Environment Protection of PMO. Locations of the contact points are indicated in Figure 5.4.1-5.



Source: PMO presentation material at 2nd Technical Seminar in Tehran

Figure 5.4.1-5 National Contact Points for Emergency Events

These emergency contact points are registered and announced formally to the related international organizations to ship operations such as International Maritime Organization (IMO), International Tanker Owners Pollution Federation (ITOPF) and others. These facilities function as provincial oil spill response center with response equipment stockpile of the province. Refer to Table 5.4.1-1 shown below.

Table 5.4.1-1 Oil Spill Response Equipment Stockpile in the Gulf Coast

Item	Equipment	Khomein	Bushe	B. Abbas	Chabahar
1	Oil Spill Response Vessel	-	1	-	-
2	Barge (500-ton)	1	2	1	-
3	Scavenger Vessel	2	2	3	-
4	River Booms (+ Wheel)	600	600	300	200
5	Coastal Booms (+ Wheel)	600	1300	600	500
6	Ocean Booms	300	600	600	-
7	Absorbant Boom (m)	700	1100	700	300
8	Disk Skimmer (Small)	1	1	1	-
9	Disk Skimmer (Large)	1	1	1	1
10	Brush Skimmer	2	3	1	1
11	Weir Skimmer	2	3	1	1
12	Absorbant Sheet (m ²)	400	500	400	100
13	Spare reels	2	2	1	-
14	Floating Tank (25 m ²)	2	2	2	-
15	Floating Tank (10 m ²)	6	6	6	3
16	Washing Equipment	2	1	2	1
17	Water Pump	2	2	2	1
18	Heavy Oil Pump	3	3	3	1
19	Blower	7	10	7	3
20	Diesel Generator	4	5	4	1
21	Dispersant (Barrels)	-	-	-	-

Source: PMO presentation material

(e) Relevant Organizations

The responsible organizations to be involved in the probable emergency situation are as follows.

- Ministry of Road and Urban Development/ PMO
- Department of Environment (DOE)
- Ministry of Interior (MOI)
- Ministry of Petroleum (MOP)
- Ministry of Defence
- Ministry of Agricultural Jihad (Fisheries organization)
- Ministry of Foreign Affairs (MOFA)
- Ministry of Energy
- President's Deputy for Strategic Planning and Control
- Ministry of Industry, Mine and Trade (Islamic Republic of Iran Shipping Line)
- Ministry of Economic Affairs and Finance (Islamic Republic of Iran Customs)
- Islamic Republic of Iran Red Crescent Society

2) National OSCP

In compliance with international convention OPRC and protocol of Kuwait convention, PMO established the National Oil Spill Contingency Plan (NOSCP) titled “National System for Oil Pollution Preparedness, Response & Cooperation at Sea & Navigation Rivers”. The NOSCP was approved by the parliament in 2012. The NOSCP consists of six (6) articles.

Article 1	Purposes, definitions and basic strategy for response
Article 2	Governmental related organization and Working Group
Article 3	Roles of Working Group
Article 4	Regional response organization
Article 5	Roles of responsibilities of organizations to be involved
Article 6	Reports, cooperation, training and exercise

The NOSCP defines that the national authority responsible for implementation of the national contingency plan for the disaster arisen by oil spill on water is PMO. It also specifies the practical response scheme and strategy including the areas to be covered and the oil spill events to be dealt. The responsible organizations for response depending on the scale of the oil spill and severity and extent of the expected impacts caused by the event are defined as follow in accordance with the tiered response strategy.

- Tier 1 Small oil spill: less than 50 tons of oil
- Tier 2 Medium oil spill: 50~500 tons of oil
- Tier 3 Large oil spill: more than 500 tons of oil, or the accident bearing the risk of such a spill

The response to Tier 1 oil spill (small and local oil spill) shall be dealt with by the operator of the source facility of the event. The Tier 2 oil spill (medium and regional oil spill) shall be the responsibility of provincial PMO branch in accordance with the Provincial Contingency Plan. Tier 3 oil spill (large and trans-boundary oil spill) shall be responded by PMO with support of MEMAC in accordance with the mutual aid emergency scheme of the Gulf countries.

For effective planning, coordination and proper monitoring of the implementation of the national plan, the “Working Group”, which is chaired by PMO, shall be established by the representatives of the relevant ministries and organizations.

The tasks of the Working Group include:

- Approval of national and provincial oil spill contingency plan
- Coordination of response operations of Tier 2 and 3 oil spills
- Monitoring of the performance of the response operations taken by the related organizations

In addition to the above, a provincial working group shall be established in each of the coastal provinces in order to prepare the provincial contingency plans and coordination of the implementation of the provincial contingency plan.

The NOSCP defines the duties of the relevant organizations in charge of NOSCP as follows.

PMO

- Implementation, management, control of NOSCP
- Preparation, supervision and management of provincial centers for response equipment stockpile
- Training and exercise/ drill program
- Operation of national response communication center
- Decision and request for assistance to other countries

National Civil Aviation Organization

- Aerial observation of oil pollution on water

National Meteorological Organization

- Supply of meteorological information of the event area

Department of Environment

- Identification of ecological sensitive and valuable marine and coastal areas to be protected
- Assessment of the damage to the environment due to the oil spill
- Management, supervision and monitoring of protective measures during and after response operations
- Material permission and approval of the chemical dispersants to be used for the operation

Ministry of Foreign Affairs

- Assistance and cooperation for receiving the international supports

Ministry of Defence

- Cooperation of response operation (use of the ports and berths managed by the forces)

Ministry of Petroleum

- Proper incident preventive provisions on offshore facilities and operations
- Mutual cooperation for the use of ports and berths, and response equipment for immediate and effective responses
- Identification and notification of the highest risk of oil spill associated in the activities of petroleum development and production
- Preparation of information for physical and chemical characteristics of the different type of crude oil and products

Ministry of Agriculture Jihad

- Identification and disclosure of the sensitive fish-farming, fishing grounds and ports
- Cooperation for use of the fishing ports and berths for response operation

Ministry of Energy

- Identification and announcement of the sensitive facilities to oil pollution constructed in the coastal area (i.e. seawater intake facility of power generation plant and seawater desalination plant, etc.)

Ministry of Economic Affairs and Finance (Iranian Customs)

- Cooperation and arrangement of temporary or permanent entry of the response equipment from the foreign countries

General obligations of the related organizations in charge of implementation of the national plan include, but not limited to:

- Immediate report of the event to the national authority (PMO)
- Regular training and exercise
- Report of the latest situation of the oil spill and response operations undertaking
- Implementation of the response plan within the legal responsibilities of the organizations and decision of the Working Group

In addition to above oil spills, PMO shall prepare effective contingency plan for potential spill/release of Hazardous Noxious Substance (HNS) including chemical products from ship, terminal and port into sea in accordance with OPRC-HNS Protocol adopted in April 2011.

3) Companies' OSRP in the Pilot Areas

In accordance with the general oil spill response scheme of Iran, the petroleum related companies involved in the offshore operations accompanying potential oil spill risks shall have practicable and effective oil spill response plan (OSRP) at each operational facility.

(a) Mahshahr Area

In Mahshahr area, the Marine Pollution Control & Combating Center, which is the provincial organization of PMO, is in charge of response operation for any oil spill incidents occurred at the sea and the facilities along the coasts in the region. (See figure 5.4.1-6)

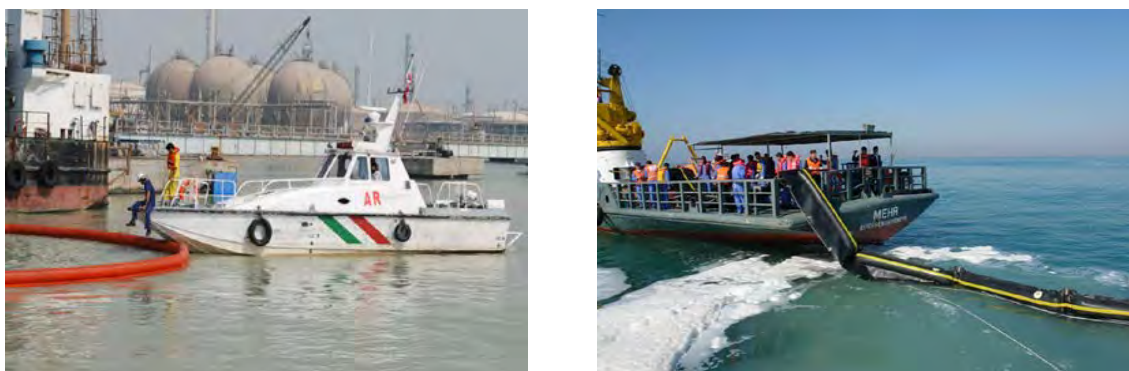
The operating companies of the facilities at the coast such as petrochemical companies, loading terminal operation company, are primarily responsible to initially combat any oil spill. However, the center functions as initial responder of oil spill in the area when notified by an observer of the event or operating company. The emergency response team of the center implements the specific contingency plan of the area using combating members, response equipment and materials prepared in their stockpile and response vessels of the center.

PMO regularly conducts oil spill response exercise in the area with participation of the organizations concerned to the probable emergency event. (See Figure 5.4.1-7.)



Source: PMO presentation material

Figure 5.4.1-6 Oil Pollution Control & Combating Center



Source: PMO presentation material

Figure 5.4.1-7 Oil Spill Response Exercise at Mahshahr

(b) Khark Island

NIOC has two (2) subsidiary companies related to oil operations on the island and offshore oil field development in the region, which are Iranian Offshore Oil Company (IOOC) and Iranian Oil Terminal Company (IOTC). Both companies are responsible for the prevention of the accidental oil spill in their operational activities and adequate emergency response to the event when it occurred unexpectedly.

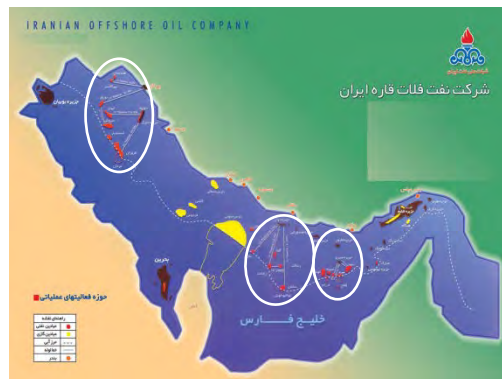
IOOC Oil Spill Response Plan

IOOC established a comprehensive oil spill response plan (OSRP) dealing with the potential oil

spill incidents in the offshore operational zones (Khark, Bahregan, Laval, Sirri, and Kish) in the Gulf as shown in Figure 5.4.1-8. The OSRP is allocated for all oil spills from operations activities and facilities for oil field development such as drilling operation, oil wells, oil production platform, pipelines, crude loading operations.

The OSRP is comprised of 17 sections as follows.

- Introduction
- Objectives
- Definitions
- Regulations
- Activities and covered areas
- Structures, duties and responsibilities
- Risk assessment
- Tiered response
- Report submission
- Training, exercise
- Operational command system
- Operational strategies
- Equipment for protection of marine pollution
- Use of chemicals
- Review and revision of the plan
- Contacts
- Attachments



Source: Study team

Figure 5.4.1-8 IOOC Operational Zones in the Persian Gulf

The OSRP has been developed in accordance with the requirements of the relevant legislations of Iran and international and regional conventions ratified by the government as well as the general oil spill response scheme and strategies defined in the national plan. And this plan defines the responsibilities of IOOC for implementation of the plan for Tier 1 oil spill and the responsibilities of the national response organization (i.e. PMO) for Tier 2 and 3 oil spills.

The OSRP also assumes the oil spill risks accompanied with the operations, which include the possibilities of oil spill from oil wells and crude production facilities and equipment, and subsea pipelines.

The oil spill response team consists of four response groups under the incident controller.

- Operational group
- Incident management Group
- Planning group
- Supply and backup group

The OSRP describes the tasks of each operational group and the response to the escalation of oil

spill tier as well as the practical information and notification procedures for proper communication among all organizations concerned to the plan in order to enable proper decision-making for response. Furthermore, the OSRP specifies the types and numbers of major oil spill response equipment to be prepared at the respective operational zones and the procedure and limitation of use of dispersant chemical.

IOTC Oil Spill Response Plan

IOTC established a local OSRP dealing with possible oil spills in their operational sea areas in the Khark District. The covered area of the OSRP shown in Figure 5.4.1-9 was defined by dedicated coordination with Boshehr Port Authority, which includes operational areas of two (2) crude export terminals (east and west) of Khark Island and the subsea pipeline routes from the island to main land.

The OSRP is comprised of 19 sections and appendices including procedures, forms, and related information necessary for effective response operation.

The sections consist of:

- Introduction
- Goals
- Definitions
- Legal framework to be complied
- Covered areas
- Organization, roles and responsibilities
- Risk assessment
- Tiered responses
- Notification and reporting procedure
- Training and practice
- Response command system
- Response operations
- Response equipment
- Sensitive maritime areas
- Oil dispersants to be used
- Change of response operations
- Coast/ shoreline cleaning and oily wastes disposal
- Language to be used
- Communication methods and contact points



Source: IOTC OSRP

Figure 5.4.1-9 Covered Area of IOTC's OSRP

The OSRP defines tiered response depending on the spill volume of oil at site, which are:

- Tier 1: Less than 80 m³ (500 barrels)
- Tier 2: 80 ~ 160 m³ (500 ~ 1000 barrels)

- Tier 3 Larger than 160 m³ (1000 barrels)

The OSRP describes that Tier 1 oil spill response is responsible to the response team of Khark Island, and Tier 2 oil spill response is commanded by the head quarter of the company with coordination with IOOC. Tier 3 oil spill shall be handed over to regional or national response teams managed by PMO.

The Tier 1 oil spill response is further levelled in three, i.e. Tier 1-1, 1-2 and 1-3 according to spill volume.

The OSRP also defines in detail the response organization and responsible members of the groups and reporting procedure for initial notification and procedure for assessment of the emergency situation as well as command procedure for response operation. In addition, the OSRP shows basic operational methods for dispersant application, containment of oil slicks on water using oil booms and recovery by oil skimmers.

A list of response equipment deployed at the base in Khark Island and contact directories of the members of emergency/ crisis teams in Khark Island and the head quarter of the company are included in the OSRP.

Guide for Local Marine Oil Spill Response Plan

In March 2008, PMO issued a guide for local oil spill response plan (local plan) to IOOC for preparation of the OSRP for Khark Island region covering the crude export terminals of the island.

The guide suggests three main factors for successful local plan, which are

- Risk assessment and application of the results in compiling the local plan
- Assurance of communication and information sharing among all persons involved in the plan
- Creation of a suitable framework for decision-making during response operation

The guide requests that the local plan should solely able to respond to Tier 1 oil spill taking into consideration of the environment and social sensitivities of the region and the results of risk assessment.

(c) Assaluyeh Area

Gas Refinery Complex and Petrochemical Complex

All the production facilities and auxiliary equipment and pipelines of gas refinery plants and petrochemical plants in PSEEZ are located on land in the area. Therefore, it is assumed that the oil spill from the facility in such plant, even if oil spill incident occurred, will not directly affect the marine environment in the region. Accordingly, the SPGC and each petrochemical company, operators of the plants in PSEEZ, have no offshore OSRP.

Product Loading Facility (port facility)

TTPC (Terminal and Tanks Petrochemical Company) is the sole operator of the loading berths of the various liquid and solid products in PSEEZ. Meanwhile, SPGC, the operator of gas refinery complex, is responsible to operate several single point mooring (SPM) berths located several kilometres off the complex areas for loading of gas condensate. Condensate is loaded from onshore storage tanks to tankers through subsea loading pipelines and SPM.

Potential risks of accidental spill/ release of chemical product from loading facility or ship are assumed in the routine loading operation and/ or plying ships in the sea area.

TTPC has established Tier 1 OSRP dealing with potential unexpected spills of fuel oil (heavy fuel and diesel) caused by accident of related vessel as well as spills of condensate and other chemical products, which categorized as hazardous noxious substance (HNS). The response resources of TTPC Tier 1 OSRP are provided to respond to possible 15 tons oil spill, while the National Oil Spill Contingency plan (NOSCP) requires being capable to at least 50 tons oil spill.

On the other hand, SPGC has not been in progress yet for preparation of OSRP dealing with possible oil spill incident in the operational area of SPM condensate loading system.

4) Current Efforts for Strengthening Preparedness for Oil Spill Response

(a) Preparation of Tier 1 OSRP

In order to strengthen the emergency response scheme in Iran, PMO, the responsible organization of the national plan, is making serious effort in preparing sufficient Tier 1 oil spill response, which shall be provided by operators of the source facilities of oil spills. The facilities subject to encouragement include the fixed and floating oil and gas production platforms installed in the Persian Gulf.

According to the national plan, the necessary initial response actions to any oil spill are the responsibility of the operator of the facility regardless of the volume of oil released. The actions to be taken immediately include the earliest notification of the event to the organizations concerned to emergency responses, proper understanding of the oil spill situation and effective initial protective operations for minimizing of the impact arising from the spill.

In May 2010, in the discussion with Ministry of Petroleum (MOP), PMO advised MOP that all offshore oil production platforms shall prepare appropriate Tier 1 OSRP for potential oil or chemical spill into sea. Furthermore, PMO also advised MOP about the minimum oil spill response equipment to be provided on the offshore oil production platform as per Table 5.4.1-2.

Table 5.4.1-2 Oil Spill Response Equipment for Offshore Platform

Row	Type of Equipment	Quantity
1	Open sea boom with rails related	500 m
2	Absorbent Boom	1000 m
3	Disk Skimmer (Depending on the product or platform activity)	1
4	Brush Skimmer (Depending on the platform activity)	1
5	Power pack	1
6	Individual safety equipment	15 full set
7	Pump	2
8	Powerful cleaner for coastal station and a suitable place for washing equipment	2
9	Possibility of using a suitable pier and pipe-laying for coastal reservoirs	50 m ² pier
10	Pollution response boat	1
11	Pollution response special floater, equipped with fire extinguisher	1
12	oil pollution recovery (collection) barge	2
13	Air blower (boom inflation)	500 m ²
14	Sorbent (sheet pad)	20 barrels
15	Dispersant	50 m ²
16	Platform equipment storage	1
17	Coastal replacement 10-ton crane	5000-ton
18	Oil waste materials storage and collection tank Reservoir for land installations (if required)	20-ton, 1
19	Oil materials transfer tanker in land installations (if needed)	1
20	Sea-mop (if needed)	1
21	Weir skimmer	2
22	Portable fire-extinguisher (in warehouse)	2
23	20-ton inflation floating tank	1
24	4 seating, Gemini boats	1
25	onshore clean-up equipment for coastal facilities	
	25-1. Spade	10
	25-2. Mop	10
	25-3. Bucket	10
	25-4. Cannabis bags	10
26	5-ton lift truck, for coastal establishments	1

Source: PMO letter to MOP (No. S-4343 dated May 11, 2010)

(b) Authorization of Tier 1 OSRP

The Tier 1 OSRP for individual oil related facility at local shall be prepared by the operator of the facility in compliance with the requirement of the national plan and related laws and regulation of the country. The Tier 1 OSRP shall identify the area to be covered, applicable response strategies and measures, emergency response organization, roles and responsibilities, information and communication system, response equipment and vessels to be used, as well as training. The effective response strategies and measures shall be decided properly depending on the environmental and social sensitivities of the region and the assessment results of the risk of the potential oil spill on the sensitive areas.

PMO stipulated the rule for authorization of the local Tier 1 OSRP prepared by the operating company of the facility. The draft Tier 1 OSRP shall be submitted to the Oil Pollution Control & Combatting Center of PMO in the province. The Tier 1 OSRP is approved through review of the

center and amendment according to the comments.

The approved plan is integrated into the national contingency plan as part of authorized local plan.

5.4.2 Review of the Existing Oil Spill Response Model

OSRP shall be developed based on the scenarios of possible oil spill accidents assumed in the area and sophisticated oil spill models are practically utilized for writing such appropriate scenarios as a tool.

Oil spill response models have generally two types. One is the trajectory model that can predict probable fates (drifts and weathering) of spilled oil on water varying from hour to hour based on the meteorological and oceanography data of the spill site. The other is stochastic model that can estimate the probabilities of oil spill effects on environmental and social sensitive areas in the region using the statistical data of meteorological and oceanography data.

On the occasion of oil spill event, the trajectory model is utilized for prediction of behaviors and fates of the spilled oil depending on the situations of the event and weather and sea conditions at the site. The predicted information provided by the modeling is used for planning of effective oil spill response tactics and operations.

On the other hand, the stochastic model, which analyzes the movement of spilled oil based on the statistical data of meteorological and oceanography data, can estimate the possibility of spilled oil drifting to some shoreline. The stochastic model allows to estimate the response recourse required for proper shoreline protection according to the grade of an oil spill accident.

(1) Trajectory Model

1) Selecting the Trajectory Model

The existing the oil spill response model in ROPME gulf is following below;

- GNOME and ADIOS2
- OILMAP
- PAJ

GNOME and ADIOS2 are the oil spill models developed by NOAA (National Oceanic and Atmospheric Administration). GNOME analyzes the trajectory of the spilled oil including the simple weathering process. ADIOS2 analyzes the weathering process of the spilled oil in detail. Although these models can be used individually, NOAA recommends to apply according to the purpose by using the combination of both models.

OILMAP is an application developed by Applied Science Associates, Inc (ASA) in the USA. ROPME is using the improved application based on OILMAP. PAJ (Persian Gulf version) is an application developed by Petroleum Association of Japan in Japan.

These models are applicable to predict the trajectory and weathering progress of spilled oil on water in detail.

On the occasion of oil spill, the analyst is required to predict properly and rapidly the probable drift and fate of the oil. So as to evaluate the applicability of oil spill models, it is important to satisfy the following requirements.

- a) Variety of oil types
- b) Availability of marine data
- c) Availability of wind data
- d) Availability of forecast data (sea current, wind data)
- e) Clear/ visible output
- f) Operationality (GIS function, etc.)

Satisfactory to the above items of the aforementioned applications are reviewed as follows.

a) Variety of Oil Types

As follows the oils in the Middle East, an analyst can select the target oil with no trace of hesitation.

b) Availability of Site Data (sea current)

The sea current in the region is one of the largest factors directly affecting the oil drift on water. GNOME has set the wind driven current that was developed based on the oceanographic cruise data provided by ROPME. PAJ has set the average of current based on statistical data. OILMAP needs to optionally input the data for value.

c) Availability of Wind Data

The wind field (direction and velocity) is one of the factors that move the spilled oil on the sea surface. Since it is difficult to set up the exact wind information at the time of incident in the model, some available wind information (dominated wind direction and velocity in the region) should be practically set up in the model. GNOME and ADIOS2, OILMAP are provided with the specific user-interface to accessing the real wind information source available in the region for ease of wind data setting.

PAJ has a function for setting up the necessary wind information manually and automatically and PAJ Gulf version is provided with the statistic wind data of the Gulf region in 2004 originally. However, the user-interface with the regional information source is not equipped with the model so far.

d) Availability of Forecast Data

The forecast data of the wind and current is attractive for users. These data are published via the website “GOODS” by NOAA. NOAA calculates the current field in global scale every day and

presents it with a format of NetCDF and can import to GNOME. The forecast data of the current field is prepared in two types. One is the Global Navy Coastal Ocean Model (NCOM) which resolution is 1 degree. The other is the global HYbrid Coordinate Ocean Model (HYCOM) which resolution is 1/12 degree. For the period of the forecast, NCOM is approximately 5 days and HYCOM is approximately 9 days. Also NOAA calculates the wind field in global scale as with the current field and is publishing the NCEP Global Forecast System (GFS) which is a similar format of the current field. The resolution for the space of GFS is prepared in two types which is 1 degree and 1/2 degree. The resolution for the time of GFS is every 6 hours at 00, 06, 12 and 18 UTC. PAJ applies the wind field of the global scale by Japan Meteorological Agency.

e) Clear/ Visible Output

ADIOS2, OILMAP and PAJ except GNOME are available to output the weathering calculation results in graphs and lists. For the trajectory of the spilled oil, GNOME and OILMAP can indicate in animation figures together with estimated time and amount of the spilled oil for drifting down to the shoreline easily. Meanwhile, since PAJ outputs the calculated drift oil patterns every step time, the user must evaluate the timing for drifting down to the shoreline by visual confirmation. In addition, PAJ has no function to calculate the amount of the spilled oil drifted down to shore.

f) Operationality (GIS function, etc.)

The trajectory of the spilled oil is displayed on the map. For grasping the distribution of the drifted oil, the functional tool for free zooming in and out on the map is quite useful. GNOME and OILMAP have such function. Meanwhile, PAJ has similar function only on the setup screen.

The findings of above review are shown in Table 5.4.2-1.

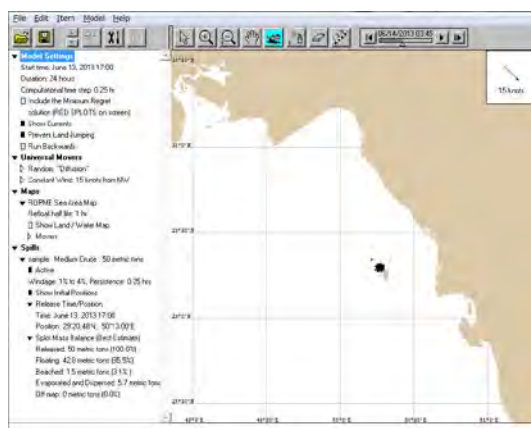
Table 5.4.2-1 Satisfaction Level for each Application

	GNOME and ADIOS2	OILMAP	PAJ
a) Types of oils	✓	✓	✓
b) Current field	✓	X	✓
c) Wind information	✓	✓	✓
d) Forecast data	✓	X	✓ ¹⁾
e) Output	✓	✓	X
f) Handleability (function of GIS)	✓	✓	X

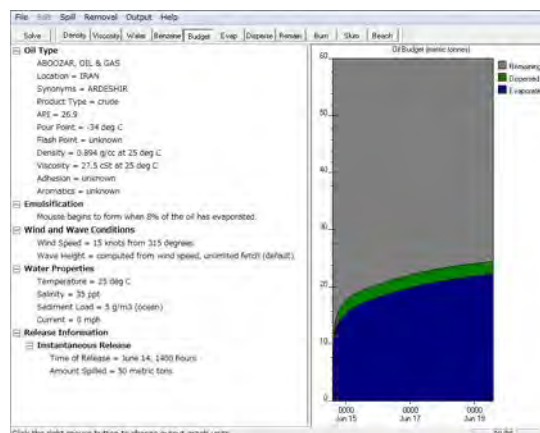
Source: Study team

According to the above, GNOME and ADIOS2 fully satisfied the items required for the purpose. Therefore, GNOME and ADIOS2 are considered as the most applicable oil spill models for ROPME sea area among several candidate models available in the region. The same models are

also introduced by MEMAC. The typical outputs of GNOME and ADIOS2 are shown in Figure 5.4.2-1 and 5.4.2-2 for reference.



Source: Study team



Source: Study team

Figure 5.4.2-1 Output (trajectory) of GNOME

Figure 5.4.2-2 Output (fate) of ADIOS2

In this project, trajectories and fate of spilled oil on water from each pilot area as well as affected coastal areas by the spilled oil were simulated according to the possible oil spill scenarios using GNOME and ADIOS2. The outcomes of the studies are described in **Appendix 5** of this report.

(2) Stochastic Model

Trajectory Analysis Planner (TAP), developed by NOAA, analyzes statistics from potential spill trajectories generated by GNOME and outputs the possibility that any oil spill will reach a specific segment of shoreline. TAP assists with the following planning tasks:

- Assessing potential threats from possible spill sites to a given sensitive location,
- Determining which shoreline areas are most likely to be threatened by a spill originating from a given location,
- Calculating the probability that a certain amount of oil will reach a given site within a given time-period, and
- Estimating the levels of impact on a given resource from a spill.

NOAA's On-Scene Spill Model (OSSM) was used to provide statistics of oil spill movement in the Inner ROPME Sea area from the Strait of Hormuz to Shatt Al Arab. TAP (Persian Gulf version) utilizes data from 126,000 modelled trajectories generated in the following way:

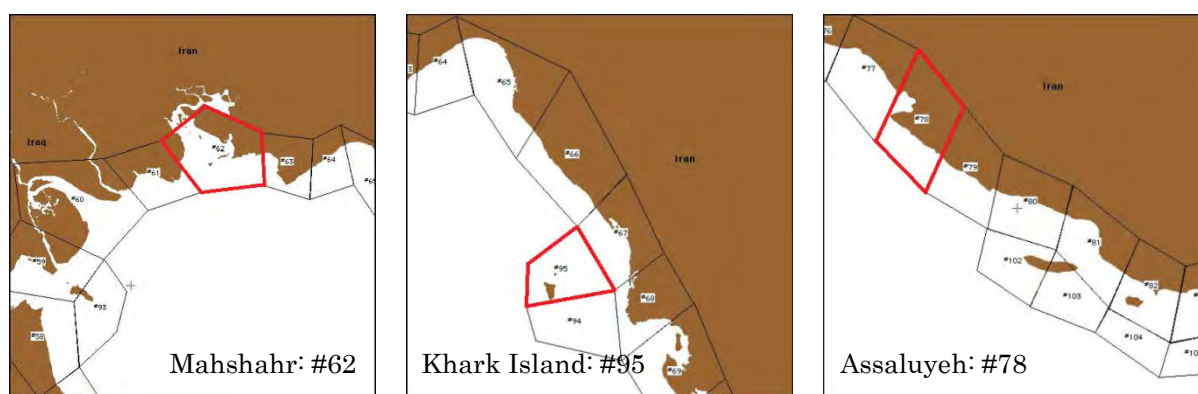
- Number of different spill sites: 126
- Number of seasons: 2
- Number of model runs per start site, per season: 500
- Number of particles used to represent the oil for each run: 1,000

TOP assumes 126 highly possible spill sites in the Gulf region. The 52 sites among them are located in the territorial waters of Iran, which include major offshore crude production fields such as Bahrgan Sar, Nowruz, Aboozar and Foroozan, and the pilot areas of this project such as Mahshahr, Khark Island and Assaluyeh. The locations of these offshore fields and each pilot areas are indicated on the environmental sensitivity maps formatted in TAP. (See Figure 5.4.2-3 and 5.4.2-4.)



Source: Study team

Figure 5.4.2-3 Main Offshore Product Facility in Iran



Source: Study team

Figure 5.4.2-4 Receptor Site of each Pilot Area

The project, using TAP (Persian Gulf version), examined the possibilities of impacts of spilled oils from the above offshore crude production facilities on the environmental sensitive areas along the coasts. The results are described in **Appendix 5** of this report.

It is assumed that depending on the location of the spill source (Bahrgan Sar, Nowruz, Aboozar or Foroozan), the season (November to January or February to October), the probable affected coastal areas would vary largely. In the worst case, it is predicted that 70-80% of probability of impacts on the coasts of north-east end of the Gulf and the center of Bushehr province. On the other hand, it is

also expected that 30-70% of possible impacts on the opposite coasts of the Gulf such as the coasts in Saudi Arabia, Bahrain, Qatar and UAE.

Furthermore, 50-90% of probable impacts on the environmental conservation areas (Heleh, Mond, Seraj, Faror Island, Hara) along the coasts of Iran, and 80% of probable impact on the pilot area (Khark Island) are predicted. Low probabilities of impacts on Mahshahr and Assaluyeh are expected.

5.4.3 Review for Introduction of Remote Sensing System

Although the information about the location and the distribution of the spilled oil on water can be collected by visual observation using boats, it is difficult to do it in rough weather and during night time. To resolve such problems, the remote sensing technology using aircraft and satellite is focused in these decades.

Requirements for oil pollution monitoring from aircraft and satellite are;

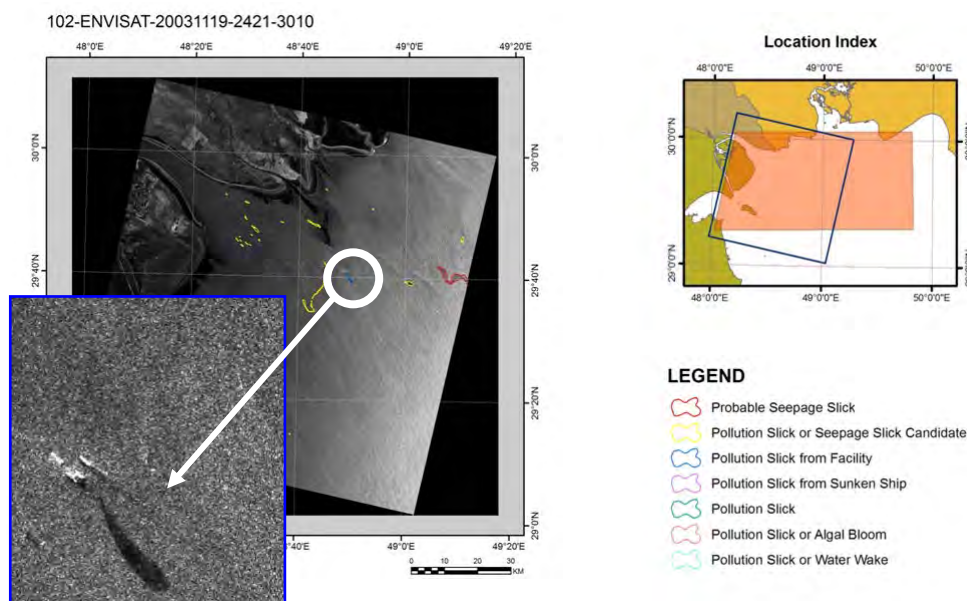
- Applicable in any weather conditions regardless of cloud amount
- High resolution for sensing
- Short returning cycle to the same target location

The synthetic aperture radar (SAR) using microwaves is the one sensor, which satisfies all the above requirements. Expected benefits of introducing remote sensing system for detecting oil on water is described below.

(1) Remote sensing technology when detecting the oil on the sea surface

The oil on sea surface can be detected using the characteristics of backscattering of SAR. The sample of detected oil by SAR are shown in Figure 5.4.3-1. This method is applicable for the exploration of offshore oil field through detecting natural oil seeping from the seafloor and monitoring oil slicks coming from accidental oil spills from oil tanker and others.

On the other hand, it is pointed out that SAR is practically not able to detect the oil on water when the wave condition is higher than 2 m and wind higher than 6 m/s as well as on too calm sea surface.



Source: Study team

Figure 5.4.3-1 The Detected Oil in the Persian Gulf

LANDSAT or MODIS with visual range sensors is available to detect oils on water in the time of clear sky during day time. MODIS with low resolution sensor is suitable to monitor a wide range of sea surface for daily basis.

Aircraft may be possible to cruise in rough weather where boat is not able or allowed to mobilize. The observation by the aircraft flying beneath the clouds in the sky is effective in the clouded condition when satellite sensing is not possible. National Maritime Research Institute in Japan has developed the helicopter-based fluorescence LIDAR using the optical characteristics of oil (macromolecular liquid), that oil produces fluorescence under ultraviolet light.

Through these advanced technologies, it is possible to collect information necessary for monitoring and tracking of oil drifting on water.

(2) Advantages of the Remote Sensing System

1) Satellite

The SAR is the best sensor to detect the spilled oil on water. The satellite constellation plans which operate several satellites on the same orbit are now in progress by the space organizations of each country for enhancement of temporal resolution of the system.

Germany developed the spotter satellite SAR-Lupe and is operating 5 satellites. The private company in Germany operates 2 TerraSAR-X satellites. The spatial resolution of these satellites is below 1m.

Various advanced remote sensing systems using satellites with high spatial and temporal

resolutions have been developed in the world. The data of satellite imageries are strictly managed by the governmental agents and affiliate companies of the respective countries. Accordingly, the procedures for acquisition/procurement of the objective satellite data vary from one country to another.

On the occasion of the emergency case, the time required for acquisition of satellite imagery data, especially for SAR data, are various depending on the orbit/ returning cycle of the satellite. Use of satellite imagery in a large oil spill accident is expected to be subject to the International Charter on Space for Major Disasters in accordance with the agreement to be concluded among related agencies. Furthermore, it is desirable to configure the system for rapid extraction of the suitable satellite imageries for the purpose among numerous existing data stored by each agent through identification of the satellite available at the time and location of the event as well as the orbit and the type of sensor of the satellite.

ROPME, to which Iran participates, is currently in progress for developing the ROPME Integrated Information System (RIIS) formulating the marine environmental information of the ROPME Sea Area. This system includes the Remote Sensing Images Information System (RSIS), which is dedicated to aggregating satellite imageries and other information.

Through future operation of RSIS, it is expected that SAR and optical imagery information could be shared fairly among related countries and utilize such information effectively for the purpose.

2) Aircraft

Aircraft with SAR and optical sensor is available for the observation of oil drift avoiding the clouds which is obstacle for sensing by satellite as well as visual observation and photographic interpretation. The National Oil Contingency Plan (NOSCP) of Iran includes the tactics of monitoring and tracking of oil slicks by aircraft(s) of the National Civil Aviation Organization.

3) Advanced Data Analysis

The observation results from satellite and aircraft are provided as the digital imagery data. Analysis of such observation data requires dedicated software such as ERDAS IMAGINE, ERDAS ER-Mapper and Exelis ENVI. These softwares supports several types of image format and have user-friendly functions for ease of analysis. Meanwhile, since the imagery analysis needs various and sophisticated related knowledge, it is required to train capable experts or specialists in this field.

4) Active use of Information to Oil Spill Modelling

For planning of effective response operations to oil spill, it is necessary to select suitable protection measure(s) depending on probable changes of situations (fate) of oil at the site. For this purpose, more reliable prediction of oil behaviour on water according to varying situation of oil with time is

required to oil spill modelling. Therefore, it is always required to collect and analyse the comprehensive information of the oils at site.

In order to predict probable drift and fate of the spilled oil, it is possible to improve accuracy of modelling results through assumption of more suitable oil spill scenario for modelling in reference to the information and analysis data provided by satellite and/ or aircraft observation.

5) Database

It is generally considered that the source locations of natural seeping of oil from sea bottom and leak of existing subsea pipeline are always constant. Since several satellites equipped with SAR observe periodically on the constant orbits, it is possible to identify the expected locations of natural oil seeping and/ or leaking points on subsea pipelines through database of the observation findings figured on GIS. As shown in Figure 5.4.3-1, probable oil natural seeps and oil leaks from offshore installations as well as ships can be detected by the same technology.

Introduction of ROPME Integrated Information System (RIIS), which aims environmental observation and monitoring of accidental oil spills in the ROPME sea area including the Persian Gulf using satellite remote sensing technology, is now in progress.

It is expected that the needs and use of such accumulated satellite information and database will be further diversified in the future.

5.5. Issues relating to Oil Spill Emergency Response System

5.5.1. Current Situation

Iran has well ratified the relevant international conventions with respect to prevention and combating of the oil pollution in the sea area as well as necessary compensation for the probable damages arising from the emergency events and the regional convention for mutual cooperation for oil spill response among the Gulf countries.

The Port and Marine Organization (PMO) is the responsible authority for the national oil spill contingency plan (NOSCP) of Iran and in charge for the preparation of the necessary framework for implementation of the national plan in accordance with the requirements of the ratified international conventions.

The NOSCP established by PMO defines the primary strategy of 3-tiered response and the organizations in charge of the respective tiers, which Tier 1 is the operator of the spill source facility, Tier 2 is the regional organization of PMO and Tier 3 is PMO with support of MEMAC. PMO has also prepared dedicatedly the emergency response scheme of Tier 2 for regional, and Tier 3 for national level and such schemes are practicable and functional.

However, preparation of Tier 1 for local level of response scheme and necessary preparedness is

still in progress, which is the responsibility of the operator of the facility concerned.

5.5.2. Issues to be Strengthened

(1) Tier 1 Local OSRP

According to NOSCP, Tier 1 OSRP is responsible to the operator of the spill source facility. In the petroleum industry, oil and gas development companies, refinery and petrochemical companies and oil export terminal/ port companies shall establish the local OSRP initially to deal with any oil spill incident at their facilities.

1) Mahshahr

In Mahshahr area, Terminals and Tanks Petrochemical Company (TTPC) is the organization in charge of the initial oil spill response at the product loading facility. However, the regional emergency center of PMO is ready to respond to the oil spill in the area with their response resources stored in the center. For response to spill incident causing from the products loading facility in the area, a practicable paid emergency response scheme has already established among the operating companies and the provincial MOP emergency center.

The operating companies including TTPC are required further strengthening the initial notification and reporting procedure for the emergency center at oil spill event in the area.

2) Khark Island

In Khark Island, IOOC has already developed the comprehensive OSRP covering the whole operational areas in the Gulf. PMO has suggested MOP/IOOC to provide the local OSRP with necessary response resources at each offshore platform for potential oil spill caused by the operational activities. IOTC, the operating company of the crude export terminals of the island, has established a local OSRP covering the sea areas of the export terminals and subsea pipeline routes from the island to the mainland. The OSRP describes emergency response organization, responsible personnel, procedures for reporting and response operations etc.

For further strengthening the oil spill preparedness of the area, it is required to enhance the emergency response scheme of IOOC and IOTC as follows.

IOOC: Development of local Tier 1 OSRPs for each offshore production platform (Aboozan, Forooza) and Dorood oil field and organization of response resources (response personnel and equipment)

IOTC: Review and establishment of collaboration with IOOC OSRPs for mutual aid

3) Assaluyeh

Assaluyeh area has a huge gas refinery and petrochemical complexes along the coast and massive export facility for the petrochemical products and 3 single point mooring (SPM) systems at offshore for loading of condensate. TTPC, operator of petrochemical loading berths, has established a functional Tier 1 OSRP capable to respond 15 tons oil spill. Meanwhile, so far, no OSRP for SPM condensate loading berths has been provided by SPGC, the operator of the facility.

Accordingly, TTPC is required immediately to provide additional response resources capable to respond to at least 50 tons of oil spill in compliance with the NOSCP. Furthermore, SPGC is also required to establish an OSRP with necessary response equipment for SPM loading system.

For establishment of sufficient and effective OSRP for Assaluyeh area, integration of both OSRPs in the same sea area is considered to be practical and more effective. Further discussion between TTPC and SPGC with participation of their mother companies is expected for strengthening oil spill preparedness in this area.

The NOSCP comprising of the 3-tiered response strategy is completed by preparation of practicable OSRPs with sufficient response resources for the respective tiers of emergency, which shall be provided by PMO and operators of the spill source facilities.

As mentioned above, the preparation of Tier 1 OSRPs for each pilot area is still in progress. However, it seems that the progress of preparation of the respective areas varies depending on the different situations of the area. In order to encourage the tasks, it is required to further discuss the following issues among the organizations concerned in the area.

- Consistent awareness of importance of OSRP among the organizations concerned
- Potential oil spill risks on the facility and operation
- Assessment of probable environmental and social impacts caused by the potential oil spill
- Verification of primarily responsible organization for initial response to the oil spill
- Definition of emergency response scheme and strategy in the area
- Establishment of the practicable and effective OSRP with resources
- Integration of Tier 1 OSRP with NOSCP

(2) OSRP-HNS

Iran adopted OSRP-HNS convention in 2011, which is an amendment of OPRC convention and deals with the spills of hazardous and noxious substance (HNS) from ship or offshore facility in water.

The materials with following properties other than oil are considered as HNS except radioactive and infectious substances. Details listed in the convention include as follows.

- Flammable
- Explosive
- Toxic

- Corrosive
- Reactive

The facilities in 3 pilot areas handle and/or produce various materials including HNS. Especially, the petrochemical products of Mahshahr and Assaluyeh area have the above properties and many of them are categorized as HNS. Accordingly, the OSRPs to be provided by the responsible organizations in the pilot areas shall deal with such HNS together with oil.

PMO has launched the study on OSRP-HNS in the national plan. The local OSRP is required to coordinate with the response strategy and procedure of the national plan.

(3) Prevention of Oil Spills

Prevention of unexpected oil spill is the most important issue to be undertaken in the operation of the production facility. The most frequent causes of oil spills in the operation are assumed to be defective facility/ equipment or deteriorated materials and operational failure, etc. Oil spill prevention is secured by adequate quality of the facility and equipment involved in the production and proper operation manners of the facility. Inspection/ monitoring of the quality of equipment and proper maintenance are an effective and essential measures to ensure the reliability of the facility and to prevent possible oil spill due to deteriorated material.

As for prevention of unexpected oil spill, it is necessary to adequately improve and enhance the facility maintenance plans through review of current situations of the related facility and equipment which could causes oil spills.

Especially, for aged facilities and subsea pipelines in Khark District, proper implementation of facility maintenance plan are effective for prevention of unexpected oil spills.

(4) Preparation of Legal Framework

National Oil Spill Contingency Plan (NOSCP) stipulates that the operating company is fully responsible to prepare and implement the emergency response plan dealing with any possible oil spill from oil and gas development facility.

Since oil spill, if occurred, may cause serious environmental pollution of adjacent sea areas and coasts and impact on local industries including fishery, the operating company is required to preliminarily ensure finances necessary for clean-up and recovery of environmental impacts as well as compensation for the socio-economic damages.

In the progress of privatization of oil industries, the earliest review and preparation of relevant laws concerning liabilities of operators of source facility to potential oil spill and preparation of finances for response operations and compensation for probable damages are required accordingly.

6. Strategies for Master Plans

6.1. Issues Identified

As discussed in the previous chapters, some issues related to the environmental management in the target areas were identified. These issues can be classified into two aspects: environmental management systems and negative impact on the natural environment. Table 6.1-1 summarizes the issues identified.

Table 6.1-1 Summary of Issues Identified

Aspect	Issue	
Environmental management system	Overall and organizational levels	• Lack of strategy and plan • Inappropriate HSE implementation structure • Insufficient resource allocation to environmental management • Lack of coordination and collaboration • Weak implementation structure of EIA
	Pilot sites	• Variation of the management systems • Inappropriate environmental monitoring method • Weak authority of zone management company
Environmental conditions	Mahshahr	• Emission of flue gases with smokes • Discharge of wastewater exceeding the effluent standard for COD and mercury • Insufficient environmental monitoring systems
	Khark Island	• Excessive flare gases burning with smokes • Wastewater discharge with excessively high oil contents to the sea • Oily contaminated soil (Catchment basins areas) • Improper waste management (drill cuttings) • Not integrated environmental monitoring systems in the industrial zone
	Assaluyeh	• Heavy air pollution caused by emissions of various flue gases and fugitive gas • Tendency of degradation of seawater and sediment qualities due to wastewater discharge to the sea • Lack of comprehensive environmental monitoring systems in the whole industrial area

Source: Study team

6.2. Necessity of a Comprehensive Plan for the Petroleum Industry

The MOP expects to promote foreign investment in the petroleum industry after lifting the economic sanctions. In order to realize the investment, the MOP should have a comprehensive plan to accelerate the environmental management in the industry and to respond oil spills in the Persian Gulf. Preparing the Master Plan for the Environmental Management will contribute to catering for the requirement from foreign investors.

Besides, the Fifth Five-Year Economic, Social and Cultural Development Plan is considered as a superordinate plan for the Project. The Development Plan provides the responsibility of the MOP and petroleum companies to follow and monitor the health-security and environmental standards. In addition, the petroleum companies also should follow the strategic environmental evaluation system and self-declaration statement system for environmental monitoring. The output from the Project will contribute to clarifying the responsibility of the MOP and petroleum companies to fulfill the responsibility stipulated in the Development Plan for environmental management in the marine and coastal area of Persian Gulf and providing clear targets/objectives to realize the Development Plan.

6.3. Formulating the Master Plan

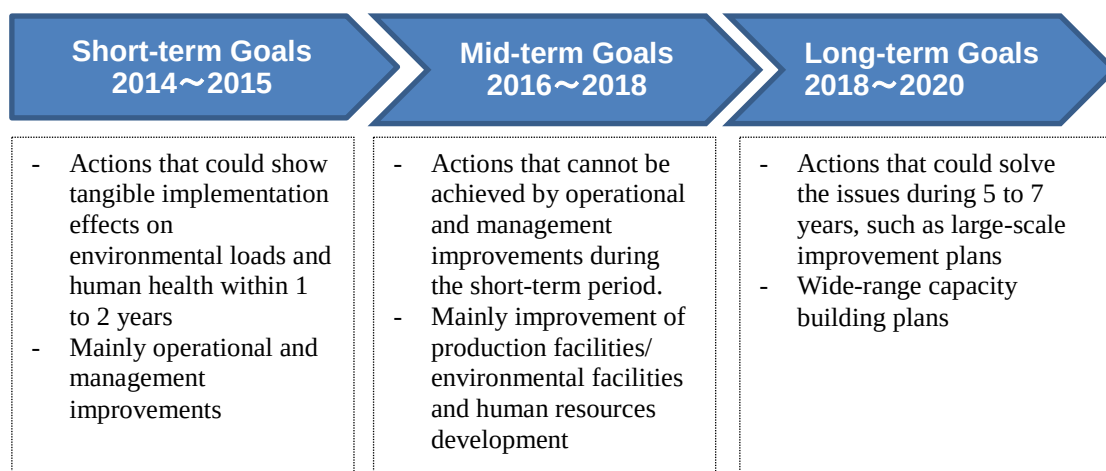
6.3.1. Setting the Basic Policy of the Master Plan for Environmental Management

The basic policy is set in light of the identified issues shown in Table 6.1. The policy consists of three components: institutional framework of the management systems, environmental monitoring systems and environmental protection measures.

- Policy 1:** Strengthening the environmental management through effective environmental technologies and practical HSE activities applicable to the operation sites
- Policy 2:** Mitigating the environmental loads through introducing the best practices among the technologies utilized, based on the technological trends in the world and oil producing countries in the Persian Gulf region
- Policy 3:** Promoting adequate environmental conservation measures through enhancing environmental monitoring systems, appropriate assessment of monitoring data and sharing information among the organizations concerned

6.3.2. Setting the Periodized Goals

The economic sanctions will affect realization of the Master Plan. Some actions described in the Master Plan may require several years for the implementation, depending on the technology utilized. Therefore, setting the periodized goals helps the HSE-MOP and the petroleum companies to take the actions described in the Master Plan and to evaluate the performance periodically. The periodized goals consists of three phases: short-term for the period 2014 to 2015, mid-term for the year 2016 to 2018 and long-term for the year 2018 to 2020. Figure 6.3.2-1 shows the periodized goals and duration for each term.



Source: Study team

Figure 6.3.2-1 Road Map to Realize the Master Plan

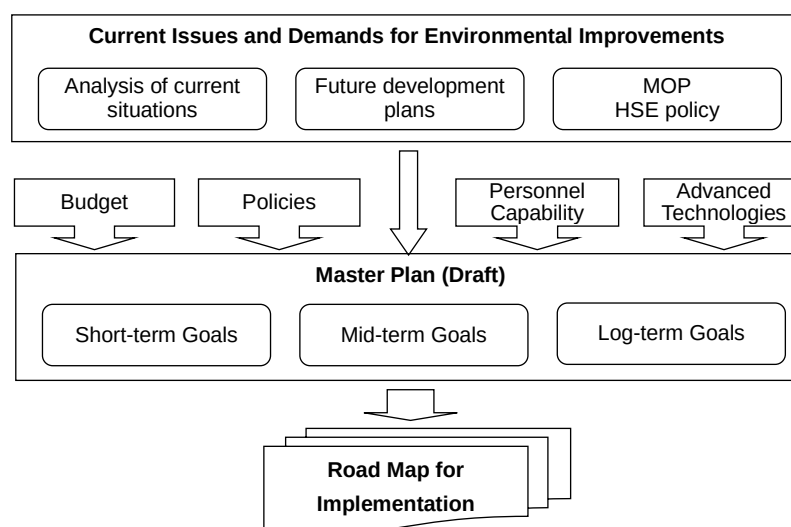
6.3.3. Preconditions and External Conditions

As discussed in Section 2.4, a series of the current economic sanctions adopted internationally to Iran affect the introduction of advanced technologies in the country. Some technologies, facilities or equipment for reduction of environmental pollution, can be introduced only after termination of the economic sanctions. The way toward loosening the economic sanctions, however, is unforeseeable at this moment. What is important is to develop viable plans, considering preconditions and external conditions. Therefore, the priority for formulating the draft master plans is given to reviewing the existing operation procedures of facilities and institutional framework. The advanced technologies are introduced as the future options.

- **Preconditions:** The draft master plans focus on reviewing the existing operation procedures of facilities and institutional framework.
- **External conditions:** The international economic sanctions to Iran cause obstruction to introducing advanced technologies from the western countries and Japan.

6.3.4. Process to Formulate the Master Plan

Figure 6.3.4-1 shows a formulation process of the Master Plan for strengthening environmental management of petroleum industry in the marine and coastal area of Persian Gulf including pilot areas.



Source: Study team

Figure 6.3.4-1 Process of the Draft Master Plan Formulation

The items of the process of the draft master plan formation are shown below:

- (i) Identification of issues of current environmental management and environmental situations in the pilot areas, and demands for strengthening and improvement of them through analysis of current situations and definition of HSE policy of MOP for the issues considering future development plan of petroleum industry.
- (ii) Consideration for budget and policies necessary for implementation of the master plan
- (iii) Capacity enhancement of organization concerned and personnel to be involves
- (iv) Study on applicable advanced technologies
- (v) Formulation of master plan based on goals set in short-term, middle-term and long term
- (vi) Setting of road map for achievement of goals

6.3.5. Basic Concept of Each Component

(1) Institutional Framework

1) Comprehensive Environmental Management Policy in the Petroleum Industry

The current HSE policy of the MOP has not been reviewed since establishment of the HSE-MOP. Besides, any implementation plan to realize the policy and method to evaluate the achievement has not been developed. The MOP does not have a clear direction to guide and support the environmental management of the petroleum companies. The lack of initiative by the HSE-MOP is one of the causes that lead to stagnation of the environmental management in the country.

Therefore, it is necessary to review the current HSE policy of the MOP, examine the environmental objectives and develop a methodology to achieve the objectives.

2) Roles of the MOP and Mother Companies

The roles, authorities and responsibilities for the environmental management of the MOP that supervises the entire petroleum industry in the country as well as the national companies and its subsidiaries have not been clearly defined. The national companies demonstrate a tendency to shrink the scope of supervisory power against the privatized companies in response to the progress of privatization of the subsidiaries. To implement the appropriate environmental management in large scale development projects as seen in Mahshahr and Assaluyeh areas where various companies together with several national companies and its subsidiaries have been participating in, it is necessary that effective environmental measures under the strong initiative of the HSE-MOP should be taken in accordance with a consensus on the environmental policies shared by all the participating organizations in the projects. In addition, the implementation of such measures requires clarifying the responsibility and authority of the HSE-MOP as a supervising entity and the national companies, together with making clear the obligations of the companies participating in the projects to the environmental management. For that purpose, formulating related laws and regulations or revising the prevailing ones might be required.

3) Strengthening the Environmental Management Systems

The HSE-MOP is affiliated to the Engineering and Internal Construction Division in the Ministry, while the HSE department of each national company is an independent unit and is positioned at the same level of other departments. The HSE-MOP and the HSE department of each national company have several sections and the environmental protection unit is responsible for supervising the environmental management activities conducted by the subsidiaries.

The number of staff deployed to the HSE department is quite limited in the national companies and its subsidiaries: one person to each section or one to some sections. The organizational structure is far from satisfactory for appropriately supervising/controlling the environmental management of the national companies and its subsidiaries. Appropriate number of human resources should be allocated to the HSE department to fulfill the responsibility.

Managers and staff members of the HSE department in the national companies and its subsidiaries have acquired basic knowledge about environmental management through various internal education programs. Opportunities for practicing the theoretical methods in each field, however, are quite limited. Furthermore, they are given very limited access to the latest information about advanced technologies in the petroleum development, production and environmental management. This causes fewer opportunities to be exposed to new environmental management technologies and the international trend on the HSE management.

There is no feedback on environmental management technologies from the HSE department to the technical departments such as engineering and production control. The plan–do–check–act (PDCA) cycle of the HSE management systems does not work across the company.

Therefore, it is necessary to provide practical trainings that are applicable for each field in order to develop the competence of responsible staff members including managers. Besides, a system to promote the collaboration and coordination across the organization should also be established.

4) Strengthening Coordination Scheme in Pilot Areas

The national companies and its subsidiaries, under the supervision of the MOP, have established and operated their own HSE management systems. Some companies have adopted management systems pursuant to ISO or similar systems, however, their management systems vary from one company group to another. This has prevented the companies that operate in a region cooperating with each other in conducting collective actions for the environmental protection. One company group or individual company has its own working field and it is impossible to adopt the completely same management systems. The companies participating in a development project in a region, however, can have common environmental objectives. To achieve the objectives, an appropriate management system that specializes in collaboration of the environmental activities should be established and operated in the area.

5) Environmental Impact Assessment

Large-scale development project must forecast and assess comprehensive environmental impact on the whole development site at the planning stage as well as take appropriate measures for prevention and mitigation of environmental impact based on the result of the assessment, which has become the worldwide trends. In Iran, environmental standards and emission standards established by the DOE and IPS of the MOP have been applied to all petroleum and gas development project and operation of plants. Although petroleum companies have made efforts to comply with these standards, there are some areas where serious air pollution occurs.

This is because of cumulative impact of air pollutants discharged from plants (emission sources) within the same area and it is impossible to avoid or mitigate the pollution only by complying with existing emission standards. There are areas where cumulative environmental impact is expected along with the expansion of complex plants in future, a system which updates with, or complements to existing emission standards, are considered as well as review of implementation structure.

(2) Environmental Protection

1) Air Pollution Prevention

Main factors of air pollution are considered to be emissions of flue gases from the flare stacks burning out the surplus gas and off-gas from each plant and combustion equipment such as boilers and heat furnaces, as well as the diffusion of fugitive harmful gases from facilities in the plants. At the same time, there is a projection of further increase in the cumulative environmental pollutions in area where its development plan is in progress. The actions to be considered are effective environmental measures towards control and mitigation of the current air pollution, minimization of the environment pollution that is estimated to further continue in the coming period, and its prevention.

It is well recognized that one of major causes of regional air pollution and the largest GHG emission source in upstream petroleum industry is flare stacks. Accordingly, the major oil producing countries in the world including the Persian Gulf region have been confronting with measures for flare gas minimization and “zero” flaring as ultimate solution.

In light of such trend of oil industries in the world, applications of flare gas minimization and zero flaring as an effective air pollution preventive measure will be seriously discussed in the master plan.

2) Water Quality Conservation

In Khark Island area, the produced water (associated water or formation water) has significantly increased in amount due to the aging of oil fields, while it is observed that the existing wastewater treatment facilities are lacking the treatment capacity to cope with the increased produced water and untreated wastewater is obliged to discharge inappropriately to sea. Along with appropriate wastewater treatment facilities being developed, water quality conservation in the neighboring sea areas requires a review and re-construction of the comprehensive wastewater treatment system.

The upstream oil sector in Iran contains many offshore oil fields and further increase of produced water is expected in future. The alternatives to sea discharge for are ultimate disposal into underground aquifer by injection of treated produced water and reuse of treated produced water for increase of crude production (EOR) by injection together with seawater into the targeted oil reservoir. For application of these methods, in addition to engineering for injection facility, dedicated analysis of underground stratum and oil reservoir as well as feasibility study are essential.

In each pilot area, apparent impacts by the industrial wastewater discharged from the plants have not been observed in the water quality and the bottom sediments of the neighboring sea areas. However, some parts of the wastewater outfalls showed a contamination tendency which is considered to have been caused by the wastewater from the plants. In the coming period, the

proceeding environmental pollution is expected to continue due to the increase in the wastewater sources along with the expansion of the complexes. It is necessary to comprehend the amount of wastewater and the environmental conditions in the neighboring sea area, to forecast the cumulative environmental impacts due to the increase of such wastewater in the future, and to consider relevant measures to mitigate those impacts.

3) Waste Management

The drilling of new oil & gas wells and the work-over (rehabilitation and maintenance) of existing oil wells are frequently conducted in offshore oil fields. A big amount of the drill cuttings are generated through the drilling operation and work-over of oil wells. The drilling works will increase along with the proceeding development plans in the coming period. These drill cuttings used to be disposed directly in the sea, while some of them contain oil contents. This has been counted as one of the main reasons for the marine pollution accompanying the offshore oil and gas field developments. Taken into account the increase in the well drillings operations in the sea in the coming period, it is required to consider appropriate treatment methods for drill cuttings, together with promoting the realization of non-oily drill cuttings through the utilization of non-oil based drill mud in drilling operation.

6.3.6. Policy of Oil Spill Response Plan (OSRP)

(1) Roles of Petroleum Industry in National Oil Spill Contingency Plan

Iran ratified the international conventions for the framework for prevention of oil pollution and response, liability and compensation for the environmental and economic damage caused by oil spills and the regional convention for cooperation in combating major incidents of marine pollution by oil spills among the countries along the Persian Gulf. According to the requirement of such conventions, the Port and Marine Organization (PMO) was nominated legally as the National Responsible Authority for the OPRC convention. Then, the PMO have subsequently developed the National Oil Spill Contingency Plan (NOSCP) as per requirement of the convention.

The primary strategy for NOSCP is in the form of a “Tiered Response” consisting of three (3) tiers depending on the scale of the oil spill/ probable extent of marine pollutions, which defines the responsible organizations for respective tiers such as Tier 1 (small oil spill) to the operator of spill source facility, Tier 2 (medium oil spill) to the provincial PMO branch and Tie 3 (large oil spill) to PMO with support of MEMAC.

Accordingly the NOSCP scheme stipulates that the operating company/ organization of the facility are responsible to take Tier 1 oil spill response. The responsible organizations for Tier 1 oil spill response in oil and gas industry are operating companies of oil and gas development, oil refinery,

petrochemical plant, oil export terminals and other related facilities. Accordingly, they are required to develop practicable OSRP to deal with initial response to any oil spill occurred in their facility and Tier 1 oil spill response operation and to provide functional response organization with sufficient resources to possible emergency situation. Therefore, the Master Plan shall discuss the enhancement of Tier 1 OSRP to be prepared by the operating companies of oil and gas industry. In addition, the Master plan shall also discuss the roles of Ministry of Petroleum (MOP), the superior authority on oil and gas industry, for the enhancement of the emergency response scheme of the sector including the affiliate national corporations and operating companies as well as preparation of domestic legislation relevant to OSRP development, recovery of environmental and social impacts as well as compensations for the damage caused by probable oil spill.

(2) Procedure for Discussion

Procedure for discussion of Master Plan for OSRP enhancement is proposed below.

- Oil and gas development plan of Persian Gulf and coastal region
- Study on potential oil spill risks associated with the development and operations
- Prediction of environmental and social impacts of oil spill (oil spill modeling)
- Discussion of basic policy of oil and gas sector for emergency response
- Discussion of effective emergency response system, organization and information procedure
- Study and discussion of effective response strategy and protective measures
- Study on preparation of response equipment and personnel
- Study on environmental recovery and compensation for socio-economic damages caused by oil spill
- Training and exercise planning
- Preparation of legal framework for emergency response and compensation

For development/enhancement of OSRPs for each pilot area, reference shall be made to guideline or instructions of PMO, authority of the NOSCP, and related international organizations.

7. Master Plan for Environmental Management

7.1. Introductions

In general, environmental management system consists of two major elements, which are institutional system and management planning. The former is a mechanism for proper management for implementation of environment plans, and the latter is means for achievement of environmental policy and goals of the organization, which include measures for prevention and mitigation of possible environmental effects caused by petroleum development activities as well as maintaining preferable environmental conditions in the areas affected by the activities. These two (2) elements are important to manage the activity of environmental control.

Study on strengthening present marine and coastal environmental management of petroleum industry in Iran, which is the objective of the project, started from identification of the issues to be improved by survey of current situations of the management framework in petroleum industry and environmental conditions in each pilot area (Chapter 3 and 4). Then, based on the findings of analysis on the situations, after defined strategy of the master plan (Chapter 6), applicable solutions for respective issues were dedicatedly discussed among the JICA study team, MOP and representatives of each pilot area.

According to above discussions, Chapter 7 (this chapter) was formulated the results as a master plan (draft) aiming to develop practicable and effective environmental plans and implementation.

The major issues to be dealt by the petroleum industry in the proposed action plans consist of following four (4) areas of environmental management.

- (i) Environmental Management Plan
- (ii) Organization and Systems
- (iii) Environmental pollution control
- (iv) Environmental monitoring

Those action plans on above four (4) areas were summarized in the chapter 9, and each action plan was specified the role & responsible bodies and the schedule of achievement goal.

7.2. Environmental Management Plan

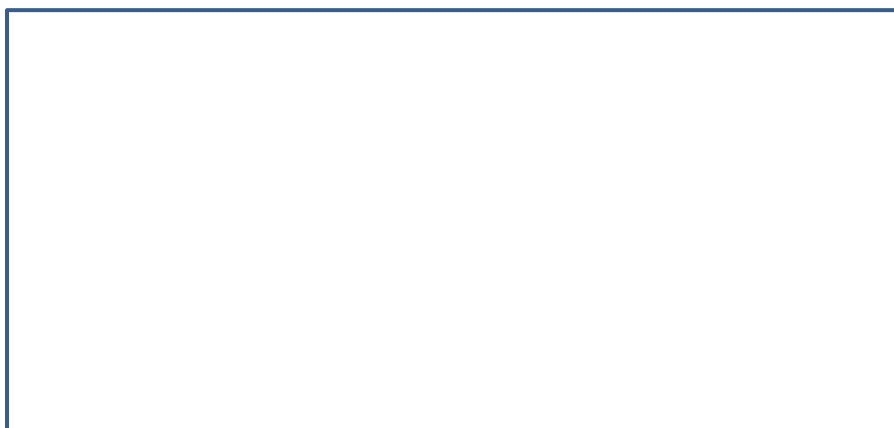
7.2.1. The Basics of Environmental Management

The basis of environmental plan is to start from defining of HSE policy and goal, and followed by environment planning necessary for implementation of the policy and achievement of the goal,

establishment of practicable environmental management system and proper implementation of the plan through operation of the management system.

For this purpose, the petroleum industry of each country has developed their environmental management system and pollution emissions control and prevention technologies in light of lessons learnt from the past environmental pollution problems and disasters. This subsection, referring to these lessons, identifies the issues which Iranian petroleum industry is confronted with and proposes a basic policy for solving the issues.

A process of environmental impact is presented in Figure 7.2.1-1, which is comprised of “Cause”, “Change of state” and “Effect”. The cause of environmental impacts of petroleum industry is emissions of pollutants from plant operation into environment (air, water, soil) and accidental release of pollutants. Then, emission/ release of pollutants change environmental quality and consequently impacts on health of workers in the plant and residents as well as ecology in the affected area.



Source: Study team

Figure 7.2.1-1 Environmental Impact process

Environmental management of petroleum industry aiming prevention of environmental pollution due to emission of various pollutants is deeply related to integrity of facility design and operations which secures safe plant operation. Accordingly, for implementation of environmental plan, a form of HSE integrated health (H) and safety (S) management and environmental (E) management is effective for petroleum industry and it is required to develop a comprehensive HSE management plan based on clear HSE policy defined by the operating organization.

The following subsections will describe how each foreign country adopts these HSE policies, which will be served as references for discussion of basic concept for environmental management in the master plan.

7.2.2. Lessons Learnt from the Petroleum Industry in the Developed Countries

For discussion of effective environmental management policy and development of environmental plan in petroleum industry, it is helpful to refer the experiences and performances of environmental measures taken in Japan, the USA, European countries and the oil-producing countries in the Persian Gulf region. These countries have enacted strict environmental permit systems along with environmental impact assessment system, supervision and inspection by authorities as well as duty of environmental monitoring and reporting. In addition, these countries have also stipulates obligations to comply with emission/ discharge standards, penal rules to violation of the standards and tax break for implementation of effective environmental measures (incentive and disincentive schemes).

On the other hand, through collaboration with related companies in the region, the authorities have gradually prepared effective environmental pollution prevention system according to performance of the environmental measure undertaken. And then, during last several decades, they have successfully achieved significant mitigation of environmental impacts by reduction of pollutants discharged/ emitted from various industries in the region including petroleum sector.

The lessons learnt in these countries are considered to be good references for improvement of HSE management scheme of petroleum industry in Iran. The experiences in selective countries are presented below.

(1) Japan

Japan successfully achieved rapid economic growth in the 1950s - 1970s but started to suffer from serious industrial pollution. Well-known serious pollution cases include mercury poisoning in Minamata and Niigata, asthma related to pollution caused by petrochemical plants and oil refineries in Yokkaichi and Kawasaki cities, and heavy-metal (cadmium) poisoning in Toyama.

To deal with these pollution diseases, in the first half of the 1970s, the government laid down a series of strict regulations for sources of environmental pollutions in the industry, launched economic incentives and tax exemptions to prompt the industry to introduce environmental pollution prevention facilities, as well as a scheme requiring private companies to create an official post of pollution prevention administrators. There are quite a few criticisms against Japan's measures of the time, claiming that they relied on advanced "end-of-pipe" technology. Even so, the key to the success was that the country did not directly regulate environment pollution prevention technologies, leaving development of such effective technologies to the industrial circles of the private sector through administrative guidance by the presiding ministries and agencies, and municipalities.

Workshops of this study and training programs in Japan introduced the measures undertaken in each area as successful cases of reducing air pollutions. Subsection 7.4.2 gives the technical

information, which is applicable to air pollution in Assaluyeh.

Another unique feature of Japan's pollution control scheme is area specific agreements between private companies and local authorities. The approach taken in Japan at the time was fairly effective, gradually settling the serious industrial pollution problems. This is seen in Japan's high environmental efficiency compared to other industrialized countries (for example, in terms of pollution load per GDP). As the serious environmental pollutions from industrial complexes were being settled, the focus of environmental management of the petroleum industry was shifted to development of energy-saving technologies to deal with the "oil shock" in the 1980s, an improvement in the quality of local living environment in the 1990s, and global environmental issues involving resource recycling and CO₂ emissions reduction as well as sustainable development in recent years.

(2) The USA

In the USA, the significant momentum of environmental protection gathered in the 1960s, resulting in the enactment of the National Environmental Policy Act in 1969, establishment of the Environmental Protection Agency in 1970, and revisions to and enactment of the Clean Air Act and the Clean Water Act establishing the basic structure for regulations based on environmental pollution prevention technologies. For example, the Clean Water Act incorporated the system of permission to industrial effluent discharge known as the National Pollutant Discharge Elimination System (NPDES), successfully introducing regulations based on the environmental pollution prevention technologies of two levels: that is, the best practicable-control technology currently available and the best available technology economically achievable. The regulations enabled the country to reduce pollution in the petroleum industry, which particularly led to a substantial reduction in air pollutant emissions.

Another aspect of environmental management in the USA is heavy reliance on the legal system. Because of the past experiences that a vast amount of cost was incurred for environmental protection, not just the commitment of the EIA but also a risk assessment system to evaluate economic loss was introduced and used for construction of a new petroleum facility. The current risk assessment method used in the petroleum industry is a revision to the system.

Among legal cases in recent years, the Gulf of Mexico oil spill disaster in April 2010 caused a considerable amount of compensations for massive socio-economic and environmental damages due to the disaster, so that the safety and environmental risk assessment for possible incident associated with well drilling operation for oil field development have been important factor for the HSE activities.

Through wealth of experience in various petroleum operations, the petroleum industry in the USA has built a unique HSE culture according to strict social requirements for health, safety and

environment. Reflecting such experiences and requirements for the industry, the American Petroleum Institute (API) has established various standards and guidelines as recommended practices (RP) for not only technical areas, but also safety and environmental protection as well as risk management. These standards and RP are adopted widely by many oil companies, which are recognized as major HSE trends in petroleum industry in the world along with a series of environmental standards enacted by Environmental Protection Agency (EPA) of the USA.

Hence, it is effective for improvement of HSE management in Iranian petroleum industry to grasp the latest attitudes and behaviors of these institutes and to refer their standards and practices.

(3) The European Union

The EU countries have worked together for unification of EU environmental laws and standards and each country revises their environmental laws and regulations complying with the EU requirements. The environmental scheme of the EU basically consists of the integrated pollution prevention and control (IPPC) and the eco-management and audit scheme (EMAS), both of which are based on the BAT principle. In the wake of a serious fire accident and incidents occurring in the course of oil fields development of the North Sea since the 1970s listed below, the petroleum development industry in the region started to consider the measures for safety and environmental management and set out various safety and environmental management schemes after 1995, which are the basis for current HSE management system practically adopted to petroleum industry in the world.

- 1988: Piper Alpha fire & explosion accident on offshore platform
This accident has served as a trigger to formulate a scheme of “Safety Case” study and proper risk management through operations risk assessment in the offshore oil field development activities in UK.
- 1991: Tax for air and water pollutants in Norway
For conservation of marine environment and fishing resources in the North Sea, offshore oil operation companies are required to further control pollutant emissions into the environment in the region through amendment of the environmental taxation from concentration basis to total amount basis.
- 1996: Decommissioning for Brent Spar offshore facility in North Sea, UK
Oil pollution due to an inadequate decommissioning manner for offshore oil production facility has motivated further enhancement of the corporate social responsibility (CSR) among oil companies in the region.

From experiences of various disasters and incidents involving between the 1965 to the latter half of the 1990s, the environmental protection measures in the oil industry in each country has

transformed to the current environmental management system and pollution prevention technologies.

For strengthening environmental management in Iran, it is necessary to enhance the comprehensive HSE activities along with safety standards of production facility, and operational risk management in light of these experiences.

7.2.3. Lessons Learnt from the Persian Gulf Countries

The environmental management plans of petroleum industry in each oil-producing country in the Persian Gulf region are gradually improved by introduction of the specific HSE management system to oil sector and BAT principle with assistance of the international major oil companies involving in the development projects, but the progresses are different among the countries.

The most advanced country in the region is Abu Dhabi in UAE, where the practicable HSE system and functional procedures have been well prepared.

Subsection 3.5 outlines the HSE system of Abu Dhabi National Oil Company (ADNOC). The ADNOC adopted a new HSE management system similar to the international major oil companies (BP and others) in 1990s. Since that time, they improved the proper HSE system to meet the climate and culture of Abu Dhabi with the experience of some two decades in operating the system, and is now equipped with its own well-developed environmental codes and practices, manuals, EIA procedures, audit system and so on.

The petroleum industries of Abu Dhabi are located in the Persian Gulf, which is similar situation to Iran, so that, it is assumed that the HSE system of ADNOC could be a good reference for improvement of the HSE management system in Iran.

7.3. Institutional Framework

7.3.1. Strategy for Environmental Management and HSE Implementation

As discussed in “Section 3.3 Environmental Management Policy and HSE Management System”, the national HSE policy has not been reviewed since its introduction. Besides, the MOP has no plan to realize the policy and does not develop measures to monitor and evaluate progress of the policy implementation. Based on the result of interview surveys with the relevant organizations, site visits and capacity assessment of the petroleum companies, the issues related to the institutional framework can be sorted as follows :

- Lack of strategy and plan
- Inappropriate HSE implementation structure
- Insufficient resource allocation to environmental management
- Lack of coordination and collaboration
- Weak implementation structure of EIA

To solve the issues, as the first step, the HSE-MOP should develop the strategy to strengthen the implementation structure of environmental management and to realize the national HSE policy. The strategy to address the issues mentioned above are the “Six Points Agenda for Environmental Management in the Petroleum Industry” shown in Figure 7.3.1-1. The Agenda includes six strategies: 1) reorganizing the HSE management structure, 2) promoting HSE culture development, 3) formulating specific regulations for the environmental protection in the petroleum industry, 4) rationalizing resource allocation, 5) improving the EIA implementation procedures, and 6) promoting capacity development at all levels.

Strategy 1 Reorganizing the HSE management Structure is related to all the issues. Without appropriate management structure, the national HSE policy cannot be achieved. Strategy 2 Promoting HSE Culture Development is also indispensable to realize the HSE management systems. It will lead to a change in mind-setting of stakeholders and will contribute to accelerating the following strategies. Strategy 3 Formulating Specific Regulations for the Environmental Protection makes clear the authority and obligation of key players on the HSE implementation in the petroleum industry. This strategy also provides a vision to control the environmental protection activities in industrial areas. Strategy 4 Rationalizing the Resource Allocation gives clear pictures of environmental protection technology and resource allocation. Strategy 5 Improving the EIA Implementation Procedures provides a direction to strengthen the implementation structure of EIA. Strategy 6 Promoting Capacity Development at All levels indicates the training contents required to strengthen the capacity to implement the master plan.



Source: Study team

Figure 7.3.1-1 Six Points Agenda for Environmental Management in the Petroleum Industry

This section describes the strategy in detail and actions to be taken by the MOP and the petroleum companies. Table 7.3.1-1 shows the breakdown of the Six Points Agenda.

Table 7.3.1-1 Breakdown of the Six Points Agenda

Strategy 1	Reorganizing the HSE management structure
Action 1-1	Improving the organizational structure of the MOP
Action 1-2	Strengthening the capacity of Environmental Protection Section of the HSE-MOP
Action 1-3	Redefining roles of key players on the HSE management
Action 1-4	Developing the supervisory structure of the HSE-MOP
Action 1-5	Delegating the authority of environmental management
Action 1-6	Rationalizing the HSE implementation structure
Strategy 2	Promoting HSE culture development
Action 2-1	Pointing a direction of the HSE culture development
Action 2-2	Encouraging the petroleum companies to evaluate the HSE culture development
Action 2-3	Promoting Coordination and Collaboration across the Company
Strategy 3	Formulating specific regulations for the environmental protection
Action 3-1	Identifying the legal framework to be followed by the petroleum industry
Action 3-2	Institutionalizing the “One Zone One Management Principle”
Action 3-3	Implementing environmental management based on an environmental hazard map
Action 3-4	Introducing a measure to control the total emission in one industrial zone
Strategy 4	Rationalizing the resource allocation
Action 4-1	Identifying the operational level of plants from the environmental protection perspective
Action 4-2	Introducing advanced technology to reduce the environmental loads
Action 4-3	Evaluating the effect of resource allocation to the environmental protection
Strategy 5	Improving the EIA implementation procedures
Action 5-1	Developing specific EIA guidelines and check list for the petroleum industry
Action 5-2	Developing specific SEA procedures for the petroleum industry
Action 5-3	Developing specific CSR procedures for the petroleum industry
Strategy 6	Promoting capacity development at all levels
Action 6-1	Planning the staff deployment and setting the target years
Action 6-2	Planning education and training programs

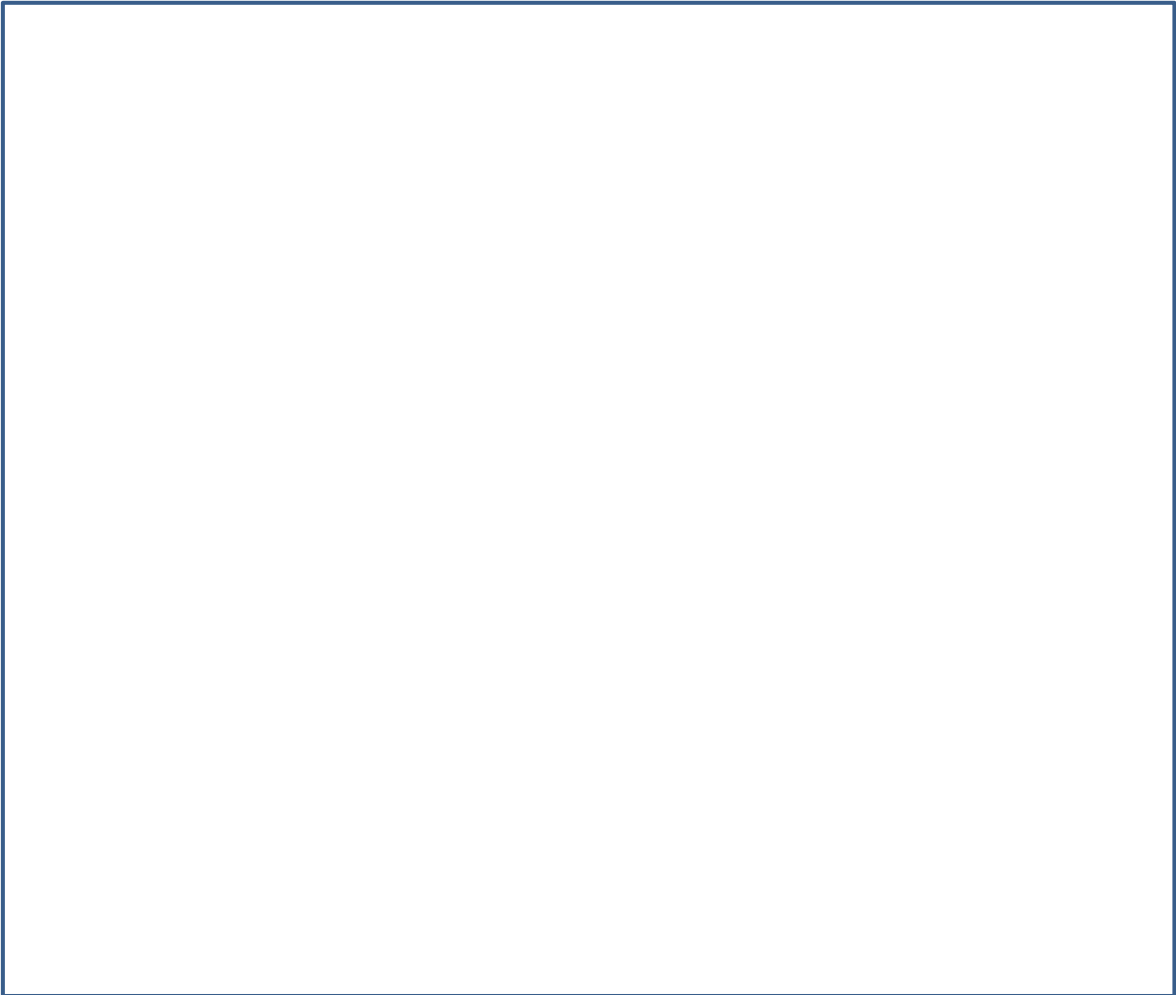
Source: Study team

Strategy 1	Reorganizing the HSE Management Structure

As discussed in Section 3.7, the MOP and the petroleum companies have problems in the implementation structure of HSE management. An inappropriate structure causes a conflict between environmental protection and production and discourages creating the desirable environment of HSE implementation. To realize the national HSE policy and improve the environmental conditions in the petroleum industry areas, the HSE management structure should be reorganized. Actions to be taken are as follows:

Action 1-1 Improving the Organizational Structure of the MOP

Figure 7.3.1-2 shows the reform plan of the MOP’s organizational structure.



Source: Study team

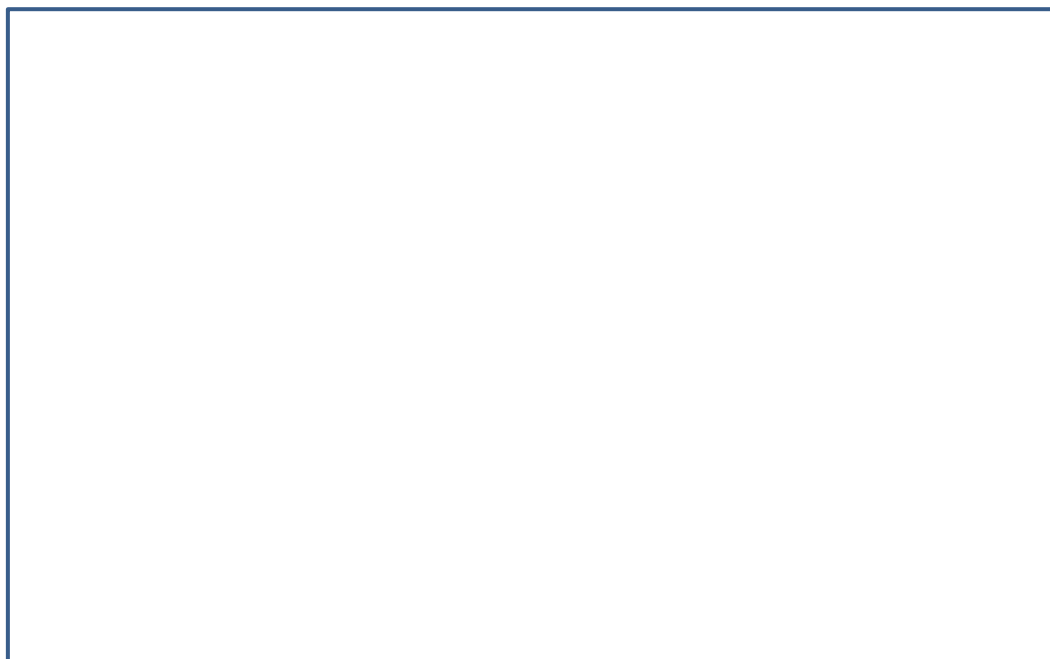
Figure 7.3.1-2 Reform Plan of MOP’s Organizational Structure

The most important point of the reorganization is that the HSE unit should be independent from the

line divisions such as the Engineering and Internal Construction because the role of the unit is to evaluate the performance of HSE management in line with the national HSE policy. Currently, the HSE-MOP is one of the departments under the Engineering and Internal Construction Division. Production expansion is the first priority of the petroleum industry in the country, followed by the HSE performance. In particular, the environmental protection is the last aspect considered in the petroleum projects. The tendency hinders the HSE-MOP from playing the expected role to realize the national HSE policy. To make more attention paid to the HSE performance in the ministry, the organizational structure should be reformed.

Action 1-2 Strengthening the capacity of Environmental Protection Section of the HSE-MOP

The MOP has changed the organizational structure of HSE Department as discussed in Chapter 3. The change was expected to improve the capacity to supervise the HSE implementation of the petroleum companies. However, two posts of the Environmental Planning and Control Unit are still vacant. Currently, only one environmental expert is engaged in communication with the national companies (see Figure 7.3.1-3). However, the implementation structure is not efficient.



Source: Study team

Figure 7.3.1-3 Strengthening the Capacity of the Environmental Protection Section

As the capacity should be strengthened in quantity and quality, the HSE-MOP should therefore make clear when the staff deployment is realized and should also prepare a training program to develop the capacity on environmental protection in the petroleum industry. The training contents required to the Environmental Planning and Control Unit as shown in Table 7.3.1-2.

Table 7.3.1-2 Education and Training for the HSE-MOP

Category	Education and Training Items
Master Plan for Environmental Management and Oil Spill Response	- Goals and scope of the master plan - Basic policy of the master plan - Institutional development and technology - Action plans
Formulation and Promotion of the HSE Culture	- Steps of the HSE culture development and activities at every step - Promoting and improving the HSE culture - Evaluating the HSE culture development - Actions required for the development of HSE culture at the management level
Execution of the Integrated HSE Management Systems	- Concept of the integrated HSE management systems - Developing the organization structure to operate the integrated HSE management systems - Evaluating the integrated HSE management systems - Actions required for the operation of the integrated HSE management systems at the management level
Environmental Management Regulations	- Developing the cooperation systems among the departments to execute the SEA and EIA - Actions required for the execution of the SEA and EIA at the management level - Outline of new environmental regulations such as the total emission control systems and company's responsibility - Developing the organizational structure to introduce the new environmental regulations such as the total emission control systems - Actions required for the introduction of the new environmental regulations such as the total emission control systems at the management level
Environmental Survey and Monitoring	- Sampling measures (sampling points, sampling methodology, etc.) - Compiling the sampling data - Analyzing the sampling data - Reporting the analysis result
Technology to reduce pollutions	- Air pollution control - Water pollution control - Soil pollution control - Waste management
Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA)	- Outline of EIA required to the petroleum industry - EIA guidelines by industrial sector prepared by the DOE - How to evaluate the EIA statement - Matters required for the project proponent (evaluation points) - How to utilize the EIA statement for supervision of the operation - Methodology of SEA prepared by the DOE - Sustainability indices and measuring methods prepared by the DOE
Communication with Civil Society	- Gathering comments from the public and NGOS on the petroleum projects - Information disclosure

Source: Study team

Action 1-3 Redefining Roles of Key Players on the HSE Management

The national HSE policy of the MOP does not function well at the moment and the roles of key players are not clear. The MOP should therefore clarify and redefine the roles of key players on the HSE management. The key players of the HSE management are as follows:

- Government: MOP, DOE and PMO
- Companies: National companies, subsidiaries, and private companies
- Civil society: Citizens and NGOs

Figure 7.3.1-4 illustrate the basic relationship between the HSE-MOP and the petroleum companies. The role of the HSE-MOP is basically to provide a national framework for environmental management in the petroleum industry, such as national policy and guidelines. Table 7.3.1-3 shows the roles of key players on the HSE Management. The roles shown in the table is based on the responsibility to execute the Six Points Agenda mentioned above.



Source: Study team

Figure 7.3.1-4 Basic Relationship between the HSE-MOP and the Petroleum Companies

Table 7.3.1-3 Roles of Key Players on the HSE Management

Players			Roles
Government	MOP	HSE	- Developing and revising the national HSE policy, strategy and plans - Setting performance indicators to evaluate the implementation of the national HSE policy, strategy and plans - Monitoring and evaluating the performance of the national HSE policy, strategy and plans - Developing and enforcing specific regulations for environmental protection in the petroleum industry - Monitoring and evaluating the HSE management of the petroleum companies - Promoting the HSE culture development in the petroleum industry - Promoting the implementation of SEA and EIA in the petroleum industry - Taking budgetary steps to introduce the environmental protection technology - Cooperating with other units of the MOP in the project implementation - Reviewing and endorsing the environmental protection part of Iranian Petroleum Standards (IPS) updated by the national companies - Holding events that contribute to raising awareness of the environmental management in collaboration with the petroleum companies - Cooperating with the PMO in the case of oil spills - Disclosing information about the HSE performance
		Engineering and Internal Construction	- Incorporating HSE aspects into construction plans and design - Cooperating with the HSE unit in the project implementation - Disseminating the importance of HSE in the project implementation to the engineering section of the national companies and subsidiaries - Reviewing and endorsing the Iranian Petroleum Standards (IPS) updated by the national companies from the technical perspective
		Development of Manpower/Management	- Coordinating training programs on HSE management system and HSE culture development with the HSE unit - Incorporating HSE aspects into the training programs of the ministry staff
	DOE		- Developing, revising and enforcing the environmental laws, regulations and standards - Monitoring and evaluating the emission and discharge - Managing and utilizing the online monitoring records transmitted from the operating companies via the online monitoring systems and sharing the data with stakeholders - Developing the implementation systems of SEA - Promoting the implementation of EIA and evaluating the statements - Disclosing information about the activities
	PMO		- Developing the national contingency plan (for Tier 2 and Tier 3 levels) - Instructing concerned organization to prepare the local contingency plan (for Tier 1 level) - Executing the emergency response in cooperation with the relevant organizations - Disclosing information about the activities
	National Companies (NIOC, NPC, NIGC and NIORDC)		- Developing the HSE management systems (policy, implementation procedures, evaluation indices, auditing, preparedness for emergencies and so on) - Operating the HSE management systems (risk assessment, environmental monitoring, review of the management systems and so on) and conducting the internal audit - Supervising and auditing the HSE management systems of the subsidiaries - Promoting and disseminating the technology to reduce the environmental loads - Supervising the implementation of SEA and EIA and reporting the result to the HSE-MOP - Updating and operating the IPS based on the applicable technology and the latest environmental standards and regulations - Reporting the HSE performance to the HSE-MOP - Addressing emergencies in cooperation with the relevant organizations - Holding events that contribute to improving the HSE culture and raising awareness of the environmental management in collaboration with the

Players		Roles
		HSE-MOP - Disclosing information about the HSE management activities
	Subsidiaries of the National Companies (operation)	- Developing the HSE management systems (policy, implementation procedure, evaluation indices, auditing, preparedness for emergencies and so on) - Operating the HSE management systems (risk assessment, environmental monitoring, review of the management systems and so on) and conducting the internal audit - Implementing the activities to reduce the environmental loads - Transmitting the monitoring records via the online monitoring systems to the DOE - Implementing SEA and EIA and reporting the result to superordinate organizations (the HSE-MOP and four national companies) - Reporting the environmental conditions and HSE performance to the national companies - Responding emergencies and cooperating with the concerned organizations - Holding events that contribute to improving the HSE culture and raising awareness of the environmental management in collaboration with the HSE-MOP - Disclosing information about the HSE management activities
	Subsidiaries of the National Companies (zone management)	- Developing the HSE management systems (policy, implementation procedure, evaluation indices, auditing, preparedness for emergencies and so on) - Operating the HSE management systems (risk assessment, environmental monitoring, review of the management systems and so on) and conducting the internal audit - Organizing a liaison meeting in the zone regularly - Organizing a separate meeting to discuss an individual issue such as environmental management in the zone - Encouraging the companies operating in the zone to implement SEA and EIA and reporting the result to superordinate organizations (the HSE-MOP and four national companies) - Operating the integrated environmental monitoring systems and analyzing the monitoring records - Giving direct orders for a company that violates the regulations or standards to remedy a fault or improve the operations/facilities - Responding emergencies and cooperating with the concerned organizations - Holding events that contribute to improving the HSE culture and raising awareness of the environmental management in collaboration with the HSE-MOP - Disclosing information about the HSE performance
	Private Companies	- Developing the HSE management systems (policy, implementation procedure, evaluation indices, auditing, preparedness for emergencies and so on) - Operating the HSE management systems (risk assessment, environmental monitoring, review of the management systems and so on) and conducting the internal audit - Submitting the environmental monitoring records to a zone management company - Participating in the liaison meeting and separate meeting organized by a zone management company - Implementing SEA and EIA and reporting the result to the HSE-MOP and a zone management company - Reporting the environmental performance to the HSE-MOP and a zone management company - Responding emergencies and cooperating with the concerned organizations - Disclosing information about the HSE management activities
Civil Society	Citizens and NGOs	- Observing the activities of the petroleum companies - Participating in the process of SEA and EIA

Source: Study team

Action 1-4 Developing the Supervisory Structure of the HSE-MOP

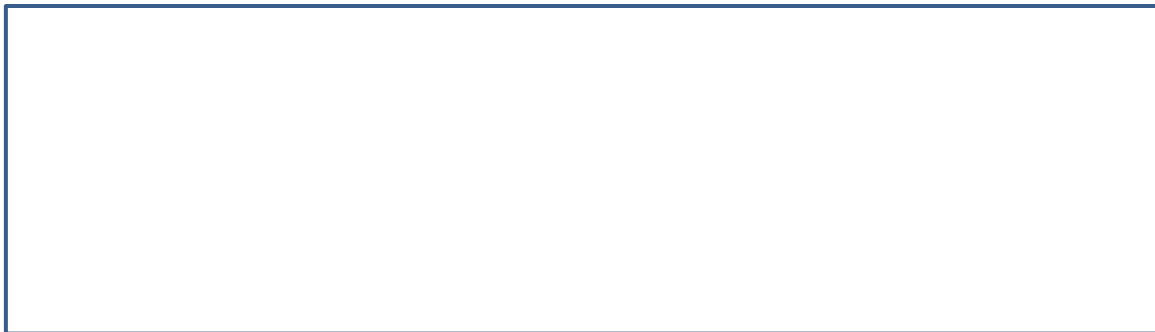
The HSE-MOP currently does not have comprehensive measures to supervise the activities of the petroleum companies. The supervision mainly depends on an occasion or problem. The HSE-MOP is supposed to point the direction of the HSE management to the petroleum companies and to monitor their activities in line with the practical strategies. The HSE-MOP should therefore carry out the following in order to develop the structure to supervise the petroleum companies:

1) Providing the Existing Committee with a Supervisory Function

As discussed in Subsection 3.1.1, the Special Environmental Committee has a function to discuss the issues related to the environmental management in the petroleum industry and to share the relevant information. The committee members are the deputy of environmental protection of the HSE-MOP and the environmental managers of four national companies. The Manager of Environmental Planning Control, the HSE-MOP should also participate in the committee. The existing system should be utilized to reorganize the supervisory structure of the HSE-MOP.

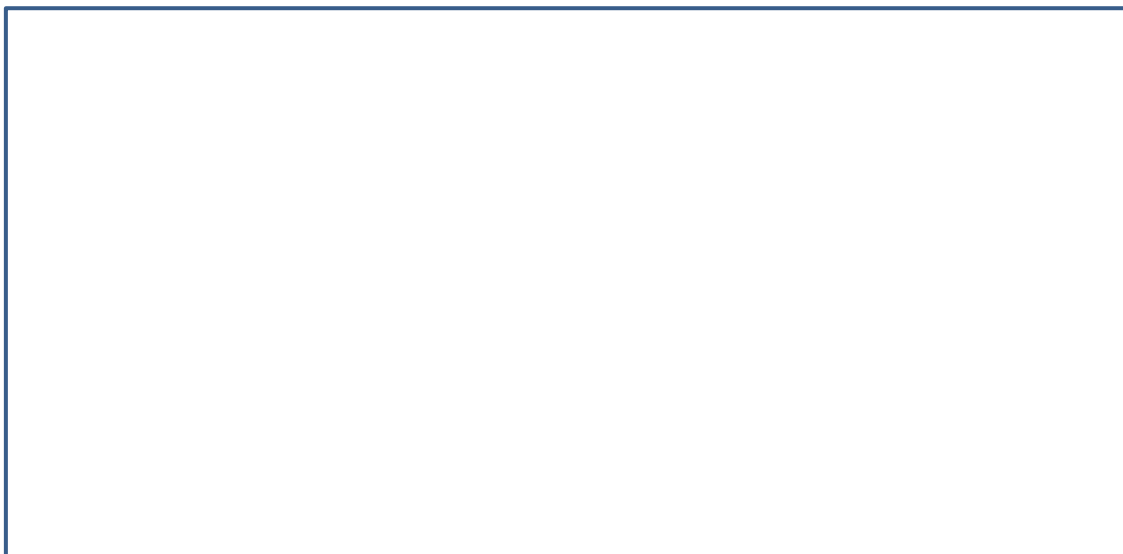
- Defining the supervisory function of the committee
- The main function of the committee should be defined as follows:
 - Implementing the periodical evaluation of environmental management in the petroleum industry
 - Reviewing the progress and achievement of the Six Points Agenda
 - Discussing the way forward to accelerate the implementation of the Six Points Agenda
 - Discussing regulations/circulars/standards to be applied to promote the environmental management in the petroleum industry, especially “One Zone One Management Principle” and “Total Emission Control Systems” discussed in Strategy 3.
- Holding the Special Environmental Committee regularly
- The HSE-MOP should hold the Special Environmental Committee meeting once a month and should prepare the meeting agenda, attendance list and discussion records. The HSE-MOP should also make clear who is responsible for the matters discussed and by when the matter should be addressed, and should check the progress of the actions in the meetings.
- Setting the annual agenda

The committee should set the annual agenda at the first meeting of each year and hold the meetings in accordance with the agenda. The annual agenda will be modified if necessary. The committee should review the activities during the year and evaluate achievement of the annual agenda at the final meeting of the year. The annual agenda should be set based on the evaluation result of the previous year. Figure 7.3.1-5 shows the annual schedule of the Special Environmental Committee. Figure 7.3.1-6 illustrates the supervising structure of the petroleum industry.



Source: Study team

Figure 7.3.1-5 Annual Schedule of the Special Environmental Committee



Source: Study team

Figure 7.3.1-6 Supervising Structure of the Petroleum Industry

2) Improving the Environmental Monitoring Systems

To evaluate whether or not the petroleum companies properly implement the environmental management, it is necessary to make clear what monitoring systems should be developed, what

indices and how the indices should be monitored, and how the monitoring result should be reported and analyzed. The following are the basic concept to improve the environmental monitoring systems:

- Designating the common environmental monitoring indices in the petroleum industry
- Unifying the monitoring stations management in one industrial zone
- Reorganizing the reporting system
- Reorganizing the performance evaluation system

The detailed improvement plan on the environmental monitoring is described in Section 7.5. The petroleum companies should recognize how to develop the monitoring systems, how to analyze the monitoring records and how to utilize the result in order to improve the operations and reduce the environmental loads.

In addition to improving the environmental monitoring system, it is also advisable to use the performance indicators shown in the IPIECA's guidance, "Oil and Gas Industry Guidance on Voluntary Sustainability Reporting", at first, and then the wide range of indices described in the Global Reporting Initiative's guidelines, "Sustainability Reporting Guidelines", can be included in the future. Moreover, performance indicators include not only the environmental monitoring records but also organizational performance such as HSE culture development and resource allocation. Table 7.3.1-4 shows the performance indicators to be described in the monitoring report of petroleum companies in the future, which include the indicators listed in the IPIECA's guidance and items to monitor the operation of the HSE management systems.

Table 7.3.1-4 Performance Indicators to be described in the Monitoring Report

Category	Performance Indicator
Climate Change and Energy	- Greenhouse gas emissions (CO₂ , CH₄ ,etc.) - Energy use (consumption) - Alternative energy sources - Flared gas (quantity of hydrocarbon gas) - Energy consumption and input-output ratio
Biodiversity	- Biodiversity and ecosystem (Qualitatively describe how the company addresses - Fresh water (quantity withdrawn or consumed)
Regional Environment	- Other air emissions (VOCs, SOx, NOx, PM, ODS, other regulated emission) - Spills to the environment (quantity of spills) - Discharges to water (quantity of hydrocarbon discharges to the water environment) - Waste (quantity of waste disposed)
HSE Culture	- Changes in development of HSE culture at all the levels including the top management
Resource Allocation	- Resource allocation to development of structure to achieve the objectives of the HSE management systems and to the management activities

Source: Prepared by the study team, referring to the "Oil and Gas Industry Guidance on Voluntary Sustainability Reporting", IPIECA

Action 1-5 Delegating the Authority of Environmental Management

Currently, the Iranian Petroleum Standards (IPS) is controlled by the MOP and updated periodically. All the petroleum companies are obliged to follow the IPS. However, the HSE-MOP is not involved in the revising work of the IPS and environmental standards referred to in the IPS has not been updated regularly in accordance with the latest national environmental standards. The national companies have the primary responsibility to control development and production of oil and gas and supervise the subsidiaries that are engaged in on-site operation in line with the IPS and other relevant regulations. The national companies should therefore have the authority to update/amend the IPS. The HSE-MOP should review and endorse the revision of IPS and give an instruction to the national companies if necessary.

The national companies have the basic responsibility for evaluation of environmental performance. However, to achieve the environmental standards in the petroleum industry zones, the primary responsibility of the environmental performance evaluation should be taken by a zone management company based on the “One Zone One Management Principle” described in Strategy 3. The HSE-MOP should therefore formulate a plan to delegate such authority to the zone management companies.

1) Updating the Iranian Petroleum Standards (IPS)

The following are the steps to be proceeded by the national companies to update the IPS:

- Gathering information about environmental protection technology
- Analyzing applicability and availability of the technology
- Updating the information of environmental standards to be followed
- Considering the factors stipulated in new specific regulations of the petroleum industry (if enacted)
- Updating/amending the environmental-related part of IPS regularly

2) Evaluating the environmental performance of the operating companies

The following are the steps to be proceeded by the zone management company to evaluate the environmental performance of the operating companies:

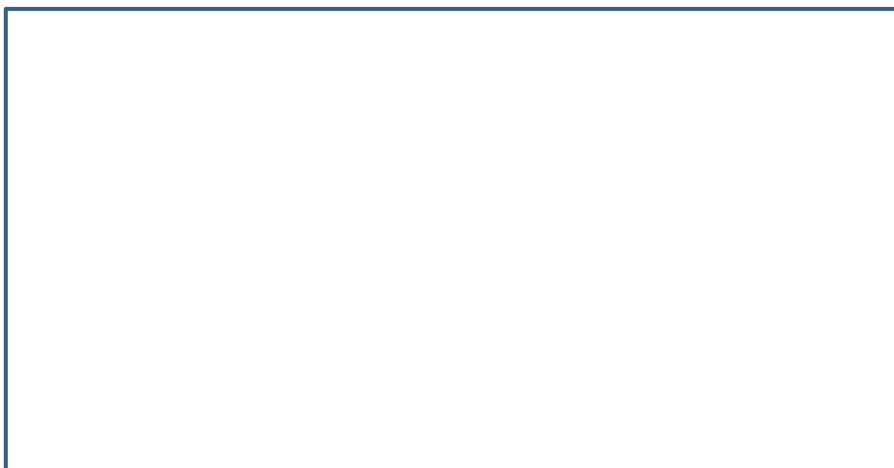
- Clarifying the roles and responsibilities of stakeholders on the environmental monitoring in one industrial zone
- Enforcing specific regulations/self-regulation in a zone

- Introducing and operating the improved environmental monitoring systems
- Creating an inventory map that shows locations of emission sources in the zone and types of potential pollutants
- Gathering and reviewing environmental monitoring reports prepared by the companies operating in the zone
- Giving a warning against and direct orders for an operating company that does not follow the environmental regulations, standards and specific regulations for the petroleum industry

Action 1-6 Rationalizing the HSE Implementation Structure

The most important thing to realize the HSE management systems is to clarify who has the responsibility for HSE implementation. Currently, the petroleum companies give less attention to the HSE management, especially environmental protection, compared to expanding the production capacity. Executing the environmental protection is regarded as the responsibility of environmental protection unit. The conflict between the increase in production and HSE management may therefore affect the HSE performance. However, the environmental protection cannot be separated from the operational activities. The basic responsibility of the HSE implementation should be taken by the operating units including engineering and operation control because pollutions are generated from the operation process. The role of HSE unit should be to set HSE objectives and targets, monitor, evaluate and report the HSE performance, assuring compliance with the legal framework, and provide the HSE training. In addition, the top management should commit and initiate the process to rationalize the HSE implementation structure.

In proportion to reorganizing the MOP's HSE management structure, the HSE-MOP should encourage the national companies and its subsidiaries to rationalize the HSE implementation structure. The national companies and its subsidiaries should review the HSE implementation structure across the company and transfer the HSE implementation responsibility from the HSE unit to the operating units. Figure 7.3.1-7 shows the redefinition of HSE implementation responsibility. The top management and senior managers declare the rationalization of implementation structure. The HSE unit analyzes the monitoring records, specifies HSE issues to be addressed and instructs improvement of operations. Operating units implement the environmental protection activities and accommodate the instructions from HSE unit to its daily operations.



Source: Study team

Figure 7.3.1-7 Redefinition of HSE Implementation Responsibility

Strategy 2	Promoting HSE Culture Development

Based on the OGP's guidelines, the HSE-MOP has prepared the "Guidelines for the Development and Application of Health, Safety and Environment Management Systems" and encourages the petroleum companies to develop and implement the HSE management systems. According to the guidelines, the petroleum companies developed their own management systems and registered the integrated management systems (IMS) that consists of the ISO quality control and environmental management systems and OHSAS occupational health and safety management systems. However, the registration and preparation of management documents become a goal and have not yet led to efficient implementation of the HSE management systems. The HSE-MOP should therefore help the petroleum companies develop and improve the HSE culture in order to put their HSE management systems into practice. Actions to be taken are as follows:

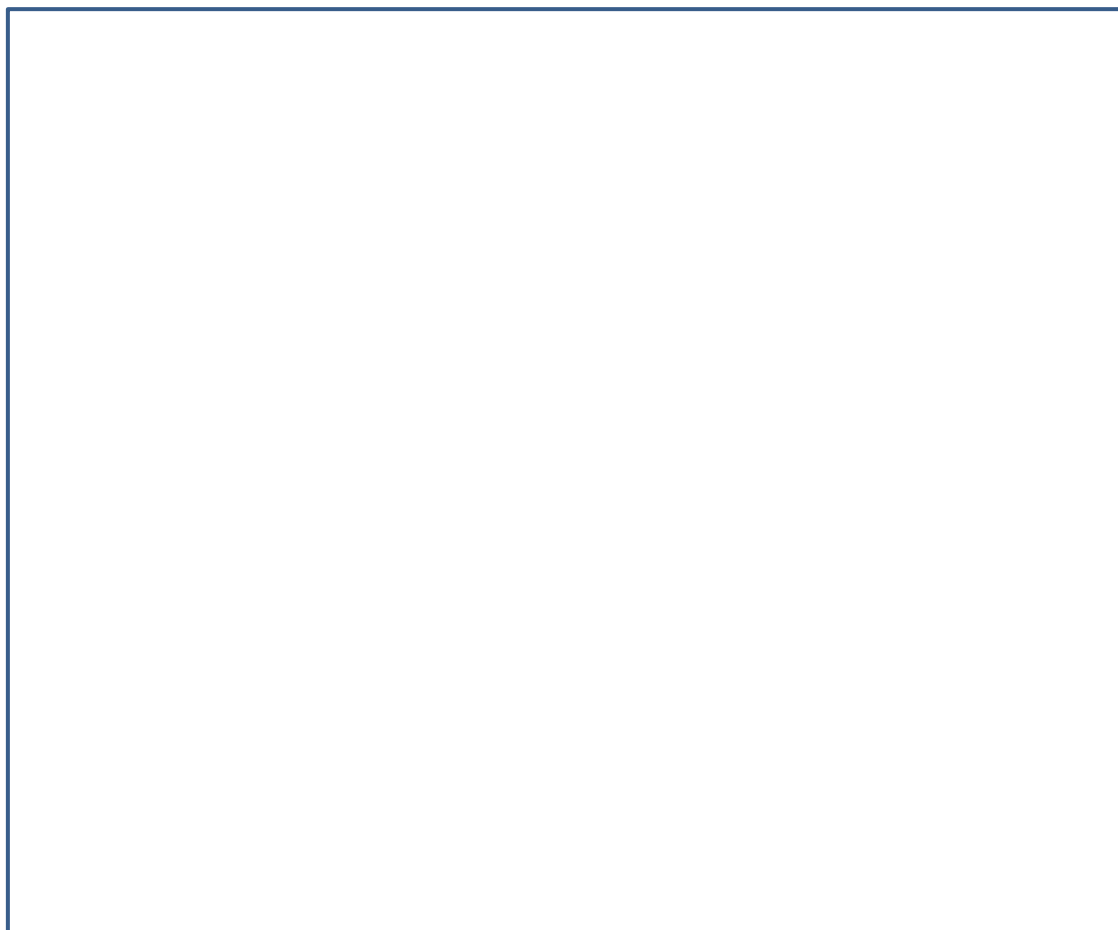
Action 2-1 Pointing a Direction of the HSE Culture Development

As discussed in Subsection 3.7.2, the HSE culture consists of two parts: visible and invisible. The visible part includes the management systems and documents such as HSE objectives, policy, crisis management procedures, monitoring guides, periodical reports and so on. The invisible part includes initiative by top management and senior managers, and employees' perception, attitudes and behavior. Some companies introduced HSE awarding programs and encourages their employees to participate in execution of the HSE management systems. This contributes to efficient production and early identification of possible risks. Raising awareness about HSE risks and understanding necessity of the management systems play an important role to change the invisible part of HSE culture. However, those existing activities has not led to change for the better in the field of environmental protection. Basically, the operating companies have the mindset that their responsibility is to abide by original design specifications and to meet the emission standards. Even though total emission in an industrial zone has negative impact on the atmosphere, they do not think necessity of process improvement to reduce generation of the environmental pollutants. The HSE-MOP should therefore make clear what the HSE culture development means, how important the HSE culture is, and what direction should be taken by the petroleum companies to develop and improve the HSE culture. Steps to point a direction of the HSE culture development are as follows:

- Sharing the vision and direction towards the HSE culture development between the HSE-MOP and the petroleum companies

- Instructing the subsidiaries to review the operation procedures and introduce the technology that contributes to the reduction of the environmental pollutants

Figure 7.3.1-8 shows the vision and direction towards the HSE culture development. The HSE culture is the driving force to put the HSE management systems into practice and to realize the change for the better. To develop the HSE culture, four directions can be taken: leadership by the top management and senior managers, incentives for reinforcing the HSE attitude and behavior, practice of engagement in operation of the management systems and the integrated management systems, and awareness raising and knowledge acquirement. The HSE culture development can be promoted by some measures such as walk through (observation) by the top management, rewarding to employees, involvement programs to drive the practice of management systems and training programs. In particular, the involvement and training programs are needed to improve the HSE culture in the field of environmental protection.



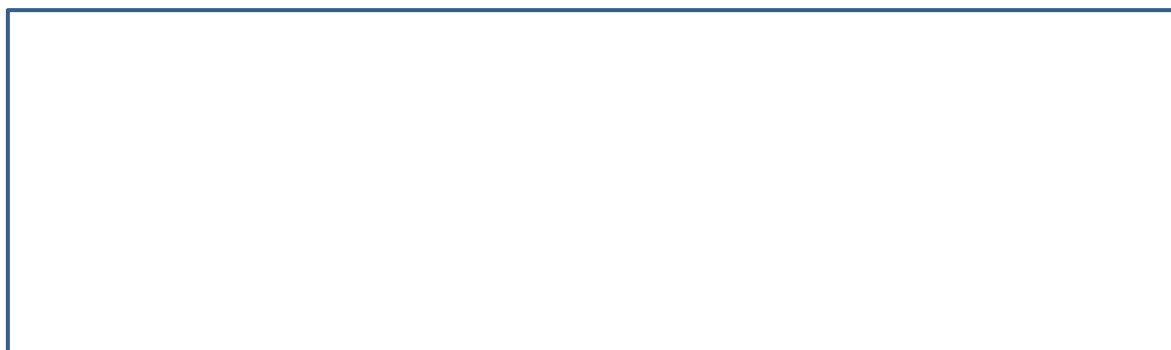
Source: Study team

Figure 7.3.1-8 Vision and Direction towards the HSE Culture Development

Action 2-2 Encouraging the Petroleum Companies to Evaluate the HSE Culture Development

The HSE culture can be developed after establishing the HSE management systems and will not take root across the organization without practice of the management systems. Implementing the management systems will contribute to the HSE culture development and will lead to decrease in the number of problems such as nonconformity to the environmental requirements and accidents. The HSE culture comprises the management systems as fundamental, the way of thinking and attitudes of the staff and their behavioral pattern derived from their understanding. The HSE-MOP should promote the petroleum companies to evaluate its HSE culture development.

The national companies and subsidiaries should assess the HSE culture development regularly, should compare the latest evaluation to the past results, and should identify at which stage they are on the process of the HSE culture development. Figure 7.3.1-9 shows the steps of HSE culture development.



Source: Study team

Figure 7.3.1-9 Steps of HSE Culture Development

The national companies and subsidiaries should also report to the HSE-MOP on the evaluation result and analysis of the development process. The following tools are useful to understand the current situation of HSE culture:

- “Hearts and Minds”, Energy Institute
- “A guide to selecting appropriate tools to improve HSE culture”, OGP

The HSE-MOP should monitor the progress of the HSE culture development and should gather the information about good practices of the HSE culture development. If any company faces difficulty in the development, the HSE-MOP can share the good practices with the company.

Action 2-3 Promoting Coordination and Collaboration across the Company

Both the HSE-MOP and the petroleum companies recognize that the integrated operation of the HSE management systems is needed. The petroleum companies actively register the integrated HSE management systems. However, each section of the HSE department in the MOP and the petroleum companies works in a different way and has less opportunity to cooperate with each other. The perception of the integrated HSE management systems varies from one environmental expert to another. Therefore, the HSE-MOP and the petroleum companies should have the common perception about the operation of the integrated HSE management systems in the petroleum industry. In addition, the petroleum companies should promote the execution of the introduced systems in line with the common perception. The following should be considered to facilitate the coordination and collaboration across the company in the petroleum industry.

1) Defining the Integrated HSE Management Systems

Registering the ISO quality control and environmental management systems and the OHSAS occupational health and safety management systems does not automatically enable a company to operate the integrated HSE management systems. The operation of the integrated HSE management systems requires the cooperation and coordination not only between occupational health, safety and environmental protection units but also across the company. The HSE-MOP should make clear what the integrated HSE management systems are and what situation represent the realization of the integrated HSE management system. The definition should therefore penetrate to the petroleum companies.

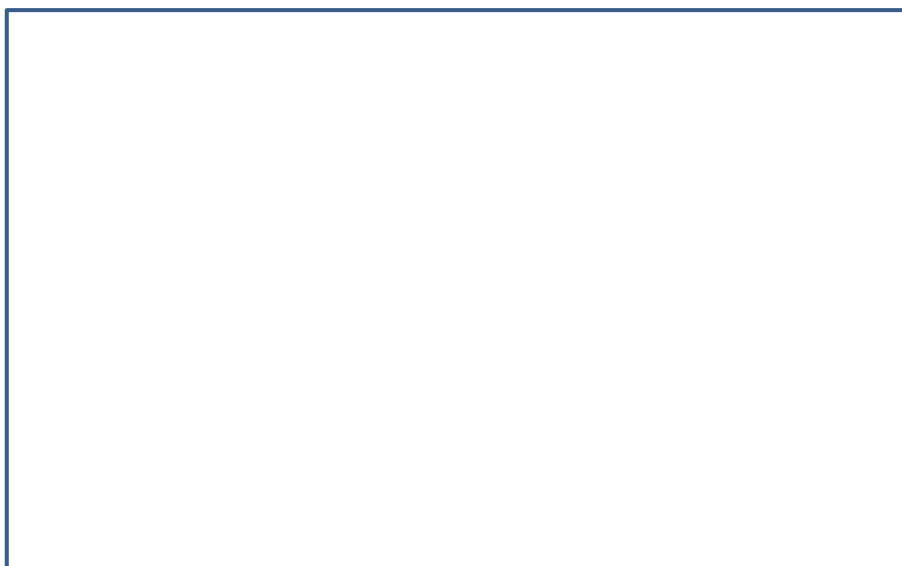
2) Encouraging the Petroleum Companies to Share the Good Practices of the Integrated HSE Management Systems

In addition to making clear what the integrated HSE management systems are, the HSE-MOP should collect information of good practices, which represent the illustrative cases of the system operations, and should also encourage the petroleum companies to share the good practices across the company. The petroleum companies should share the concept and definition of the integrated HSE management systems and the good practices of the system operation in the entire organization.

3) Promoting a Small Group Work

The petroleum companies in Iran do not have the culture in which the employees at all the levels can suggest improvement based on their own experience. The improvement procedure is basically command and control of the top management. This does not create small and incremental improvement at all the levels. That is a very important factor to realize the Plan-Do-Check-Act

(PDCA) cycle, a basic concept of management systems. This cycle is very popular and the HSE management systems in Iran also follow the concept. However, an action to bridge between Do and Check or evaluation of performance cannot be realized by the command and control improvement method because the performance evaluation requires analysis of current situation based on the culture of continuous improvement and proactive actions towards change for the better. The HSE-MOP and the petroleum companies should therefore change such command and control culture to put the HSE management systems into practice. A tool that can solve the problem is the second PDCA cycle shown in Figure 7.3.1-10. The second PDCA cycle consists of four steps: problem finding, display, clear and acknowledge. This had better be promoted by a group work that enables the team to discover what works or not in the HSE management systems and find solutions at each workplace.

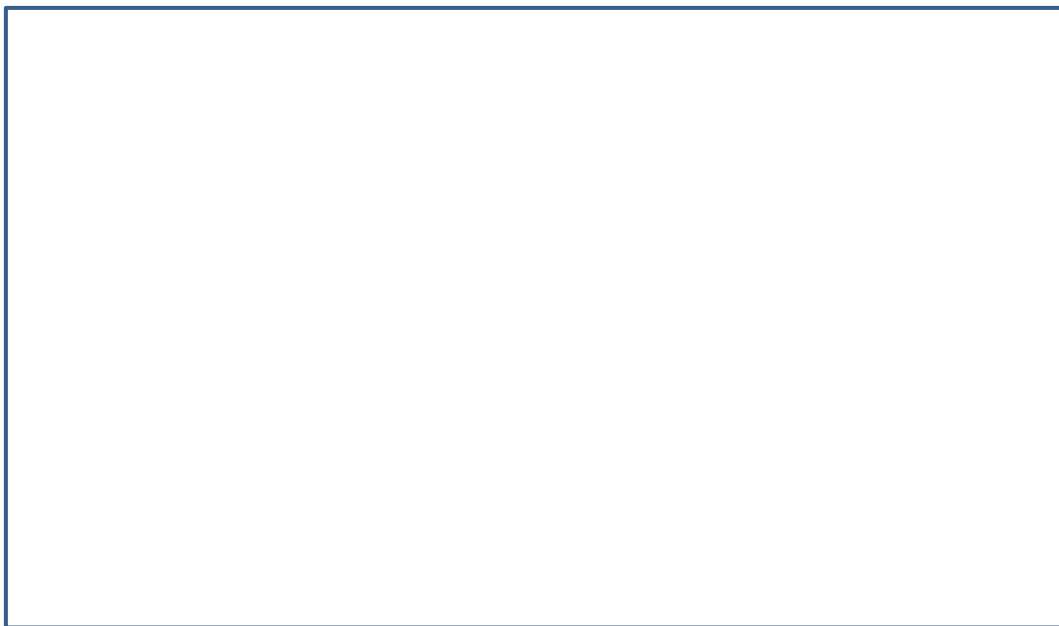


Source: PDCA (Plan-Do-Check-Act): Extended Diagram, Karn G. Bulsuk

Figure 7.3.1-10 PDCA Cycles

Implementing the second PDCA cycle can be started from a small group work. An important thing is not to build something bigger than before but to make small and incremental improvements. The group work should also be small scale in the beginning, for example occupational health, safety and environmental protection, and can be extended gradually to engineering, production control and so on as shown in as Figure 7.3.1-11. The group members are as follows:

- HSE: Managers of occupational health, safety and environmental protection (chair)
- Technical: Managers of engineering, production control, project implementation, etc.
- Administration: Managers of human resources and education and training



Source: Study team

Figure 7.3.1-11 Group Work for the Second PDCA Cycle

Components of the group work are as follows:

- Problem finding and display
 - Listing all the environmental problems that a company faces
 - Collecting information (monitoring records) that shows the environmental problems
 - Visualizing the information by using charts and graphs
- Clear and acknowledgement
 - Monitoring the situation of problems found during the daily work
 - Finding solutions in each department (voluntarily and proactively)
 - Sharing the monitoring results and solutions within the group work team

An environmental protection manager can discuss the environmental problems and can share the related information such as monitoring results and solutions with occupational health unit, safety units and other departments. This means that this group work also contributes to promoting execution of the integrated HSE management systems. The small group work should be promoted by the MOP and the petroleum companies respectively.

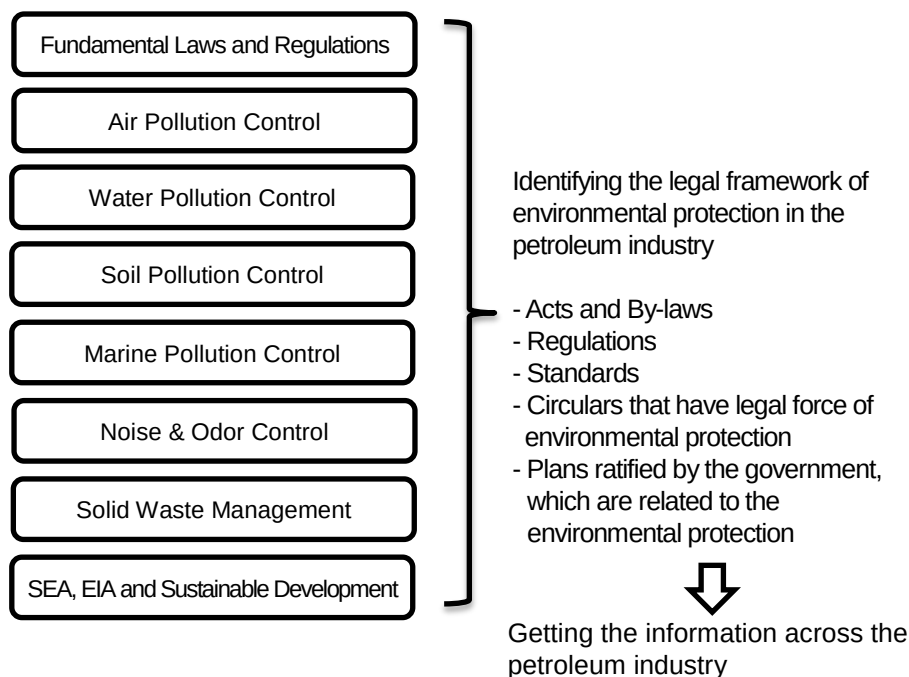
Strategy 3 Formulating Specific Regulations for the Environmental Protection

The petroleum companies should obey the laws, regulations and standards related to the environmental management such as protection from the environmental pollution, which the DOE has the authority to enforce. The petroleum companies should follow the EIA process in oil and gas development and facility expansion. However, the process has not been strictly controlled. To carry out the environmental management properly, the HSE-MOP should make clear the legal framework to be followed by the petroleum industry. Actions to be taken are as follows:

Action 3-1 Identifying the Legal Framework to be followed by the Petroleum Industry

The HSE-MOP, supervising body of the entire oil and gas industry, should identify the laws, regulations and standards to be followed by the petroleum companies. The information should penetrate the petroleum industry (see Figure 7.3.1-12). The HSE-MOP should therefore update the legal information related to the petroleum industry regularly and should also give notice to the petroleum companies when the laws, regulations and standards are amended or newly enacted.

Legal Framework of Environmental Management



Source: Study team

Figure 7.3.1-12 Identifying the Legal Framework to be Followed

NPC identified the laws, regulations and standards to be followed by the group companies in line with its own HSE management systems and prepared a booklet. The HSE-MOP should make all the national companies identify the legal framework to be followed and should also disseminate the information to its subsidiaries.

The subsidiaries are responsible for determining the laws, regulations and standards to be followed in its management systems. Many operating companies have registered the management systems that include ISO quality control and environmental management systems and OHSAS occupational health and safety management systems. Identifying the legal framework to be followed is an obligation of the companies that registered the management systems.

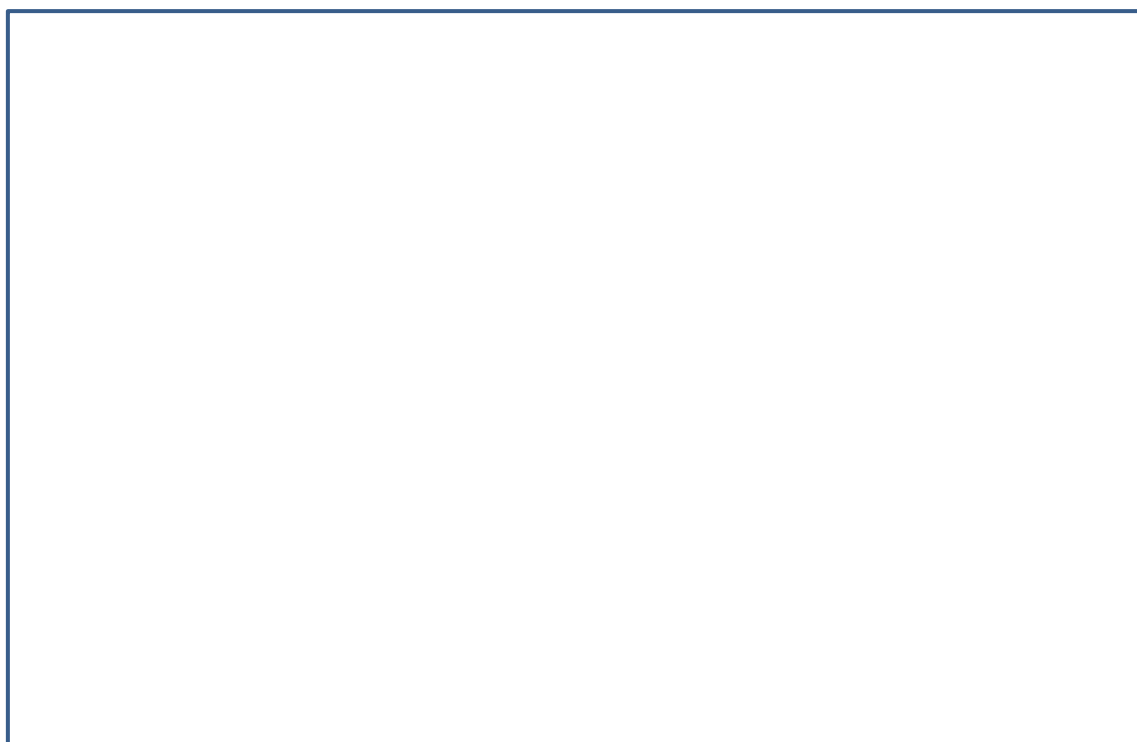
Action 3-2 Institutionalizing the “One Zone One Management Principle”

As discussed in Section 3.7, lack of coordination and collaboration among the petroleum companies was pointed as one of the challenges to realize the national HSE policy. Currently, a zone management company, such as PSEZ in Mahshahr and PSEEZ Organization in Assaluyeh, does not have strong authority to control the activities of operating companies. Individual plants may comply with the emission standards. However, it may be difficult for some industrial zones to achieve the environmental standards due to the high density of industrial facilities. It does not allow the zone to combat against the environmental deterioration in a favorable manner. In an industrial area where many industries/complexes concentrate, the appropriate environmental management can be achieved only by the strong authority of zone management and collective actions of operating companies towards common environmental goals in the zone. The following are the possible cases of the zone management:

- Case1: No organizing body to control the activities in the entire region/area (the region/area such as Khark Island)
- Case 2: An organizing body to control the activities in the entire region/area, operation in one sector such as only petrochemical group (the region/area such as Mahshahr)
- Case 3: An organizing body to control the activities in the entire region/area, operation in some sectors such as gas group and petrochemical group (the region/area such as Assaluyeh)

In Case 1, there is no organizing body to control the activities in the entire region/area. No companies initiate collective actions in such region/area. The operating companies work in a different way in the area. In such case, it is necessary to be clarified who should take responsibility to control environmental protection activities in the region/area.

In Case 2 and Case 3, an organizing body controls the activities in the entire region/area. However, the authority to control the activities is weak. The organizing body cannot order remedial actions and impose penalties directly even though the environmental standards are violated. The stronger authority should therefore be given to the organizing body in order to realize the strict control of the operations in the entire region/area. The following are the specific policies towards promotion of collaboration among the operating companies. The HSE-MOP should institutionalize the “One Zone One Management Principle”. The principle enables one management company to have the strong authority to control all the environmental protection in a zone and allows the management company to initiate the zone management considering the total emission from the plant operations. The concept diagram of zone management structure under the “One Zone One Management Principle” is shown in Figure 7.3.1-13.



Source: Study team

Figure 7.3.1-13 Management Structure under the One Zone One Management Principle

The authority to be delegated to the zone management company are as follows:

- Holding liaison meetings regularly for the purpose of discussing collective actions to be taken, such as setting the common environmental goals, sharing good practices and collaborating on training (The liaison meeting members are HSE managers of the zone management company and operating companies in the zone.)

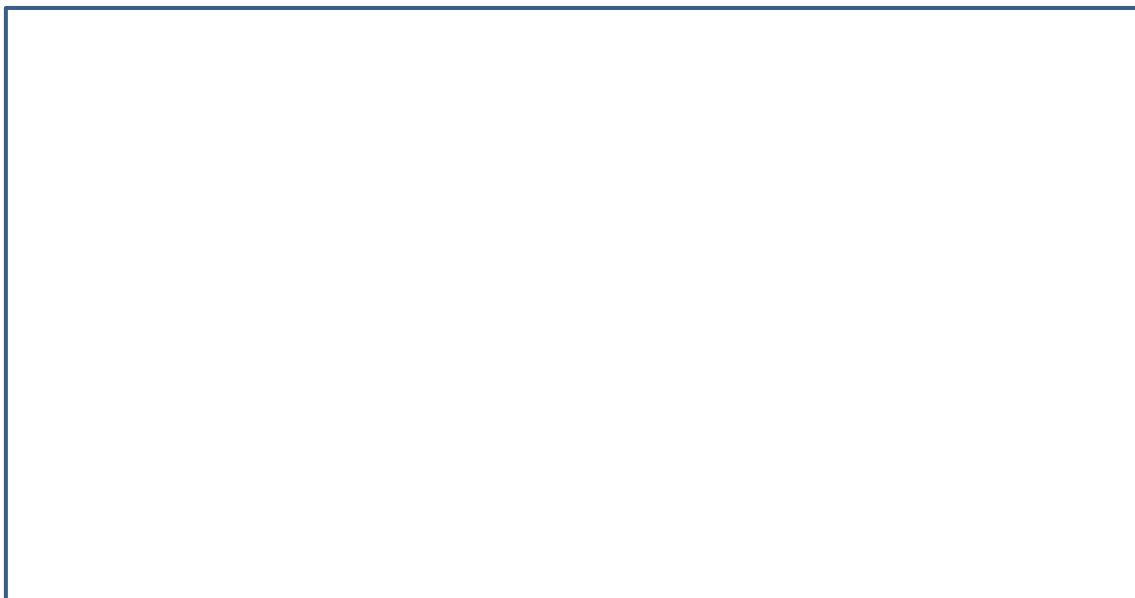
- Organizing a separate meeting to discuss an individual issue such as environmental management in the zone (establishing a regional air quality control committee as a separate meeting to the regular liaison meeting, described in Subsection 7.3.3 Total Emission Control)
- Setting and managing the monitoring stations within the zone and in the surrounding residential areas
- Gathering the information about potential emission sources and types of pollutants and the environmental monitoring records from operating companies
- Evaluating the performance of environmental protection
- Giving direct orders for a company that violates the regulations and standards to remedy a fault or improve the operations/facilities and imposing penalties (operation shutdown or fine) if necessary

The HSE-MOP should formulate regulations that delegate the authority to one management company in one industrial zone, identify petroleum industrial zones where more than two companies/complexes operate, appoint one management organization in each industrial zone and publicize the appointment.

Action 3-3 Implementing Environmental Management based on an Environmental Hazard Map

Optimizing the energy loss from development, production and operation facilities in proportion to the input-output balance is important in large petroleum industry areas such as Mahshahr and Assaluyeh, in order to reduce the environmental loads. Sources and volume of the environmental pollutants from operating plants are also to be qualitatively identified. To realize the management structure under the One Zone One Management Principle, the zone management company should have the information about the sources and volume of the environmental pollutants to evaluate efficiency of factory operations. A solution to this matter is “Creating an inventory map (environmental hazard map) that shows locations of emission sources in the zone and types of potential pollutants” stated in Action 1-5 Delegating the authority of environmental management. Zone management companies will prepare a flow chart of the environmental emissions and the environmental hazard map in the zones, based on the information collected from operating companies. The zone management companies should also get the information across the companies operating in the zones, which states that operational efficiency of the plants will be evaluated based on the environmental hazard map. In addition, the zone management companies should make the HSE department of the operating companies submit the monitoring reports that include

examination result of the environmental pollutants and situation of optimizing the operational conditions, in order to supervise the operational level of the companies based on the hazard map.



Source: Study team

Figure 7.3.1-14 Preparing an Environmental Hazard Map and Controlling Environmental Management

Introducing advanced technology for the environmental improvement will be examined to the reduction of the environmental loads that cannot be achieved by only optimizing operations. Section 7.4 and 7.5 describe the introduction of advanced technology for environmental measures and environmental monitoring respectively.

Action 3-4 Introducing a Measure to Control the Total Emission in One Industrial Zone

In addition to the conventional emission control that regulates emissions of pollutants from each stack, introducing a total emission control system is more effective to achieve the environmental standards in the area where a large number of factories are dense. The HSE-MOP should therefore take steps to institutionalize the total emission control system. The following are the brief description of steps to introduce such environmental management systems.

1) Understanding the cumulative impact on the environment

A zone management company and operating companies should understand the cumulative impact of pollutants on the environment and the necessity of collective actions to achieve the environmental standards in the zone. The HSE-MOP should encourage those companies to raise

awareness about the cumulative impact on the environment and the concept of a self-regulation system such as total emission control, utilizing the Special Environmental Committee Meeting and the liaison meeting organized by the zone management company.

2) Institutionalizing the total emission control system

The HSE-MOP should institutionalize the total emission control systems. The outline of the total emission control systems is 1) designating pollutants to be controlled, 2) designating target areas, 3) preparing a total emission control plan, 4) setting the target value, 5) monitoring and 6) carrying out on-site inspections. The detailed procedures to introduce the total emission control system are described in Subsection 7.3.3.

3) Applying such control systems in a model site

Based on the institutionalized system, the allowable discharge volume in a model site will be calculated. The volume will be set as the regional target volume. Each operating company should examine how to reduce the emission to the individual allowable level. Assaluyeh is the candidate of model site to introduce the total emission control system.

Strategy 4	Rationalizing the Resource Allocation

As discussed in “Section 3.6 Capacity of the Relevant Organizations for Environmental Management and Oil Spill Response” and “3.7 Issues related to Institutional Framework”, operational scale expansion tends to be prioritized in the petroleum industry, while little attention has been paid to the HSE management, especially environmental protection. The appropriate HSE management contributes to reducing the loss due to accidents and using the resources efficiently. The HSE-MOP and the petroleum companies should therefore promote appropriate resource allocation in order to operate the HSE management systems effectively. To reduce environmental pollutants derived from development and operations, the petroleum companies should optimize development, production and utilization of oil and gas in proportion to the balance between supply and demand. The first step to be taken is to review the current operations from the viewpoint of the balance between input and output and to identify the level of efficient operations. Based on the review, a possibility to introduce the advanced technologies should be examined to reduce the environmental pollutants that cannot be attained by only optimization of operations. Actions to be taken are as follows:

Action 4-1 Identifying the Operational Level of Plants from Environmental Protection Perspective

The operating companies know about the operational level of their own plants and factors that could lower the operational level. However, the HSE-MOP and the national companies do not always identify the operational situation of plants in detail. The HSE-MOP and the national companies should therefore identify the operational level of plants from the environmental protection perspective.

Action 4-2 Introducing Advanced Technology to Reduce the Environmental Loads

Introducing advanced technology can reduce the environmental loads that cannot be attained by only optimization of operations. Besides, this contributes to rationalizing the resource allocation in the petroleum industry. The HSE-MOP and the petroleum companies should identify the gap between the resource saving from operation with an environmental protection plan and loss from operations without the plan (operation as it is). Based on the evaluation results, the HSE-MOP and the petroleum companies should allocate appropriate financial resource to implement the environmental protection plan. The following are the procedure to select the technology and options for the environmental protection.

1) Applying the procedure to select available and applicable technology

The technology to control pollutions generated from the petroleum industry should be selected, based on consideration of legal requirements, local conditions, scale of environmental impact and so on. There are two general procedures to examine the applicable technology: best available technology (BAT) and as low as reasonably practicable (ALARP). The detail of those procedures is described in Subsection 7.4.1.

2) Implementing air pollution reduction programs

The technology to reduce the air pollution leads to not only reducing pollutants in the atmosphere but also making efficient use of gas. This means the air pollution control can reduce the loss from operation. The technology is categorized into four types: reducing the flaring gas, minimizing the pollutant generation, removing the pollutants, and diffusing and diluting the pollutants appropriately. The detail of those procedures is described in Subsection 7.4.2.

3) Implementing water pollution control programs

Water pollution spoils a view. The pollutants have a negative impact on the human body and industry such as fishery and tourism as well. The water pollution control can reduce the cost to recover the environmental contamination. The water pollution control is composed of two types: reducing wastewater and pollutants in the production process and improving wastewater treatment facilities. The detail of those procedures is described in Subsection 7.4.3.

4) Implementing soil pollution control programs

Problems of soil pollution depend on a cause of leakage, a location, soil conditions and composition, aging and so on. The detail of the soil pollution control is described in Subsection 7.4.4.

5) Implementing waste management programs

Inappropriate waste management also has a negative impact on the human body and other industry as well as the environment. Especially, there are three challenges to be addressed: treating spent catalysts, treating oil sludge, and treating drill cuttings. The detail of the treatment method is described in Subsection 7.4.5.

Action 4-3 Evaluating the Effect of Resource Allocation to the Environmental Protection

The HSE-MOP should monitor whether or not the petroleum companies allocate the resources to implement the environmental protection plan in an appropriate manner. The national companies should report to the HSE-MOP on the execution of the plan and financial resource allocation in order to achieve the environmental objectives.

The HSE-MOP should also evaluate the resource allocation that the petroleum companies report and should provide recommendations for remedial actions to them if the resource allocation is not appropriate.

Strategy 5	Improving the EIA Implementation Procedures

The DOE published EIA guidelines covering petrochemical and oil refinery sectors. However, the contents of the guidelines are very general. In addition, the MOP and the petroleum companies do not equip any practical guidelines to prepare EIA reports. To improve and standardize the quality of EIA, preparing such technical guidelines is essential. Actions to be taken are as follows:

Action 5-1 Developing Specific EIA Guidelines and Check List for the Petroleum Industry

The petroleum industry includes onshore and offshore oil and gas production sector, petrochemical sector, oil and gas refining sector and oil and gas distribution and transportation sector. Specific consideration on potential environmental risks should be given to each sector. It is necessary to identify the types of petroleum projects in which implementation of EIA is required. In addition, the guidelines should also include the specific contents of survey and report in the petroleum industry. The detail is described in Subsection 7.3.2.

Action 5-2 Developing Specific SEA Procedures for the Petroleum Industry

The general strategic environmental assessment (SEA) guidelines are being prepared by the DOE based on Article 184 of the Fifth Five-Year Economic, Social and Cultural Development Plan. The pilot sites are the large petrochemical industrial complexes where cumulative and multiple environmental pollution could affect the surrounding area. In addition to the general guidelines, the HSE-MOP should therefore have the specific SEA procedures for the petroleum industry. The detail is described in Subsection 7.3.2.

Action 5-3 Developing Specific CSR Procedures for the Petroleum Industry

The HSE-MOP intends to place an emphasis on social responsibility of the petroleum companies in the project implementation. To disseminate the concept and requirements of the Corporate Social Responsibility (CSR), the HSE-MOP should have the specific CSR procedures for the petroleum industry. The detail is described in Subsection 7.3.2.

Strategy 6	Promoting Capacity Development at All Levels

To operate the HSE management systems properly, deploying the staff members to the HSE department and providing them with education and training programs are very important. This means that such effective operation of the HSE management systems requires the appropriate resource allocation to physical development as well as staff deployment and human resources development. Actions to be taken are as follows:

Action 6-1 Planning the Staff Deployment and Setting the Target Years

The environmental management is the element necessary for each stage of petroleum projects. The impact to be considered is not limited to the natural environment but includes socio-economy and covers a wide range of effects. The petroleum companies that operate a lot of producing wells and facilities should consider such impact in those areas. The national companies should also supervise the great number of companies. It is impossible that only one or two experts properly control all the activities of environmental management in those companies. To realize the planned organizational structure, the petroleum companies should prepare a staff deployment plan and make clear when the plan should be completed.

Action 6-2 Planning Education and Training Programs

The petroleum companies have documents that include job descriptions and qualifications such as academic degree and work experience for all the positions, prepare their own training plan every year, and provide training programs necessary for the capacity building. However, as shown in “Section 3.6.2 Result of Capacity Assessment”, the capacity gap of the staff members in charge of environmental protection was identified at the individual level. To execute the policies stated in this Master Plan, the petroleum companies should have education and training programs on the environmental management at all the levels including the top management. Table 7.3.1-5 show the specific education and training programs.

Table 7.3.1-5 Education and Training for the Petroleum Companies

a. Target Group: Top Management & Directors of Divisions

Category	Education and Training Items
Master Plan for Environmental Management and Oil Spill Response	- Goals and scope of the master plan - Basic policy of the master plan - Institutional development and technology - Action plans
Formulation and Promotion of the HSE Culture	- Steps of the HSE culture development and activities at every step - Promoting and improving the HSE culture - Evaluating the HSE culture development - Actions required for the development of HSE culture at the management level
Execution of the Integrated HSE Management Systems	- Concept of the integrated HSE management systems - Developing the organization structure to operate the integrated HSE management systems - Evaluating the integrated HSE management systems - Actions required for the operation of the integrated HSE management systems at the management level
Environmental Management Regulations	- Developing the cooperation systems among the departments to execute the SEA and EIA - Actions required for the execution of the SEA and EIA at the management level - Outline of new environmental regulations such as the total emission control systems and company's responsibility - Developing the organizational structure to introduce the new environmental regulations such as the total emission control systems - Actions required for the introduction of the new environmental regulations such as the total emission control systems at the management level

b. Target Group: Environmental Managers & Experts

Category	Education and Training Items
Formulation and Promotion of the HSE Culture	- Steps of the HSE culture development and activities at every step - Promoting and improving the HSE culture - Evaluating the HSE culture development - Actions required for the development of the HSE culture
Execution of the Integrated HSE Management Systems	- Concept of the integrated HSE management systems - Integrating the operation into the HSE risk management - Sharing the good practices including case studies of other countries - Evaluating the integrated HSE management systems - Actions required for the operation of the integrated HSE management systems - Matters to be included in the unified monitoring forms that is reported to the MOP and evaluation methods for the achievement of the objectives
Environmental Survey and Monitoring	- Sampling measures (sampling points, sampling methodology, etc.) - Compiling the sampling data - Analyzing the sampling data - Reporting the analysis result
Air Pollution Control	- Indices to be monitored and measuring methods - Promoting the collective actions or self-regulation in a region such as total emission control systems - Setting the target values for the total emission control systems - Improving the operations towards flaring gas reduction
Water Pollution Control	- Improving the existing treatment systems and examining the matters to be considered for introducing the integrated treatment systems
Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA)	- Outline of EIA required to the petroleum industry - EIA guidelines by industrial sector prepared by the DOE - How to evaluate the EIA statement - Matters required for the project proponent (evaluation points) - How to utilize the EIA statement for supervision of the operation

Category	Education and Training Items
	- Methodology of SEA prepared by the DOE - Sustainability indices and measuring methods prepared by the DOE
Oil Spill Modeling	- How to operate the simulation model - Application of the simulation result to the preparedness for emergencies and emergency response
Waste Management	- Understanding the issues of drill cutting discharge to the sea - Treatment methods of drill cuttings
Communication with Civil Society	- Objectives of CSR and the activities - Sharing the good practices including the case studies in other countries - Information disclosure - Possibility of other participatory activities

Source: Study team

7.3.2. Strengthening EIA Systems for Oil and Gas Industry

(1) EIA for Oil and Gas Development

1) Current EIA System in Iran

In Iran, Decree 138 (1204/1994) stipulates the industrial sectors subject to implementation of environmental impact assessment (EIA) and the DOE, as the authority, is responsible to review and approve the EIAs submitted.

The sectors subject to EIA includes power generation plants (larger than 100MW), steel plants, dams and river structures, industrial estates (larger than 100 ha), airport (longer than 2,000m runway), and the downstream oil sector such as oil refineries and petrochemical plants, but excluding the upstream sector of oil and gas development industry. (Refer to Subsection 3.4.3 for details.)

According to the EIA process of the DOE, the company which intends to implement a project subject to EIA shall provide the project plan to the DOE. Where called upon by the DOE to conduct EIA on the project, the company shall implement an EIA study and submit the EIA report to the DOE for approval. The DOE organizes a committee consisting of experts on the field to evaluate the validity of the EIA report.

2) Necessity of Specific EIA Guidelines for the Oil and Gas Industry

Meanwhile, onshore and offshore oil and gas development projects usually associate with varieties of environmental impacts depending on the site location of the project, target products, type and configuration of production facility, construction and operation activities, project phases as well as extent of affected area and period of the project, which are much different from other industrial sectors.

For appropriate implementation of EIA on the petroleum industry, it is essential to establish specific EIA guidelines to the respective oil sectors according to the characteristics of oil and gas

development with reference to the general EIA guidelines of the DOE. The petroleum industry in Iran includes onshore and offshore oil and gas development sector, petrochemical sector and oil and gas refinery sector. Each sector is required to have adequate environmental measures for reducing the potential negative environmental impacts of particular project and operation activities. Therefore, the HSE-MOP shall develop the EIA guidelines and checklist applicable to the petroleum projects listed below in collaboration with the mother companies.

- Offshore oil and gas development project
- Onshore oil and gas development project
- Petrochemical plant project
- Oil refinery plant project
- Oil and gas pipeline project

(2) Specific EIA Guidelines for the Petroleum Industry

1) Contents of the EIA Guidelines for the Petroleum Industry Projects

The EIA guidelines for petroleum industry projects shall include the following contents:

- Project phases and activities
- Scope of EIA (HSE risks and social impacts), process and method
- HSE policy and applicable laws and standards
- Environmental and social baseline study
- Potential environmental and social impact aspects of the project
 - Environmental impacts in normal situation and abnormal (emergency) situation
- Particular HSE risks and social impacts and applicable mitigation measures
- Cumulative environmental impacts
- HSE and social management plan
- Consolidation of EIA report
- Reference information

The items to be considered especially for the petroleum industry projects are (a) project phases and activities and (b) scope of EIA (HSE risks and social impacts). The EIA implementation is required at each project phase. The HSE risks and social impacts include the aspect of health, occupational health and environmental protection. The following are the contents to be included in the EIA guidelines for the petroleum projects.

(a) Project Phases and Activities

Oil and gas development project starts at exploratory survey of the expected oil and gas field in exploration phase. According to the survey results, the project proceeds to development and

production planning, and feasibility study of the project. After the feasibility study, the project proceeds to an implementation phase. In the construction phase, drilling of oil and gas production wells, designing of production facilities, procurement of materials and construction of the facilities are executed. After completion of construction, project proceeds to the operation phase, where the target oil and gas are produced. Production activity in the operation phase carries on for long term (15 – 20 years in case of medium scale of oil and gas field). Along with the aging of the reservoir, the production activity is terminated and the project proceeds to the decommissioning phase. Activities in this phase include isolation of production wells, demolishing and abandonment of the production facilities. Finally, the project is ultimately completed. EIA shall be implemented in the respective project phases as shown in Table 7.3.2-1.

Table 7.3.2-1 Project Phase, Activities and EIA Required

Project Phase		Activities	EIA Required
1	Exploration	- Seismic survey, exploratory/appraisal drilling (Investigation and appraisal of oil and gas reservoir)	- EIA on offshore seismic survey - EIA on exploratory/appraisal well drilling
2	Planning	- Development plan, production and facility plans, feasibility study (FS)	- Preliminary EIA based on the development plan, conceptual design of production facility, and feasibility study
3	Construction	- Production well drilling, facility design, procurement of materials, facility construction	- Comprehensive EIA based on the basic design of the production facility, construction and operation plan as well as decommissioning plan
4	Operation	- Facility operations, oil and gas production, transportation, storage, export	- EIA on modification/expansion of the production facility
5	Decommissioning	- Termination of production, abandonment/ demolishment of production facility	- EIA on decommissioning

Source: Study team

Since the construction projects of refinery and petrochemical plants do not have an exploration phase, the EIAs on these projects shall be applied in the planning phase and subsequent phases. The preliminary EIA (Pre-EIA) in planning phase shall be made roughly based on the information of development plan, conceptual design of planned production facilities and the outcomes of preliminary environmental and social impact studies. The results of the Pre-EIA shall be reflected to the HSE and social considerations in the basic engineering and detailed design of the production facilities and construction and production activities in the next phase. The comprehensive EIA to be made in the construction phase shall be carried out based on the detailed information of the final production facility plan, construction plan and production plan. The comprehensive EIA shall include accurate HSE risk and social impact assessment as well as applicable HSE risk

management and measures for mitigating the social impact on the project.

(b) Scope of EIA (HSE Risks and Social Impacts)

The EIA on offshore oil and gas development project shall address the particular HSE and social aspects shown in Table 7.3.2-2, depending on the site location and characteristics of oil and gas produced.

Table 7.3.2-2 HSE Risks and Social Impacts

Environment	Health and Safety	Social
- Environmental pollution	- Occupational health & safety	- Living & livelihood
- Ecology/ biodiversity	- Accident	- Indigenous people
- Topography & Geography	- Natural disaster	- Historical heritage
- Hydrology	- Emergency response	- Company reputation

Source: Study team

Emissions/discharges of various pollutants or hazardous materials into air, water or on land are expected associating with project activities and operation of production facility. It is effective to introduce numerical models for forecast of dispersion of the hazardous materials in the air and sea and assessment of probable environmental impact on the environment of project site and adjacent areas. In addition, for prediction of environmental and social impacts and establishment of effective emergency response plan for accidental release/spill of toxic gas, oil, petrochemical product, it is also effective to use gas and oil dispersion model.

2) EIA Procedures for the Petroleum Projects

The EIA procedures for the petroleum projects are as follows:

- Definition of project description
- Study on summary of environmental and social conditions of the project site (Screening)
- Scoping of major HSE and social impact aspects of the project
- Examination of alternatives
- Environmental and social baseline survey
- Identification of potential HSE and social impacts arising from the project
- Assessment of HSE and social impacts of the project
- Discussion of protection and mitigation measures for the impacts
- Preparation of EIA report

(3) Reviewing Procedures of EIA

The operating petroleum company which is the project proponent shall be the EIA executor. The MOP and the mother companies, which are the upper supervisory organizations of the companies, are responsible for monitoring the progress of EIA and evaluating the validity of preventive and mitigation measures against HSE risks and social impacts possibly associated with the project implementation. In order to fulfill the roles of the upper supervisory organizations, the HSE-MOP and the respective mother companies shall follow a practicable procedure to review the EIA. Therefore, the HSE-MOP should prepare a check list that can be commonly used in the petroleum projects to evaluate the validity of the EIA in collaboration with the national companies. The following are the basic items, but not limited to:

- Fairness of the EIA report (scope, contents, procedure, methodology, etc.)
- Compliance with specific EIA process (including information disclosure to stakeholders)
- Compliance with applicable legislations
- Validity of the project plan (including alternatives)
- Understanding of environmental and social conditions of the project area
- Existence of cumulative/combined environmental impacts with other project(s)
- Potential environmental pollutions and protection/ mitigation measures (air, water, wastes, soil, noise, odor, etc.)
- Potential impacts on natural environment and protection/mitigation measures (ecosystem, topography/ geography, hydrology)
- Social impacts and mitigation measures (involuntary resettlement, living and livelihood, historical heritage, landscape, working conditions, etc.)
- Occupational health and safety measures
- Accident prevention and emergency (contingency) plans
- HSE and social management plans
- HSE and social monitoring plans

The mother companies, to directly supervise its subsidiaries, are required to identify the particular HSE risks and social impacts caused by the project in each sector and discuss the specific evaluation items in addition to the above.

(4) Strategic Environmental Assessment (SEA)

Large scale industrial development plans are being implemented in Mahshahr, Khark and Assaluyeh areas in accordance with the national development plan of Iran. In these areas, several projects are executed in the same area or adjacent areas in parallel or in phases. According to such situation, the environmental impacts arising from the respective projects are considered as

cumulative impacts or combined pollutions in the whole areas. Therefore, it is extremely difficult to assess the entire environmental impacts resulted by the regional development project and discuss the effective protective measures through EIA studies on individual projects. For discussion and execution of effective environmental protective measures for such regional development project, it is essential to introduce Strategic Environmental Assessment (SEA) which will address the whole projects planned in the region.

In Iran, the concept of the SEA has already been introduced by the Fourth Five-Year National Development Plan. Subsequently, Article 184 of the Fifth Five-Year National Development Plan states the implementation of SEA for national and regional level of development projects, which mainly aims:

- a. Sufficient consideration of cumulative/ combined environmental impacts
- b. Proper assessment of regional impact assessment
- c. Promotion of national and regional level of sustainable development
- d. Monitoring of national and regional level of development plans
- e. Establishment of execution scheme for practicable SEA system

The DOE is currently preparing applicable SEA guidelines based on the Fifth Five-Year National Development Plan. Similarly, the petroleum companies are required to carry out the SEA when they execute the development plan as project proponent. The HSE-MOP is made responsible for ensuring the implementation of the SEA for the oil and gas projects. Therefore, the HSE-MOP should provide the specific guidelines for the petroleum industry to implement the SEA related to regional development project in the petroleum industry in cooperation with the DOE.

For example, in Assaluyeh region, Phases 1 to 10 of the development projects have already been completed, and the subsequent Phases 11 to 24 projects are currently undergoing or under preparation. The current serious air pollution, which is the major concern of the region, is considered to be caused by the combined and cumulative impacts due to massive flue gas emissions from operating gas refinery plants in Phase 1 to 10 and adjacent petrochemical plants. According to progress of the subsequent development projects, further environmental degradation is expected in the same area. For effective improvement of such environmental condition in this area, it is essential to tackle the issue through proper prediction of long-term possible environmental impacts and dedicated discussion of effective mitigation measures at regional level in accordance with the concept of SEA.

The EIA study on individual project shall be made by the operating company which is the proponent of the project. However, it is assumed that the MOP and the related mother companies shall assist the operating company to implement the SEA on large scale development project such as Assaluyeh. Accordingly, for establishment of the SEA scheme of the petroleum industry, the roles and responsibilities among the HSE-MOP and mother companies should be clarified.

(5) Information Disclosure

The EIA information of industries is disclosed limitedly to the stakeholders including relevant governmental organizations and local communities of the project sites under the current EIA system authorized by the DOE. On the other hand, among oil related industrial sector in Iran, privatization by introduction of private finances is promoted strongly in the petroleum industry for this decade. According to such trend, internationalization by introduction of foreign investment is also expected for promotion of oil and gas development projects in near future. The companies that embrace international oil and gas development are generally required to implement corporate social responsibility (CSR) including proper environmental and social considerations as internationally competent company.

The CSR of international companies also requires fair disclosure of information related to the intended project activities to all the stakeholders, which includes project plan, environmental and social impacts associated with the project and protection/mitigation measures as well as performance of the plan. The stakeholders in international oil and gas development projects generally consist of foreign shareholders/investors, banks, insurers, customers of products, international oil organizations, neighboring countries, international medias, international NGOs, etc. in addition to domestic stakeholders. For dedicated execution of the CSR, the petroleum companies as proponent of oil and gas development project are required to establish the comprehensive information disclosure plans. In order to accelerate the movement, the HSE-MOP should provide the guidelines for CSR in the petroleum industry in collaboration with mother companies.

(6) Corporate Social Responsibility

The HSE-MOP recognizes the importance of executing corporate social responsibility (CSR) to various activities in the development project and operation of the respective national companies and their subsidiaries. The HSE-MOP will request them to regularly issue a CSR report or sustainable report on their activities.

CSR is a process with the aim to embrace responsibility for the company's actions and encourage a positive impact through its activities on the customers, consumers, shareholders, financiers/renders, employees, local communities, regulators, NGOs and all other members who may also be considered as stakeholders. CSR is a form of corporate self-regulation integrated into a business model enabling company's continuity together with sustainable development of the community. In order to realize the implementation of CSR in the petroleum industry in the country, the HSE-MOP should provide the guidelines for CSR in the petroleum industry in collaboration with mother companies.

The international standard for CSR ISO 26000 titled "Guideline on social responsibility" was published in November 2010, which does not require complying with it similar to other

management standards such as ISO9000, ISO14000, etc. The guideline suggests the following seven subjects but excluding contribution to society such as donation, voluntary activities, etc.

- Organizational governance
- Human right
- Labor practices
- Environment
- Fair operating practices
- Consumer issues
- Community involvement and development

Based on the subjects shown in the ISO's guidelines, the petroleum companies can include the following points in their CSR reports, which are provided in the documents prepared by the international organizations of oil industry, such as IPIECA, OGP and API:

Environment

- Climate change and energy
 - Greenhouse gas (GHG) emissions, energy consumption, alternative energy sources, flare gas
- Ecosystem services
 - Biodiversity and ecosystem services, water quality conservation
- Local environmental impacts
 - Gas emissions, oil spills to environment, wastewater discharges, wastes

Health and Safety

- Workforce protection
 - Workforce participation, workforce health, Occupational injury and illness, incidents
- Product health, safety and environmental risks
 - Product stewardship
- Process safety and asset integrity
 - Process safety

Society and Economy in the Region

- Community and society
 - Local community impacts and engagement, indigenous peoples, involuntary resettlement, social investment
- Local content
 - Local content practices, local hiring practices, local procurement and supplier development
- Human right

- Human rights due diligence, human rights and suppliers, security and human rights
- Business ethics and transparency
 - Preventing corruption, preventing corruption involving business partners, transparency of payment to host government
- Labor practices
 - Workforce diversity and inclusion, workforce engagement, workforce training and development, Non-retaliation and grievance system

According to the international and domestic requirements on CSR of the petroleum industry, major petroleum companies and others in the world including the Persian Gulf countries practically execute their own CSR activities and voluntarily publish annual CSR reports or sustainable reports indicating the performances of their CSR activities. In response to such trend of CSR of the petroleum industry, the HSE-MOP has stated a promotion of CSR activity to the petroleum companies in the country. For effective promotion of the CSR activities, the HSE-MOP shall strongly call the attention of all national companies to execute the CSR activities and establish specific CSR guidelines for the petroleum industry in Iran.

7.3.3. Total Emission Control

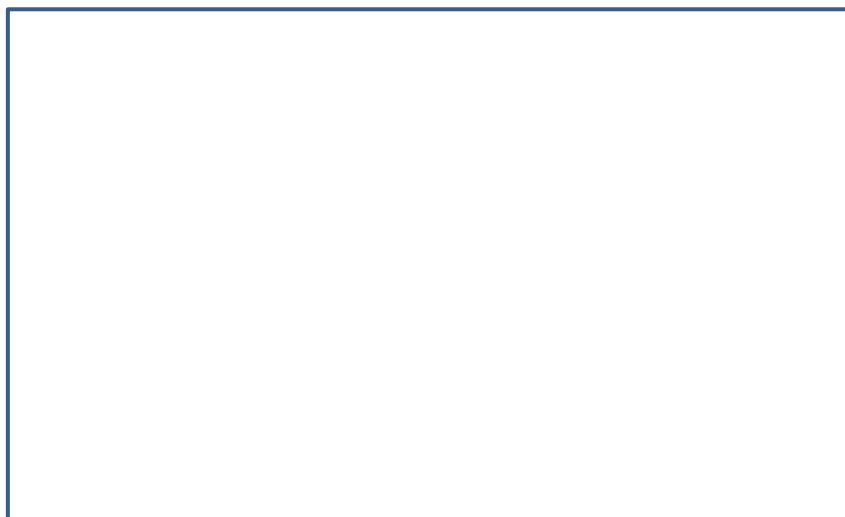
Environmental Standard is set for protection of public health for maintaining desirable living environment. For achieving the environmental standards, emission standards are set for each factory depending upon the raw material, production and capacity in Iran. However, controlling atmospheric quality with emission controls specified for each source such as factories and chimneys may become difficult if a large number of factories are dense. In such locations, introducing a total emission control system, which controls the emission from the whole factories in the area, is more effective in addition to emission control, which is applicable for individual factories. The total emission control is a system to designate such region, calculate the allowable emission volume for achieving the environmental standards with air diffusion simulation and regulate the emission from factories. Basically, this kind of environmental regulation should be institutionalized by the DOE, the national authority of environmental protection in the country, as the national air pollution control scheme. However, the capacity of the DOE, especially human resources and equipment in local offices, is very weak at the moment. Introducing such system requires not only legislation by the DOE but also initiative of the petroleum industry to control the cumulative environmental negative impact in one industrial zone. Therefore, the HSE-MOP can promote the actions towards institutionalizing the total emission control system in cooperation with the DOE.

(1) Outline of the Total Emission Control System

The principle of total emission control is to identify the relation between the emission source of the target pollutants and ambient air quality, to clarify the prospect to achieve the air quality standard and to regulate the emission sources. Therefore, it is necessary to clarify the relation between the emission source of the target pollutants and ambient air quality in a scientific and rational manner. In accordance with the Air Pollution Control Act of Japan (1968 (last revision: 2013), the outline of total emission control system can be summarized as follows¹:

- To clarify the relationship between the emissions of designated pollutants and ambient air quality using scientific and rational methods in the target area;
- To establish the target reduction emission volume of the specific pollutants discharged from designated factories having more than a certain capacity, and;
- To set the total emission standard for achieving this target reduction volume and establish the allowable emission volume for each factory.

Figure 7.3.3-1 shows the concept of total emission control. Introduction of total emission control has advantages in (i) effectiveness in improvement of the regional atmospheric quality and (ii) easiness in control of air quality after introduction. On the other hand, there are some disadvantages such as (i) enforcement of stricter standards to public and private companies than the legally designated standards and (ii) necessity of regional consent on introduction of the system.



Source: Study team

Figure 7.3.3-1 Concept of Total Emission Control

¹ Environmental Research and Control Center, 2004, Manual for nitrogen oxides total emission control

(2) Administrative and Legal Systems

The total emission control system in Japan is enforced to the areas where achieving atmospheric environmental standard is of difficulty. In such region, governors of local governments prepare a total emission reduction plan for specific pollutants and the cabinet office of the government of Japan defines the total emission standard. A local government is authorized to inspect factories at any time. Less than one (1) year imprisonment or fine less than approximately US\$ 10,000 may be imposed to violators as penalty. The Ministry of Environment is in charge of preparation of specific standards for fuel or measurement as ministerial decrees.

Whereas, it is hard to directly apply the Japanese total emission control system to Iran since the administrative and legal system differs. Therefore, as mentioned above, the total emission control system in Iran can be initiated by the MOP in cooperation with zone management companies. The legal justification shall be based on the environmental regulations of the DOE. The administrative and legal framework to be expected for introduction of the total emission control system in Iran is illustrated in Table 7.3.3-1.

Table 7.3.3-1 Administrative and Legal Frameworks

Item	Implementing Body	
	Iran (recommendable)	Japan
Total Emission Reduction Plan	Zone management company	Local government
Total Emission Control Standard	MOP	Cabinet office
Monitoring of Emission	Operating company	Operating company
Inspection	Zone management company	Local government
Definition of measurements	DOE (MOP if necessary)	Ministry of Environment
Legal Justification	Environmental regulation of the DOE is desirable.	Basic Environmental Law & Air Pollution Control Act

Source: Study team

(3) Introducing the Total Emission Control System

1) Designating the Target Pollutant

Specific pollutants to be regulated shall be designated under the total emission control system. In case of Japan, Sulfur oxides and nitrogen oxides are defined as pollutants to be regulated. In consideration of characteristics of petroleum industry, sulfur oxides shall be designated as pollutant under this draft master plan.

2) Designating the Target Area

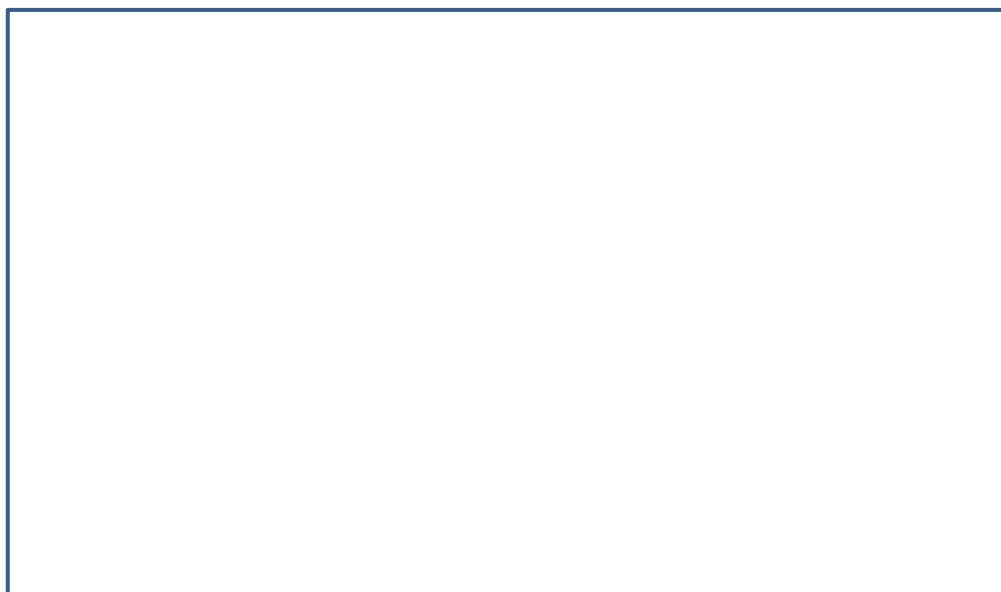
The total emission control system shall be applicable for the area where factories and industries are dense in one specific region. In consideration of the distribution of factories and industries, ambient air quality and achievement of atmospheric environmental standard as well as future development, Assaluyeh shall be designated as the region where the total emission control system is applied among the three pilot areas.

3) Preparing a Total Emission Reduction Plan

Total emission reduction plan for specific pollutant shall be prepared for actualization of total emission control in the designated area. It should contain, but not limited to, the followings:

- The total emission amount of the specific pollutants to be discharged into the air owing to any industrial and other activities;
- The total emission amount of the specific pollutants to be discharged into the air owing to any industrial activities;
- The total emission amount of the specific pollutants to be discharged into the air owing to other activities;
- The total amount of specific pollutant in the designated area which is able to achieve the atmospheric environmental standard, and;
- The target reduction volume by introduction of total emission control system, schedule and methodology.

Figure 7.3.3-2 illustrates the concept of establishment of emission reduction target by introduction of total emission control. Based on meteorological data and emission data such as emission volume and concentration, simulation model shall be established in comparison with the current ambient air quality data. By inputting the future development plan including emission sources and volume, future projection simulation shall be carried out. The result of the future projection simulation shall be evaluated with the regional target and total emission reduction plan shall be established.



Source: Study team

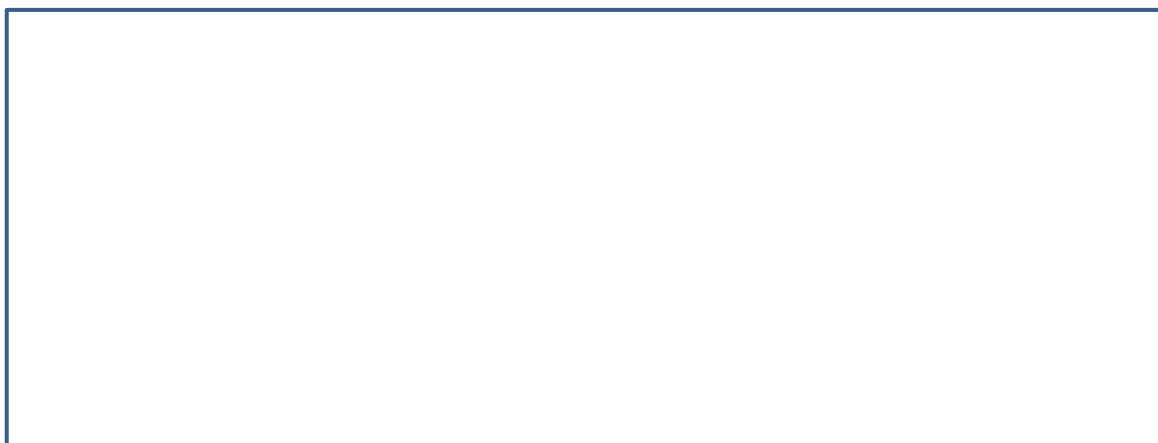
Figure 7.3.3-2 Preparation of Total Emission Reduction Plan

(a) Meteorological Data

At least one (1) year following meteorological record data is required for computer simulation. Aerological data shall be collected to identify the location of an inversion layer and, therefore, the monitoring shall be carried out at each season.

- Wind direction and speed
- Solar radiation and amount of cloud
- Aerological data (temperature, wind direction and speed, and moisture)

Figure 7.3.3-3 shows the typical methodology of data analysis for wind direction, wind speed, solar radiation and cloud.



Source: Japan Meteorological Agency

Figure 7.3.3-3 Typical Example of Data Analysis

(b) Identifying Emission

There has been no systematic database available for understanding the factories, industries, and emission condition of pollutants in petroleum and gas industry. Therefore, an inventory survey shall be carried out for identification of emission sources. Table 7.3.3-2 outlines the information to be inquired under the inventory survey.

Table 7.3.3-2 Contents of Inventory Survey

Subject	Details
1. Outline of factory and industry	- Location and address - Location map - Type of business, capacity and production process
2. Outline of facility and stacks	- Type of facility, name and type of burner - Height and diameter of stacks - Location map for each facility, stacks and their relationships - Location of stacks (code)
3. Operation condition of the facility	- Type, amount, and sulphur and nitrogen contents in the fuel - Type, amount, and sulphur and nitrogen contents in the raw material - Operational condition over season and hours (operation of burners and loads)
4. Emission volume	- Concentration of sulphur, emission volume, temperature, residual oxygen, emission speed, dry and wet gas volumes, etc.
5. Mitigation measures	- Pollutant treatment system, name, capacity and efficiency - Other mitigation measures and their effects

Source: Study team

The collected data shall be analyzed in sort of each factory, industry, season and operational hours. The total emission volume discharged from each factory and the target area shall be estimated.

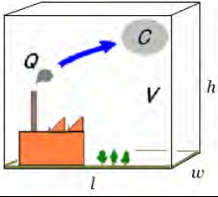
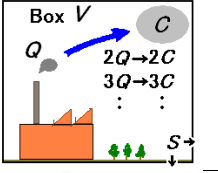
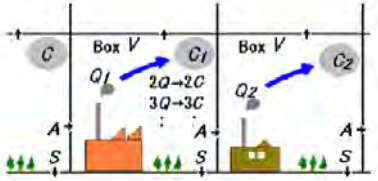
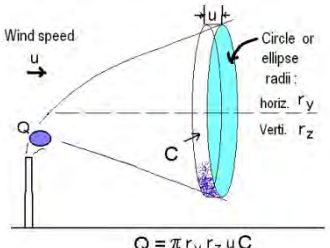
(c) Selecting a Simulation Model

Table 7.3.3-3 describes typical models for air quality simulation. The following points shall be referred during the selection of simulation formulae.

- Objectives: The simulation formulae shall clarify the relationship between the emission sources and ambient air quality.
- Emission Source and Dispersion Conditions: Distribution of various emission sources in the designated area including low emission sources shall be carefully analysed. It is also necessary to select the suitable model which enables to reproduce the current condition in consideration of topographic and meteorological conditions.
- Reproduction of Dispersion: In general, high concentration appears under unstable weather conditions including wind direction and speed. The selected model shall reproduce such high concentration with limited input data.
- Workability: A significant manpower is required for inputting data and analysis of simulation models. Therefore, workability and work volume shall be also taken into consideration for selection of the suitable simulation model.

Typical simulation models for air pollution has both advantages and disadvantages. The models shall be carefully selected in consideration of topographic and meteorological conditions, and available data sources. Therefore, while inventory surveys are carried out, it is recommended that Iranian side shall develop the best suitable models.

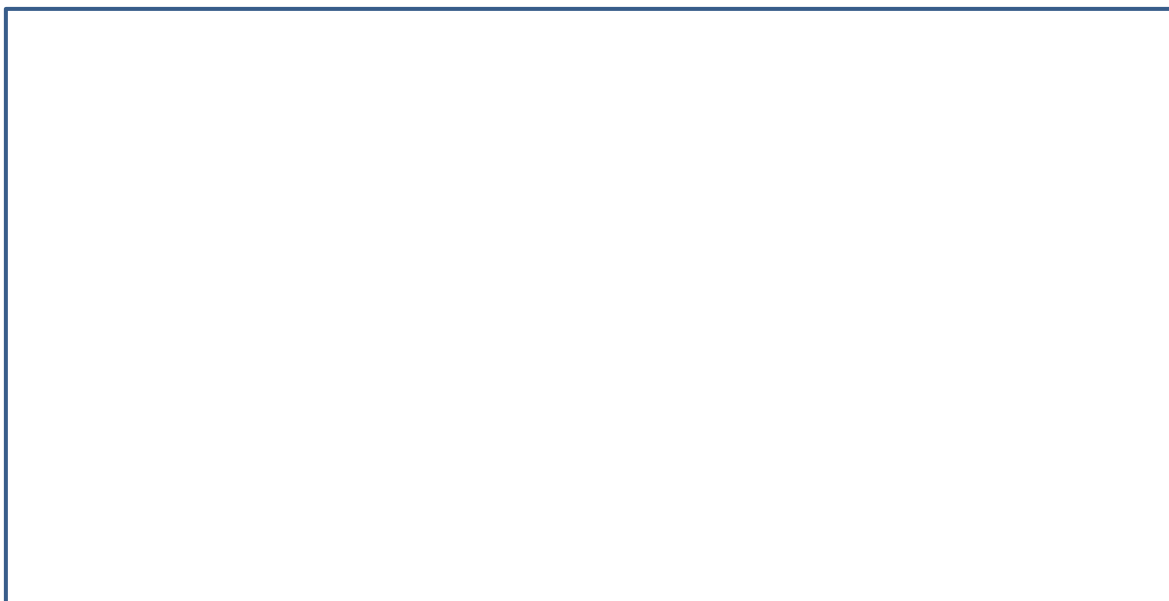
Table 7.3.3-3 Typical Simulation Models

Model Type		Outline	
Box Model	One Box		The model deals the area as one box (volume = V) and the concentration of pollutants depends on the emission volume (Q) ($C = Q \div V$).
	Difference method		Concentration (= C) is dependent over the time, emission volume and reduction from the box. $V \frac{dC}{dt} = Q - S$
	Multi-Box Model		Concentration of pollutants inside a box is uniform. The change in concentration is reproduced through frequent from and to the boxes over time.
Plume and Puff			Concentration of pollutants is reproduced by diffusion and advection. In general, plume model is suitable for flat and uniform locations. Although puff model may reproduce unsteady state, diffusion parameters are limited.

Source: Study team

(d) Comparing the Result and Monitoring Data

Results of typical simulation models are illustrated in Figure 7.3.3-4. Commonly annual average concentration and peak concentration are obtained as outputs. The results of the simulation shall be compared with the actual data (monitoring data) and appropriateness of the simulation model shall be evaluated. Input parameters and meteorological data shall be examined if the simulation model cannot reproduce the actual air conditions.



Source: National Institute of Advanced Industrial Science and Technology

Figure 7.3.3-4 Typical Outputs of Simulation

(e) Simulation

By inputting future emission source distribution and emission volumes at the target year into the model established above, future simulation shall be carried out. The simulation result will provide a concentration map and show the location with the highest concentration of the target pollutant.

(f) Evaluation

The outputs of the simulation shall be compared with environmental standards and evaluated. For those areas where high concentration of pollutants is foreseen, further details such as degree of impacts over seasons, hours, etc. shall be examined. Based on the analysis, mitigation measures shall be prepared.

(g) Preparing a Total Emission Control Plan and Target

The allowable total emission volume in the area for achieving environmental standard shall be calculated. Total emission control plan including methodology and schedule for achieving the target shall be prepared.

4) Setting the Total Emission Standards

The zone management company shall set the total emission standards to achieve the target based on the total emission control plan described in “(3) 3) Preparation of Total Emission Reduction Plan”, and shall set the total emission standards in each zone after the MOP’s approval.

5) Registration and Notification Systems

Computer simulation is dependent on the data including locations of facilities, types and emission volumes. Therefore, any information on construction of new factories and any change in factory's structure shall be registered and stored in a single database. The same format as the inventory survey may be used as registration forms. The zone management company shall prepare a database for registration of these information.

6) Monitoring and Inspection

Each factory shall conduct measurement and monitoring of emission volume and pollutant concentration. The zone management company is in charge of monitoring of ambient environmental concentration through monitoring in each zone (see Section 7.3 for the detail of environmental monitoring). The MOP and the zone control company shall be authorized to inspect at any time if any companies are suspected to violate the total emission standards established. In case if the companies are further suspected to continuously violate the standards, the MOP shall instruct improvement including change of fuel, application of mitigation measures, etc. The Zone management company shall monitor the progress of improvement.

7) Establishing a Regional Air Quality Control Committee

Cooperation of all companies in the target region is indispensable for introduction of the total emission control system and continuous execution. For securing transparency and accountability, current air quality shall be reported. Therefore, a regional air quality control committee consisting of HSE or environmental managers of the zone management company and all the operating companies shall be established as a separate meeting to the regular liaison meeting. The zone management company shall report the result of environmental monitoring and explain the inspection result and operation improvement orders at the meeting if necessary.

7.4. Environmental Protection

7.4.1 Concepts for Applicable Environmental Protection

Various technologies for protection of environmental pollutions (air, water, soils, etc.) arising from oil and gas development activities are currently available and used widely around the world. It is necessary to apply the most effective technology among them depending on the type and amount of pollutants, conditions of the site, and significance of the expected environmental impact as well as the regulatory requirements.

For selection of the most effective technologies applicable to the environmental issues subject to each pilot area, discussions shall be made in accordance with the following concepts.

(1) Best Available Technology (BAT)

Best Available Technology (BAT) shall mean that the operator has to use the very best possible technology and equipment at the time to protect the environment that can be economically justified considering the highest environmental standards.

"**Best**" shall mean as the most effective in achieving a high general level of protection of the environment as a whole.

"**Available**" techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether the techniques are used widely in the world or reasonably accessible to the operator.

"**Technology**" shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

This concept is widely applied in the world including the U.S. and European countries as well as Japan, which is based on "Polluter-pays principle", the operator shall apply the best environmental protection measures by self-selection.

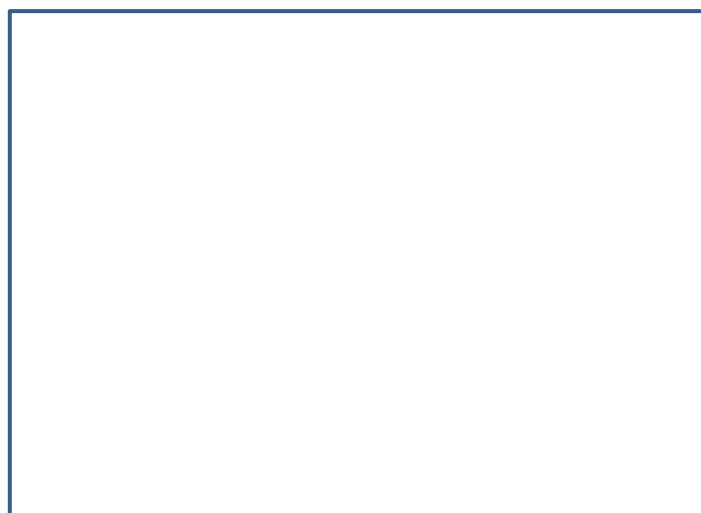
Procedures for discussion of the BAT environmental protection measure includes:

- i) Identification of pollution sources and estimation of environmental loads
- ii) Collection of related information for applicable protection technology candidates
- iii) Investigation of particular conditions of the area (environmental and social baseline, regulatory requirements, etc.)
- iv) Extraction of the most applicable technologies
- v) Discussion of availability of the extracted technologies (techniques, constructability, costs,

- operability and maintainability, safety, etc.)
- vi) Discussion/ coordination to relevant organizations
- vii) Decision for selection of applicable technology

(2) As Low As Reasonably Practicable (ALARP)

As Low As Reasonably Practicable (ALARP) shall mean that the residual HSE risk after undertaken the applicable mitigation measures shall be as low as reasonably practicable. The aim is to reduce the residual risk to the acceptable level considering the balance between the cost required for reduction of the risk caused by the project and environmental and social benefits (effect) given by the protective measures to be undertaken. Therefore, for setting of a proper ALARP level, it is required to compare the expected residual risk and estimated cost, time period and works spent for the mitigation measure. The concept of ALARP is illustrated in Figure 7.4.1-1.

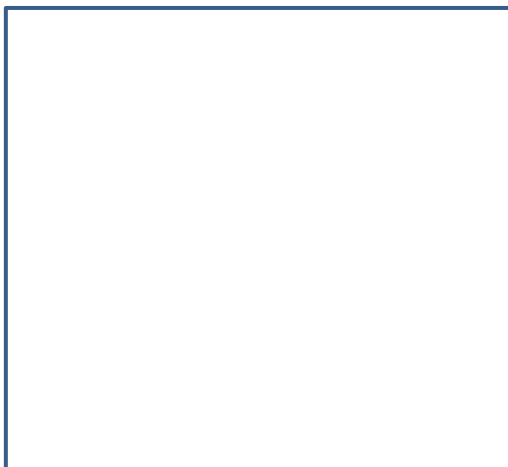


Source: Study team

Figure 7.4.1-1 ALARP Concept

- i) Unacceptable region: Intolerable
Adverse risks are intolerable of whatever the benefits gained and cost for risk mitigation measures are essential if activity is to continue.
- ii) ALARP region: Tolerable
A level of risk that is tolerable and cannot be reduced further without expenditure of costs dis-proportionate to the benefit gained or where the solution is impractical to implement
- iii) Broadly acceptable region: acceptable
Risks are negligible, or so small that they can be managed by routine procedures and no additional risk treatment measures are needed.

The ALARP region in a relationship between the cost required for risk reduction and the benefit (effect) is illustrated in Figure 7.4.1-2.



Source: Study team

Figure 7.4.1-2 Cost/Benefit (effect) and ALARP Region

7.4.2. Air Pollution Prevention

As described in Chapter 4, it is considered that main causes of air pollutions associated with operations of large scale of petroleum complexes in the pilot areas are emissions of flue gases from the flare stacks burning out the surplus gas and off-gas from each plant and combustion equipment such as boilers, gas turbines and heat furnaces, as well as the diffusion of fugitive volatile gases from facilities and gas releasing devices in the plants, etc.

Pollutants contained in flue gases and other gases emitted in the atmosphere, which are directly affected to air quality, include mainly sulfur oxide compounds (SO_x), nitrogen oxide compounds (NO_x), particle matters (PM) and other harmful compounds such as volatile organic compounds (VOC).

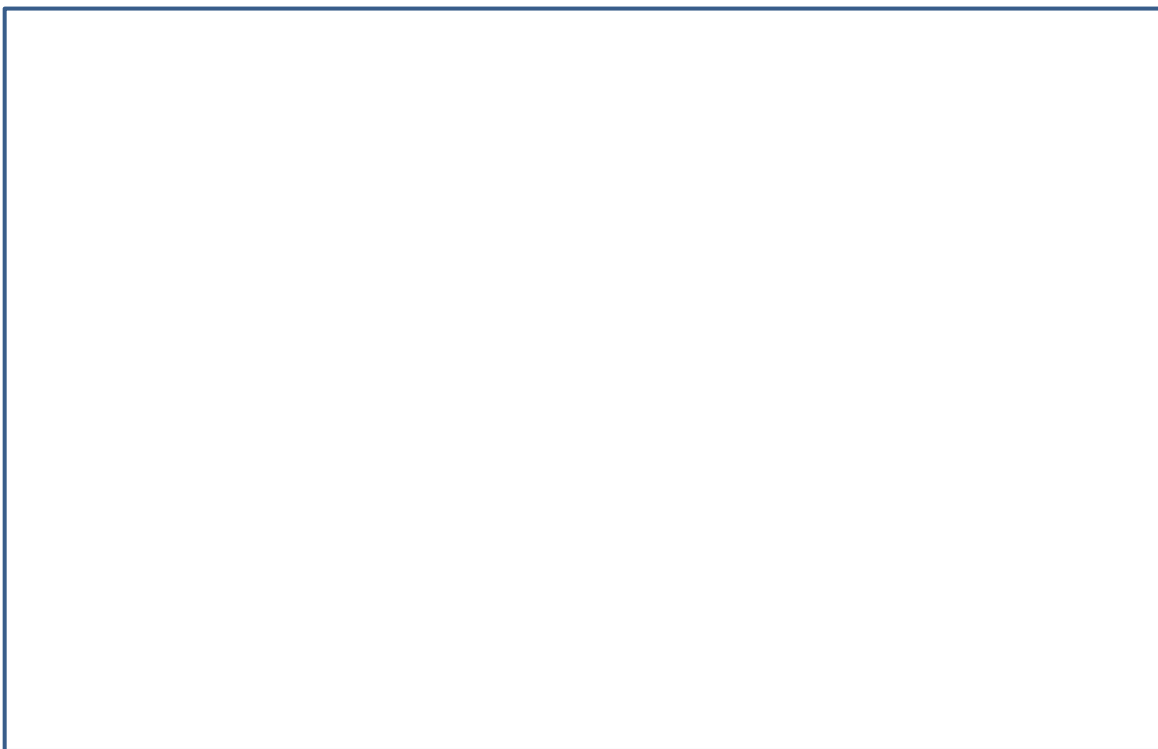
Among the various emission sources in the petroleum plant, it is well recognized that flare stack is not only one of major causes of regional air pollution but also the largest GHG emission source in upstream petroleum industry. Hence, for prevention or mitigation of air pollution caused by emission of these harmful materials, flare gas reduction is expected to be an effective measure along with other measures to control emission of the pollutants.

Subsection 7.4.2 discusses the most effective and applicable measure for solving current air pollution problems confronting in each pilot area.

The following five items are described to study air pollution prevention measures and their application. Various air pollution prevention technologies are introduced and their brief explanations are described in (1). The current environmental situation of each pilot area is summarized in (2), and applicable methods to each pilot area are discussed in (3). Furthermore, applicable air pollution prevention technologies for Assaluyeh confronting with serious air pollution are studied in (4), and in (5), expected effects of the counter measures, where several preventive measures been taken appropriately in Assaluyeh, are predicted. Then, action plans for implementation of the master plan for pilot areas are proposed in (6).

(1) Brief Explanation of Air Pollution Prevention Technologies

Four air minimization concepts are considered in the application of air pollution preventive technology and applicable technology in each concept are described.



Source: Study team

Figure 7.4.2-1 Air Pollution Prevention Technology

A. Reduction of Gas Emission Amount

The following 5 reduction technologies are proposed and described in this concept.

1) Maximum Recovery of Usable Gas

As mentioned above, flare stack is one of largest flue gas emission sources in the oil and gas production facilities. Flare gases burning out in the atmosphere by flare stacks consist on various off-gas released from oil and gas treatment process equipment and surplus gases generated from plants depending on operational situations of whole production process.

It is a fact that flare gas in oil and gas fields is wasteful because most excessive gas emitted out of the process is flared. Reduction of surplus gases caused by production process is the most effective measure to be taken firstly. It can be achieved by proper gas production planning of both offshore upstream facility and onshore downstream facility according to demand and supply balance of the whole gas product process.

Furthermore, maximum recovery of flare gas containing valuable gases and use for other purposes such as feedstock of other processing plants and/or fuel gas for process and utility equipment is also effective.

2) Efficiency Increasing of Oil and Gas Treatment Processing

Wasteful off-gas/ tail gas generated from gas processing facility is treated together with other excess gas by flare stack or gas incinerator in the facility. Various technologies which provide

higher processing performance benefits and low process waste gas generation are now available. Efficiency of sulfur recovery unit (SRU), which recovers sulfur in H_2S containing acid gas removed from raw gas in gas sweetening process, is deeply related to amount of tail gas with extremely high H_2S concentration. Low efficient or deteriorated SRU could be one of largest H_2S emission source in the facility depending on the operational conditions. Introduction of high efficient SRU or addition of adequate tail gas treatment unit in the process is effective for reduction of tail gas generation.

3) Introduction of High Efficient Combustion Equipment

This technology is especially effective for large scale combusting equipment such as steam boiler, gas turbine, heat furnace, etc. Reduction of fuel consumption and environmental preservation can be achieved by introducing high efficient combustion equipment. This method shall be considered for installation of new combustion equipment in Assaluyeh and renewal of facilities in Mahshahr as well as Khark Island.

4) Reduction of Fugitive Gas (Improvement of existing equipment)

Fugitive gas unintentionally released or leaked from equipment in facility is well recognized that it shares a considerable portion among emission sources in petroleum related plant. Fugitive gas consists of mainly volatile organic compounds (VOC) as well as BTX (butane, toluene, and xylene) included in feedstock materials, processing fluids as well as intermediate and final products of the plant, and process equipment, pipe joints, valves, pumps and compressors, storage tanks, product lading equipment, etc. are counted in release sources. In Assaluyeh, condensate tanks are observed as the largest release source harmful benzene in the plant.

Fugitive gas releases can be reduced by preventing leakage from production processing equipment and products storage tanks. Introduction of VOC gas recovery unit, operational improvement of condensate stabilizer that control the generation of VOC components in condensate, and modification of roof seals of floating roof tanks as well as proper facility maintenance are effective for the purpose.

5) Gas Underground Injection

As described in above 1), flare gas is one of largest emission sources in upstream petroleum industry. It typically consists of surplus gas generated in oil and gas production process and wasteful off-gas/ tail gas from processing unit, which possibly contain H_2S and other harmful components depending on the features of raw material and processing plant.

Zero flaring considered as ultimate preventive measure for flare gas emission can be achieved by flare gas injection into underground stratum. This method is to fully and effectively utilize flare gas for enhancing oil recovery (EOR) in oil reservoir through reservoir pressure maintenance or gas flooding of oil in reservoir by injection after recovery of flare gas.

This method is expected to contribute to conservation of gas resources as well as reduction of GHG emissions from upstream petroleum industry. Accordingly, many oil producing countries in the

world including the Persian Gulf region have been already implemented zero flaring as ultimate solution.

In Assaluyeh, a high concentration of H_2S gas is separated from feed gas in gas sweetening unit, and then, sulfur in H_2S gas is recovered by sulfur recovery unit for export in international market as byproduct. Considering future excess market of product sulfur or risks for catalyst procurement capacity of sulfur recovery unit, transition to direct underground injection of H_2S gas from sweetening unit is considered to be effective for reduction of harmful gas emission from plant as well as stable operation of the company.

B. Minimal Air Pollutants Generation

The following 2 reduction technologies are proposed and described in this concept.

6) Use of Highly Efficient Combustion Burner

(a) Appropriate Flare Gas Combustion

Minimal generation of air pollutants from flare stack is achieved by encouraging complete combustion of flare gas. Since flare gas consists of hydrocarbons (mainly methane gas and occasional oil mists), H_2S and others, incomplete combustion of flare stack cause emission of non-combusted methane gas, hydrogen sulfide (H_2S) and smokes (PM), which affects global warming and air quality in the area.

As described in Chapter 4, there are many flare stacks that releases gas with black smoke in the pilot areas. The black smoke can be prevented by improving the design of flare stacks and operation of flare system to ensure complete combustion of flare gas.

(b) Improvement of Combustion Conditions

This application restricts the generation of NO_x from large to medium scale combustion equipment such as gas turbine, steam boiler and heat furnace. Reduction of NO_x can be achieved to provide lower oxygen concentration (low air-fuel rate), shorten retention time in higher temperature area, lower combustion temperature without local high temperature spots in combustion chamber of equipment.

● Steam Injection

This technology restricts the generation of NO_x by injecting steam to combusting chamber in equipment in medium scale gas turbine.

This can be applied for gas turbines for power generators and gas boosting compressors that exist in each pilot area and the introduction of this technology is suitable especially for the area that has a problem about NO_x generation.

● Low NO_x burner

This equipment is capable of shortening the gas retention time in high temperature zone of

combustion chamber to control generation of NO_x. Introduction of this equipment is economical in such a way that only replacement of the burners is required and there is no necessity to improve the furnace and boiler. Existing equipment are being replaced to this equipment one by one in Assaluyeh area and the application of this equipment for other pilot area is also considered.

7) Usage of High Quality (low sulfur) Fuel

When a fuel used for combustion equipment in plants includes high sulfur component, sulfur compounds (SO_x) will be released as a result of combustion, which cause air pollution. Therefore, it is environment friendly to use high quality (low sulfur) fuels. Fuels in Assaluyeh have been already replaced from heavy fuel oil to natural gas for prevention of air pollution caused by emission of SO_x. On the other hand, in Mahshahr, the heavy fuel oil is still used by several plants. For further air quality conservation in the area, the fuel is also required to be replaced with natural gas or low sulfur content of fuel oil.

C. Elimination of Pollutants

The following reduction technology is proposed and described in this concept.

8) Installation of Flue gas Treatment Facility

This technology involves the installation of exhaust gas desulfurization system, de-nitration system, and dust collecting system as air pollution prevention measures for petroleum refineries, petrochemical plants, thermal power plants that release flue gases possibly including sulfur oxide (SO_x), nitrogen oxide (NO_x) and particle materials (PM) depending on the types of fuel using and features of the equipment. The application of these technologies can eliminate the air pollutants up to 95% and prevent air pollution greatly. The application of these technologies shall be discussed for the treatment of exhaust gas of boilers and furnaces in consideration of air quality if there is a development plan of large scale petroleum complex.

D. Diffusion of Pollutants

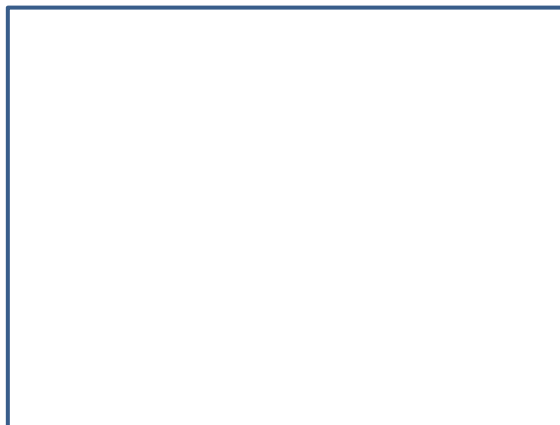
The following reduction technology is proposed and described in this concept.

9) High Stacks

This technology makes the emission gas and pollutants diffused to a farther distance and diluted by air. This technology can collect exhaust gas emitted from plants by providing concentric stacks, and can diffuse and dilute air pollutants to about 5-10 km away by using high stack height reaching about 100-150 m.

For application of high stacks and decision of effective height and location in Assaluyeh, dedicated study of air flow in the area and analysis of probable gas diffusion in atmosphere are required, because there are 1,500 m class mountain chains. The technology shall be considered for the latter

when the facilities' expansion is carried out.



Source: Study team

Figure 7.4.2-2 High Stacks

(2) Air Pollution in the Pilot Area

1) Mahshahr

As described in Section 4.1, there are facilities for downstream industry (petrochemical) in Mahshahr area. At present, there are some cases where the concentration of PM10 exceeds the allowable value and reaches the harmful concentration at the monitoring point in the complex. It is necessary to monitor the environmental conditions throughout the year and analyze the seasonal dependency trend of monitoring records to verify this cause.

2) Khark Island

Many black smoke plumes are observed at the flare stacks in crude treatment facility area in Khark Island area. This can be attributed to incomplete combustion due to liquid infusion into gas and excess gas amount. Since hydrocarbons and hydrogen sulfur (H₂S) are included in this incomplete combusted gas that results in polluting the air in the Persian Gulf and its coastal area, reduction of air pollutants by smokeless flaring at the flare stacks is required.

Flare gas reduction project by IOOC for maximizing the usable gas recovery is in progress. It is expected that upon completion of the project, current flare gases will be extremely reduced.

3) Assaluyeh

There are upstream (gas refinery complex) and downstream (petrochemical complex) facilities in Assaluyeh. Air pollution attributed to released gases such as SO_x, NO_x, PM and VOC is a major environmental problem in this area at the moment. There are many flare stacks at the foot of hill at the north side of the area and flares with black smokes are observed. The skies are covered with stagnant air of emitted gas from the plants because the area bristles with chimneys of boilers,

heating furnaces and gas turbine generators. As described in Section 4.3, since the amount of flared gas in the upstream section is larger than that in the downstream section, reducing the gas emission amount in the upstream section including gas refining plants is the first priority and the most effective way to prevent the air pollution in the area.

(3) Applicable Measures for each Pilot Area

The measures applicable to each pilot site are summarized in Table 7.4.2-1.

Table 7.4.2-1 Applicable Measures for Air Pollution Prevention in the Pilot Sites

Measures		Requirement Status				
		Mahshahr	Khark Island		Assaluyeh	
			Upstream	Downstream	Upstream	Downstream
Reduction of gas emission amount	Maximum recovery of usable gas	-	Flare: XXX Flue: -	-	Flare: XXX Flue: -	-
	Introduction of high-efficiency treatment process	Flare: XX Flue: -	Flare: XXX Flue: -	Flare: XX Flue: -	Flare: XXX Flue: -	Flare: XX Flue: -
	Introduction of high-efficiency combustion equipment	Flare: X Flue: X	Flare: X Flue: X	Flare: X Flue: X	Flare: XX Flue: X	Flare: X Flue: X
	Reduction of fugitive gas	Facility: X	Facility: X	Facility: X	Facility: XXX	Facility: X
	Gas underground injection	-	Flare: XXX Flue: -	-	Flare: XXX Flue: -	-
Minimizing pollutants generation	Use of high-efficiency combustion burner	Flare: XX Flue: X	Flare: X Flue: X	Flare: XX Flue: X	Flare: XX Flue: X	Flare: XX Flue: X
	Use of high quality (low sulfur) fuel	Flare: X Flue: X	Flare: X Flue: X	Flare: X Flue: X	Flare: XX Flue: X	Flare: X Flue: X
Eliminating pollutants	Installation of flue gas treatment facilities	Flare: X Flue: X	-	-	Flare: X Flue: X	Flare: X Flue: X
Diffusing pollutants	High stacks	Flare: X Flue: X	-	-	Flare: X Flue: X	Flare: X Flue: X

Note: XXX - as soon as possible, XX - desirable, X - according to future plan, - unnecessary

Flare – requirement status for flare gas, Flue - requirement status for flue gas,

Facility – requirement status for fugitive gas

Source: Study team

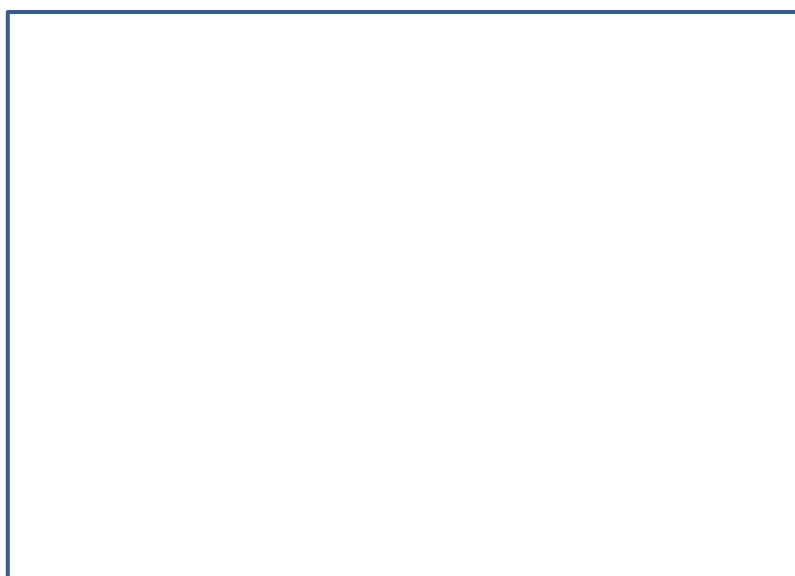
(4) Strategy for Air Pollution Prevention in Assaluyeh

1) Effect of Air Pollution Prevention in Assaluyeh

This part describes the procedures for the air pollution prevention in the gas refinery zone of PSEEZ in Assaluyeh, which is the most serious among the environmental issues in the pilot sites. As discussed in Chapter 3, the financial resources have not been allocated to the environmental management sufficiently. In order to realize the appropriate resource allocation to the environmental protection, it is indispensable to note the effect of air pollution prevention. The excess flare gas is one of the sources that cause the air pollution and may have an impact on public

health. In addition to the source of air pollution, the excess flare gas can be considered as economic loss from the viewpoint of gas resource conservation. The economic loss was estimated as the amount of difference between the cases with the effective use and without reduction of the surplus gas. Figure 7.4.2-3 shows the economic loss for three scenarios using different unit gas price. Preconditions for the estimates are as follows:

- The amount of excess flare gas account for two percent of total gas production in the SPGC's gas refinery plants (Phase 1 to 10).
- The unit gas prices applied to the estimates are 5 US\$/MMBtu (market price in the U.S. in 2013), 10 US\$/MMBtu (market price in the Middle East in 2013) and 15 US\$/MMBtu (expected price in the Middle East after five years).



Source: Study team

Figure 7.4.2-3 Economic Loss from Excess Flare Gas Flaring in Assaluyeh

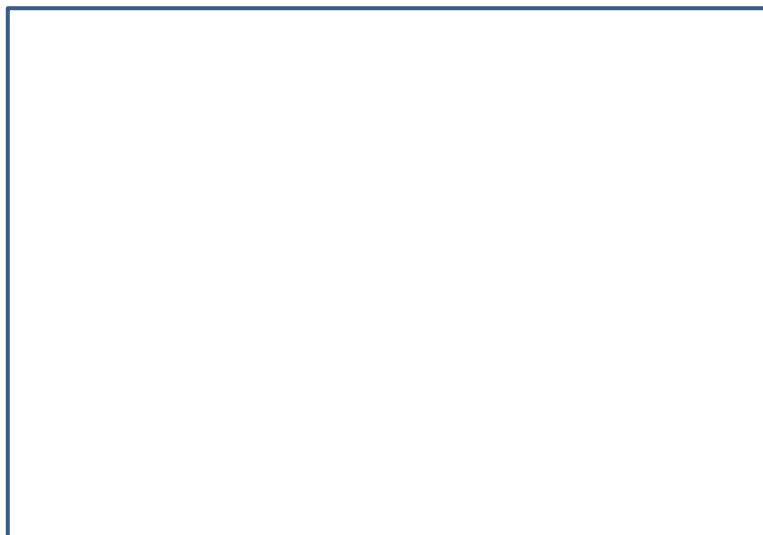
The gas price linked with a crude oil price is expected to increase to 15 US\$ in 2018. In this case, the economic loss from excess gas flaring will amount to 800 million US\$ in ten years. Even if the market price in the U.S. is taken, the economic loss still amounts to 200 million US\$. This result means that maximizing the usable gas recovery achieves reduction of the huge economic loss from the excess gas flaring as well as the air pollution prevention. Therefore, it is expected that the investment in facilities based on a flare gas reduction plan can be recovered from the reduction of economic loss.

2) Air Pollution Prevention in Assaluyeh

There are two approaches to the air pollution prevention in Assaluyeh: (a) reducing flare gas and (b) eliminating pollutants as described below.

(a) Reducing Flare Gas

This approach consists of 3 steps as show in Figure 7.4.2-4.



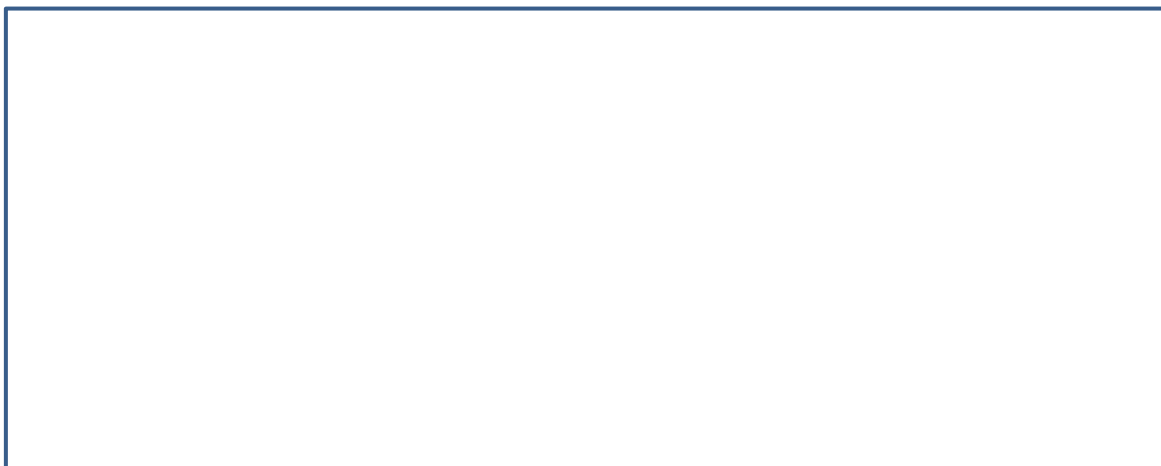
Source: Study team

Figure 7.4.2-4 Procedure of Flare Gas Reduction

The following are the procedures of the step by step implementation.

Step 1: Operation Improve - Production Control for Surplus Gas Reduction

Excess gas flared by flare stacks is caused by imbalance between feedstock gas supply from offshore production platform and gas treatment demand of onshore gas refinery plant. As shown in Figure 7.4.2-5, the production control at production wells of the offshore platforms prevents the surplus gas from flaring and promotes effective gas use. The gas produced at the offshore platforms is transferred to the onshore plants through the long distance pipeline with two phase flow. Improving the operational skills such as production control at the offshore platforms reduces the amount of surplus gas from the average 2 percent of total production at the moment to about 1.0 to 1.5 percent. As stated in Section 4.2, the excess flare gas ratio has been decreased to around 0.7 percent in Phase 1 and 2&3 plants, where the operations had been started earlier, by improvement of operational skills. Therefore, the excess flare gas ratio in the rest of gas refinery plants in Assaluyeh can be reduced from 2 percent to 1 percent by improving the operational skills.

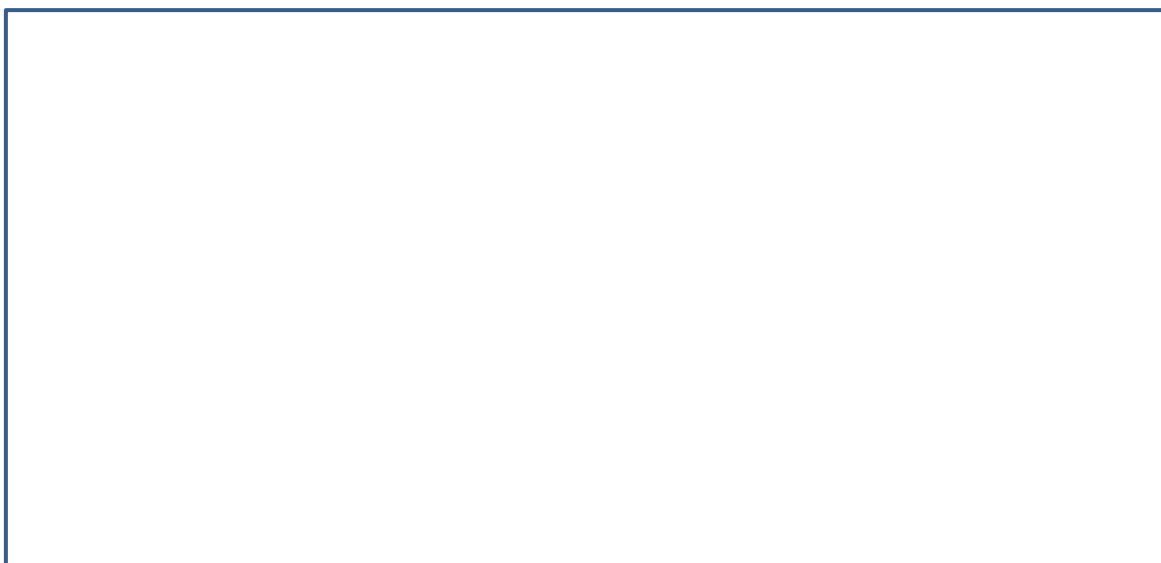


Source: Study team

Figure 7.4.2-5 Production Flow and Surplus Gas Reduction

Step 2: Facility Improvement – Flare Gas Recovery for Reuse

The excess flare gas generated at each phase is flared at individual plants because the existing plants in each phase are operated individually. This measure recovers the excess flare gas generated at each onshore plant that accounts for 1 percent of the total production and transfers the recovered gas to the expected plants after Phase 15 (see Figure 7.4.2-6). The excess flare gas will be recovered by this measure and decreases by more than 90 percent. This will contribute to reduction of air pollution due to SO_x to a large extent. As recovering the excess flare gas avoids the loss from flaring, investment in facilities for this measure does not inflict the large loss on the operating company.

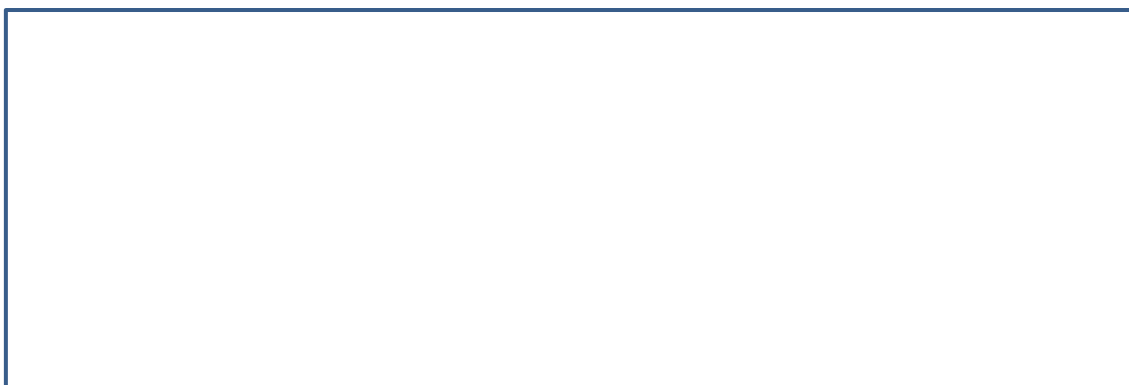


Source: Study team

Figure 7.4.2-6 Flow of Production and Excess Flare Gas Recovery

Step 3: Injecting excess Flare Gas into Underground for EOR

Excess gas is flared at present, because there is imbalance between supply of gas from offshore and demand on plant for treatment. It is considered that it is difficult to establish operational system for maintaining optimum gas supply and demand, and then, imbalance of gas supply and demand will result in producing excess gas that will be flared. It is required to have a flexible surplus gas treatment system in such a large petroleum complex. A method of flare gas underground injection for oil reservoir pressure maintenance for enhancement of oil recovery (EOR) can be used to ensure a stable operation of plant regardless of imbalanced gas supply. The application of this method contributes to both securement of environmental protection and gas resources preservation.



Source: Study team

Figure 7.4.2-7 Flow of Production and Excess Gas Injection

Phase 6, 7, 8 gas refinery in Assaluyeh was constructed to supply natural gas to gas injection system for enhancing oil recovery in Qagha-Jo oil field by reservoir pressure maintenance. The gas used for injection is natural gas containing high H₂S produced from South Pars gas field, which are similar type to the excess gases to be flared in gas refinery plants in the area.

Accordingly, the existing gas injection system in Assaluyeh could be utilized for effective reuse of not only the excess gas but also other flare gases generated in the plants. For application of such option, serious study on technical feasibility including process, mechanical, operational and oil reservoir aspects is essential.

<Acid gas underground injection and trend of sulfur market>

Approximately 5% of hydrogen sulfide (H₂S) gas is included in produced natural gas. The H₂S gas is separated from natural gas in sweetening unit in refinery plant. Then, sulfur in the separated H₂S is recovered by sulfur recovery unit (SRU) and sulfur produced as by-products is exported to markets in China, India, etc. at present. The demand for sulfur products in the market in future is expected to decrease due to self-sufficient in China and India. Considering future excess market of product sulfur or risks for catalyst procurement capacity of sulfur recovery unit, transition to direct underground injection of H₂S gas from sweetening unit is considered to be effective for reduction

of harmful gas emission from plant as well as stable operation of the company.

<Underground storage of excess gas>

It is a basic idea to have gas buffering with the existing gas delivery pipeline networks for market to respond flexibly to a probable imbalance between supply from plant and demand of the market. The excessive gas produced in plant can be tentatively captured in appropriate underground reservoir by injection for storage as buffer. There are experimental cases of gas underground storage in Iran, which are a case in oil field in Khark District by NIOC and another in pipeline network of NIGC.

Table 7.4.2-2 shows the cost estimate and implementation schedule. The production control can be achieved by only improvement of operational skills. This will lead to reducing the excess gas from the offshore platform and optimizing the flare gas treatment. The gas recovery requires investment in the facilities to reuse the excess flare gas. The project cost of the gas recovery will be medium in scale. This measure can reduce the loss from excess gas flaring. The required contents for the conceptual design of gas recovery are as follows:

- Optimization of feed gas system
- Optimization of flare stack system (stabilizing the small gas volume burning)
- Gas recovery system
- Remodeling of the existing facilities

Table 7.4.2-2 Implementation Schedule and Approximate Cost

Item	Study contents	1 st year	2 nd year	3 rd year	4 th year	5 th year	6 th year	7 th year	Approx. Cost (Thousand US\$)
Gas Recovery	Conceptual Study	■							200-300
	Basic Engineering		■						20,000-30,000
	Detail Engineering			■					
	Construction			■	■				
Gas Underground Injection	Conceptual Study				■				200-300
	Basic Engineering					■			20,000-30,000
	Detail Engineering						■		
	Construction						■	■	
Total									40,400-60,600

Source: Study team

(b) Eliminating Pollutants

In Assaluyeh area, gas refinery plants after Phase11 are under construction. If any air pollution prevention measures are not implemented, there is concern that emission of air pollutants such as SO₂, NO₂ and PM will increase in proportion to start-up of operations. In addition to reducing flare gas, therefore, it is necessary to reduce generation of pollutants in combustion equipment by proper combustion control and promote installation of flue gas treatment facilities for pollutant reduction.

Combustion Control

Steam injection, a measure to control the combustion, significantly reduces generation of NO_x. Applying this measure to the large gas turbine generator and compressor can reduce the NO_x by 60 to 85 percent. The followings should be examined as the conceptual study towards introducing steam injection. Based on the result, the basic and detailed design will be commenced.

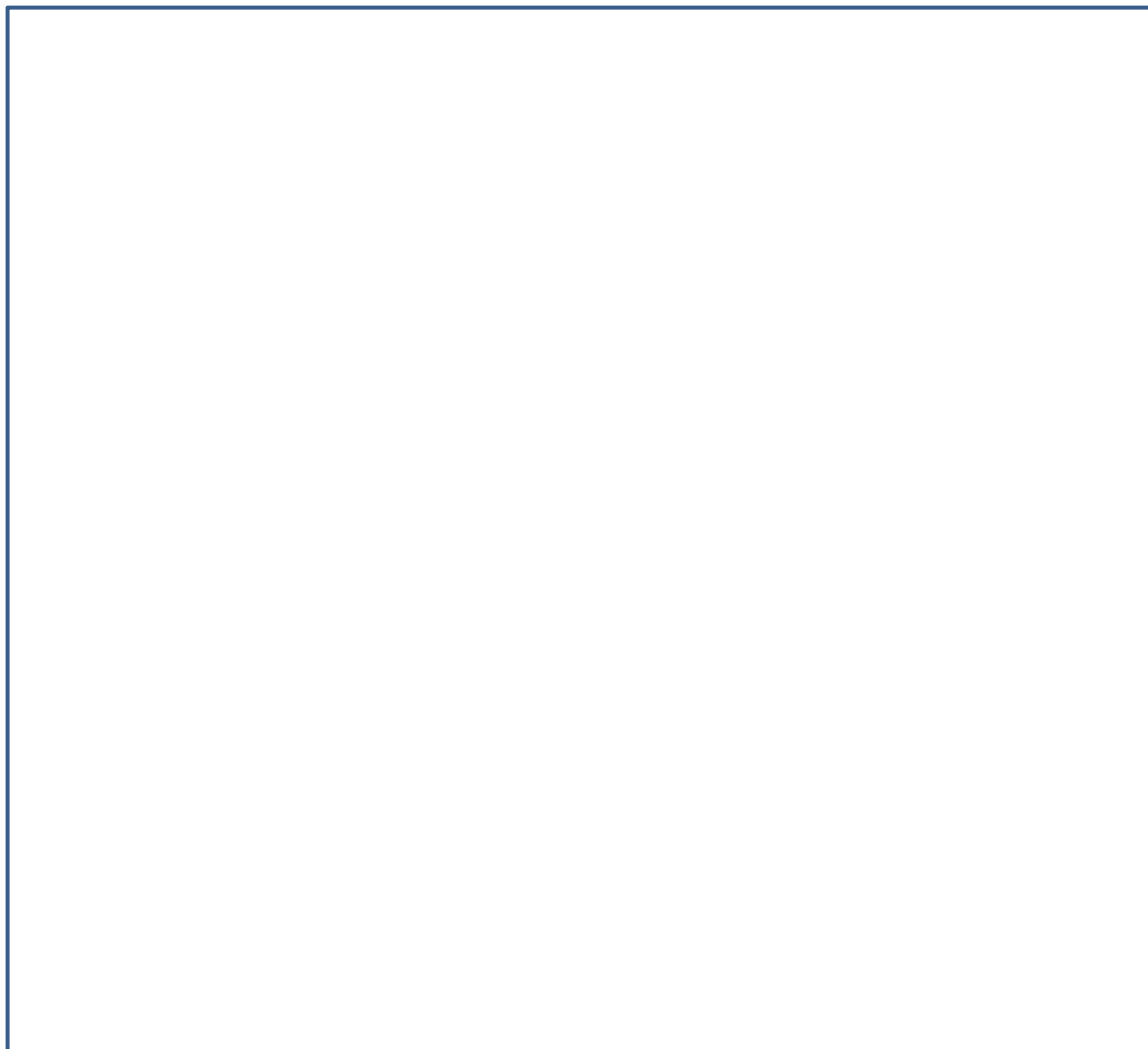
- Information gathering of gas turbine manufacturers
- Approval of remodeling of the existing gas turbine
- NO_x concentration
- Necessity of water demineralizer unit for steam generation
- Remodeling of existing facilities
- Projection of NO_x concentration after introducing the reduction measure

Flue Gas Treatment

The other one is installing the flue gas treatment facilities. The followings should be examined as the conceptual study towards introducing the flue gas treatment facilities. Based on the result, the basic and detailed design will be commenced.

- Concentration of pollutants emitted from the existing equipment
(whether or not emission from the equipment meet the environmental standards)
- Concentration of pollutants in the surrounding area of emission sources
- Selection of target equipment and gas treatment process
- Projection of pollutant concentration after installing the treatment facilities
- Projection of pollutant concentration in the surrounding area of emission sources after installing the treatment facilities
- Remodeling for existing facilities

Figure 7.4.2-8 shows the examples of flue gas desulfurization unit, electrostatic precipitator and NO_x removal unit.



Source Fuji Oil Refinery

Figure 7.4.2-8 Examples of Flue Gas Treatment Facilities

Table 7.4.2-3 shows the cost estimate and implementation schedule.

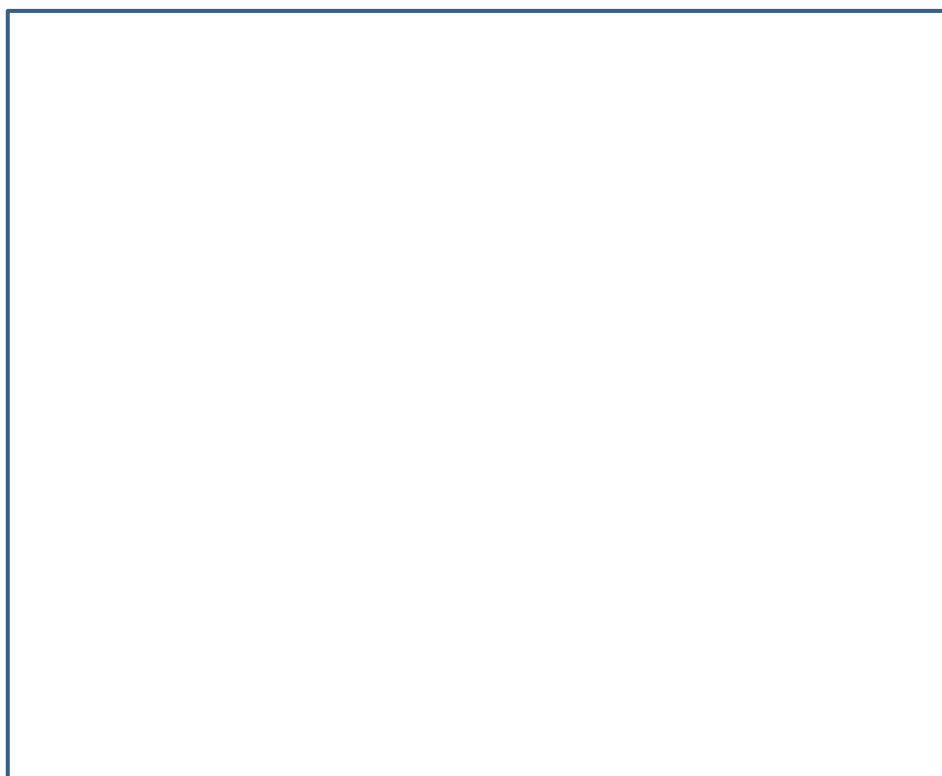
Table 7.4.2-3 Schedule and cost of air pollutants reduction program

Item	Study contents	1 st year	2 nd year	3 rd year	4 th year	5 th year	6 th year	7 th year	Approx. Cost (Thousand US\$)
Combustion measure	Steam injection								Not specified
Installment of flue gas treatment facilities	Conceptual study								200-300
	Basic Engineering								20,000-30,000
	Detail Engineering								
	Construction								
Total									20,200-30,300

Source: Study team

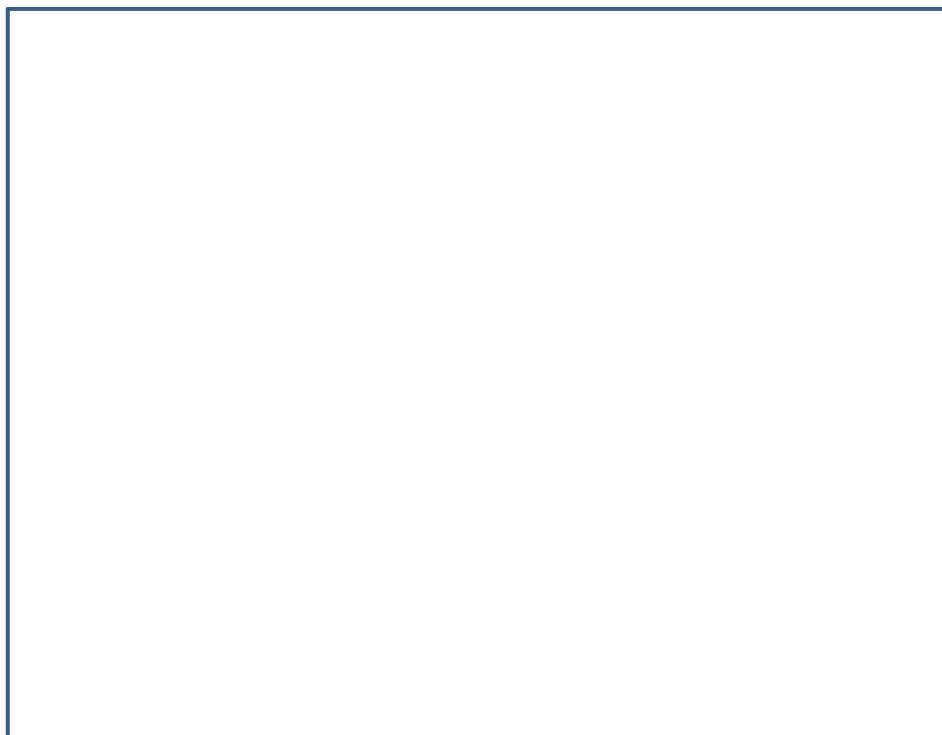
(5) Effect of the Pollutant Reduction

Figures 7.4.2-9, 7.4.2-10, 7.4.2-11 and 7.4.2-12 show the projection result on discharge of flare gas, SO₂, NO₂ and PM for the cases of introducing the reduction of flare gas and pollutants abovementioned. This projection includes the expected discharge from the planned gas refinery plants of Phase 15 and subsequent phase's projects in Assaluyeh area. The emissions will increase up to the year 2017 due to new plants operation. After introducing the reduction measures, seventy percent of the excess flare gas will be recovered and the discharged volume will decrease to thirty percent compared to the previous year's volume.



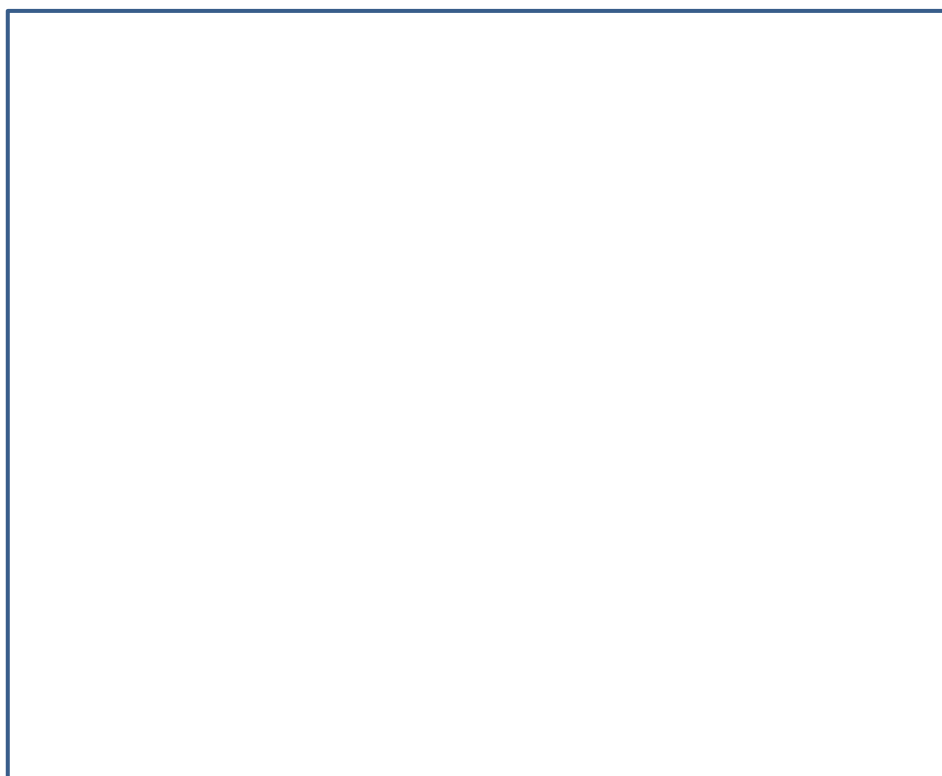
Source: Study team

Figure 7.4.2-9 Discharge Projection: Flare Gas



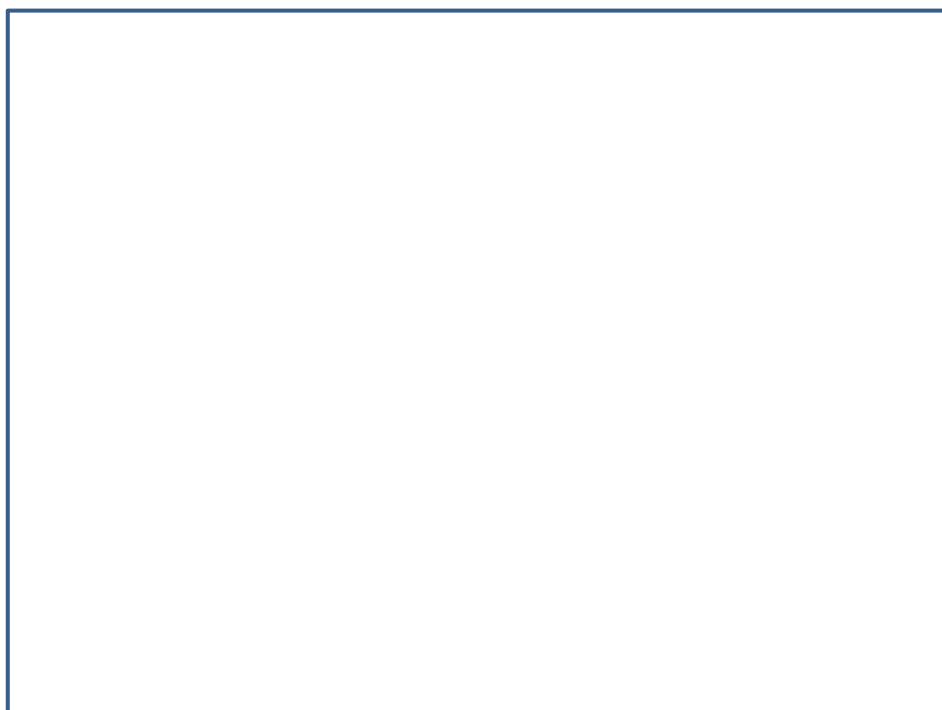
Source: Study team

Figure 7.4.2-10 Discharge Projection: SO₂



Source: Study team

Figure 7.4.2-11 Discharge Projection: NO₂



Source: Study team

Figure 7.4.2-12 Discharge Projection: PM

(6) Actions for Air Pollution Prevention

Actions to be taken in each pilot area are summarized in Table 7.4.2-4.

Table 7.4.2-4 Action for Air Pollution Prevention

Actions		Mahshahr	Khark Island	Assaluyeh
1	Understanding the situation of air quality/ pollution in the area	X		
2	Identifying emission sources of the pollutants and inventories	X		
3	Investigating the cause(s) of degraded air quality	X		
4	Discussing air pollution prevention policy (emission standards, total emission control, etc.)	X		
5	Defining targeted air quality for mitigation of environmental impact	X		
6	Studying effective air pollution prevention methods			
	- Reduction of emission gases and pollutants	X	X	X
	- Treatment/ elimination of pollutants in gas exhausted			X
	- Improvement of gas dispersion in the atmosphere			X
7	Planning air pollution prevention			
	- Improvement of facility operation			X
	- Improvement and/or installation of air pollution protection equipment	X	X	X
8	Preparing finances for the project	X		
9	Implementing the project (design, procurement and construction)	X		

Note: X means the actions to be taken in the area.

Source: Study team

7.4.3. Water Quality Conservation

Water pollution not only deteriorates the environment but also can have a negative impact on human health due to biological accumulation of pollutants, as well as on the fisheries, tourism, and other industries. Thus, wastewater discharged from petroleum industry sites to public water bodies must be treated properly.

When the existing wastewater treatment facilities are discharging inadequately treated effluent due to lacking capacity, or when additional volumes of wastewater are going to be generated as a result of addition of new facility or expanding existing facilities, upgrading of the wastewater treatment facilities and/or constructing new ones should be planned accordingly.

Then, when the future plans for expansion of the facilities for production increase are proposed, it is important to consider possible impacts on environment and various industries in the region caused by increased wastewater discharge as well as the local residents' concerns. In addition, for proper wastewater control, it is also important to pay due attention to the requirements of water quality regulations in the country considering the trend in wastewater management practices of the Persian Gulf countries and beyond.

For discussion of water quality conservation in the pilot areas, this section describes an outline of various applicable wastewater treatment technologies in the first part, (1) Outline of Wastewater Treatment Technologies, in order to study available approaches to preventing water pollution. The following part, (2) Issues and Technical Solutions on Wastewater Treatment in Pilot Areas, sorts out possible technical solutions to each of the wastewater treatment issues encountered in the pilot areas. The third part, (3) Underground Injection of Produced Water, describes the technologies related to underground injection of wastewater (for disposal, pressure maintenance in the gas and oil reservoirs, and EOR), which differ from conventional wastewater treatment methods but have already been implemented in oil producing countries in the Persian Gulf region. Such methods are expected to play an essential role in conserving the marine environment of the region in the future. The third part also summarizes the procedures for introducing the technologies, etc. The forth part, (4) Future Outlook and Goals of Wastewater Treatment, describes the outlook of the wastewater treatment in the pilot areas and outlines the goal and wastewater management plans that are established based on the outlook. Finally, actions to be taken for improvement of wastewater management are shown in the fifth part, (5) Actions of the Master Plan for Water Quality Conservation..

(1) Outline of Wastewater Treatment Technologies

1) Characteristics of Wastewater Treatment in the Petroleum Industry

The applicable wastewater treatment methods in the petroleum industry differ greatly between

upstream and downstream sectors because of difference of types and features of the wastewater to be treated and effluent standards to be complied. Wastewater from the upstream sector is mostly “produced water” (or “associated water”), which is produced as a byproduct along with crude oil. It contains high rate of salts, dispersed and dissolved hydrocarbons (oil contents) as well as slight chemical additives, trace metals and other components. The treatment method applied to such wastewater is generally a combination of physical and mechanical equipment to separate dispersed hydrocarbons (oil and grease) from water.

In the downstream sector, on the other hand, sources of wastewater are various and types, physical and chemical properties as well as the pollutants to be treated differ depending on the source processing plants. The pollutants subject to treating are dispersed and dissolved hydrocarbons (oil contents), dissolved organic/non-organic compounds, suspended solids (SS) such as residual materials and products carried from production processes in the plants. The treatment methods applied for the purposes are usually comprised of physical separation and, chemical and biological decomposition in order to comprised with strict effluent standards.

The sources of wastewater and the pollutants subject to treatment in the upstream and downstream sectors of the pilot areas are summarized in Table 7.4.3-1.

Table 7.4.3-1 Types of Wastewater and Treatment Targets in Pilot Areas

Sector	Sources of Wastewater	Target Substances
Upstream sector - Khark Island	Oil/gas production plants (offshore and onshore)	• Hydrocarbons (oil contents)
	Oil/gas processing plants (onshore)	
Downstream sector - Mahshahr - Assaluyeh	Petrochemical plants (onshore)	• Hydrocarbons (oil contents) • Dissolved organic compounds • Dissolved non-organic compounds • SS

Source: Study team

Since dissolved hydrocarbons in wastewater are not subject to treatment in the upstream sector for the time being, it is possible that some off-spec water to COD and other effluent standards applied to downstream sector is being released into the sea. Thus, it will be necessary in the future to adopt adequate technologies for water quality conservation that can treat properly the dissolved hydrocarbons and other pollutants complying with standards, or other method such as underground injection for ultimate disposal or reuse for enhancement of oil production. (Detail will be described in the third part, (3) Underground Injection of Produced Water.

2) Pollutants in Wastewater and Treatment Methods

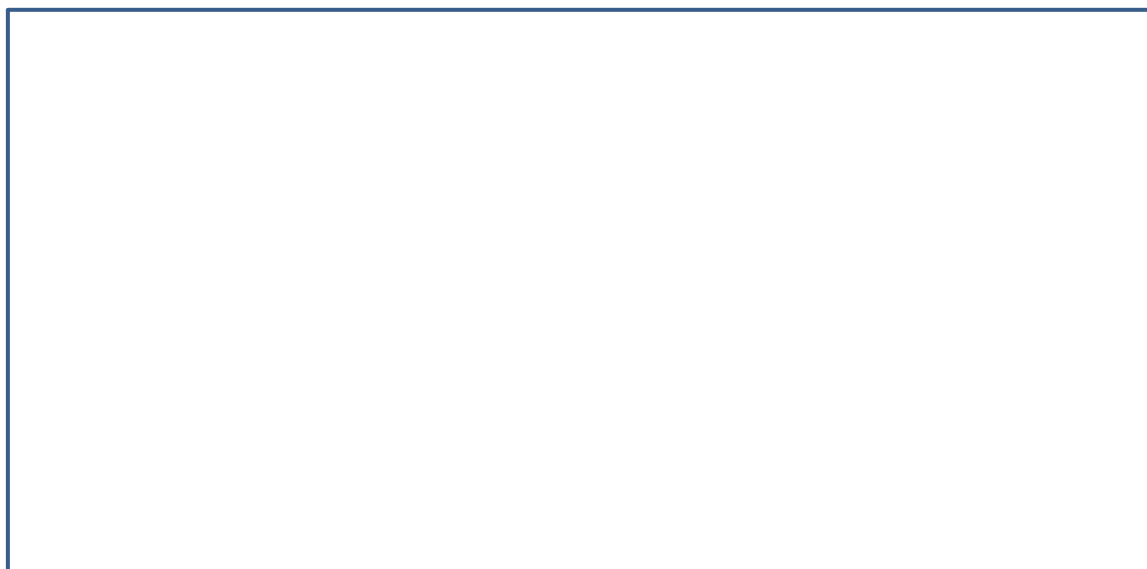
Pollutants contained in the wastewater to be treated by wastewater treatment plants are categorized into five, as shown in Table 7.4.3-2, according to types of the substances and shapes in water.

Table 7.4.3-2 Categories of Pollutants in Wastewater

Pollutants	Description
Oil contents	Hydrocarbons
Suspended solids (SS)	Small (2mm or less in diameter) solid particles suspended in water.
Dissolved solids	Chemicals originated from raw materials, intermediate products, finished products, catalytic agents, etc. (dissolved organic compounds, heavy metal ions, acids, alkalis, salts)
Solid impurities	Feed stock and product fragments, and other waste materials
Heavy particles	Sand

Source: Study team

Wastewater treatment plants are required to treat properly in compliance with the applicable effluent standards through various processes such as physical or chemical separation, chemical or biological decomposition according to the shapes and physical properties of the pollutants in water. A schematic flow of a general wastewater treatment process is shown in Figure 7.4.3-1.



Source: Study team

Figure 7.4.3-1 Schematic Flow of Wastewater Treatment Process

Basic wastewater treatment process is divided into three stages according to the levels of technical advancement, so called, primary, secondary, and tertiary treatment. The three stages are explained below.

(a) Primary Treatment

Primary treatment is a physiochemical process that targets mainly oil contents, suspended solids (SS), solid impurities, sand and other heavy particles, and some soluble substances. The process includes removal of contaminants from water based on differences of specific gravity and grain size, neutralization of acidity or alkalinity, and removal of soluble substances after insolubilization. The primary treatment also serves as pretreatment for the secondary treatment (biodegradation) process, as it removes harmful substances that would negatively affect secondary treatment. Main target substances, working principles, and equipment of primary treatment are summarized in Table 7.4.3-3.

Table 7.4.3-3 Methods and Equipment used in Primary Treatment

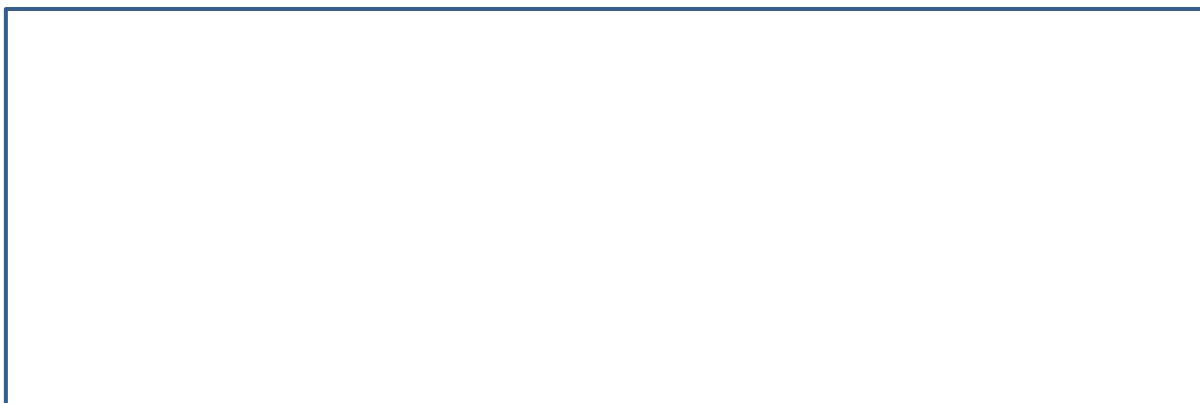
		Method	Equipment
Oil contents		Separating the oil contents by specific gravity difference	Oil separator Cyclone separator Dissolved-air floatation unit
Suspended solids (SS)		Separating the suspended solids by specific gravity difference	Sedimentation tank, Dissolved-air floatation unit
Dissolved solids	Heavy metal ions (Lead ion, etc.)	Separating sediment generated as a result of adjusting pH, using gravity	pH-adjusting tank Sedimentation tank
	Volatile substances (Ammonia, etc.)	Recovering volatile substances by facilitating evaporation by heating or aeration	Striping device
	Acids, alkalis	Neutralizing by adding acid or alkali	pH-adjusting tank
Solid impurities		Separating/removing particles larger than the screen mesh size	Screen
Heavy particles		Specific gravity difference separation	Sedimentation tank

Source: Study team

(b) Secondary Treatment

Secondary treatment is a biological process designed to degrade and remove mainly organic substances dissolved in wastewater by the actions of microorganisms (bacteria, protozoa, and metazoa). Biological treatment is mainly divided into aerobic treatment, in which aerobic microorganisms decompose and convert organic substances into carbon dioxide and water in the presence of oxygen, and anaerobic treatment, in which anaerobic microorganisms digest and convert organic compounds into methane and carbon dioxide in the absence of oxygen environment. Though the aerobic process can be further divided into several different methods depending on the treatment conditions, processing capacity and operation control method, the basic principle of the

treatment reaction is essentially the same. The same can be said in the anaerobic process (which is implemented at Tondgouyan PC in Mahshahr area). Biological treatment is widely used for degrading organic substances in wastewater, as it is generally less expensive than other treatment methods. Figure 7.4.3-2 shows the examples of aerobic and anaerobic treatment tanks and a microscope photo of activated sludge.

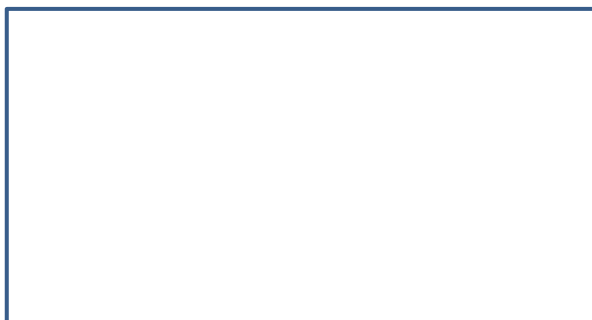


Source: http://wallsave.me/activated-sludge-aeration-tank/img.bhs4.com*1f*b*1fb83048463bf1e90dcfbf9334e814f3d2119a90_large.jpg/, <http://www.swing-w.com/products/industrial/hdmob60000000zdk.html>,
http://www.jswa.go.jp/gesuidou_jigyoku/izi/seibutu.html

Figure 7.4.3-2 Aerobic Treatment Tank (activated sludge tank) (right), Anaerobic Treatment Tank (middle), Microscope Photo of Activated Sludge (right)

(c) Tertiary Treatment

Tertiary treatment is carried out when the effluent from primary/secondary treatment does not satisfy the applicable standards. Such instances include when the SS level of effluent after secondary treatment exceeds the regulatory limit and when the effluent COD exceeds the permissible level because of residues of hardly degradable organic compounds, which neither the primary nor the secondary process can remove or decompose. Normally, residual suspended solids are removed by sand filtration, whereas hardly degradable organic compounds are adsorbed by activated carbon in most cases. Different methods are chosen in tertiary treatment depending on the types of residual contaminants. The sand filtration process at Tondgouyan PC (Mahshahr area) and the activated carbon process at ET-1 and ET-2 (Mahshahr area) and Mobin PC (Assaluyeh area) are the actual examples of the tertiary treatment.



Source: http://www.kobelco.co.jp/ecobiz/list/1182842_13068.html
<http://www.2322956.com/product/html/38.html>

Figure 7.4.3-3 Activated Carbon Adsorption Tower (left) and Activated Carbon (right)

The tertiary treatment shown in Figure 7.4.3-3 includes filtration processes using ultrafiltration (UF)/microfiltration (MF) and reverse osmosis (RO) membranes, which have not been adopted by any of the wastewater treatment facilities of the oil and gas refineries and petrochemical plants in the pilot areas. However, there is an increasing number of cases worldwide of using UF/MF membranes to reduce suspended solids in treated water virtually to zero, as well as RO membranes to virtually completely eliminate both suspended solids and soluble substances and to recycle and reuse treated water.

3) Measures for Wastewater Treatment Problems

When problems exist in wastewater treatment process, their causes need to be investigated before working out solutions. While the causes of trouble are diverse, the main cause (excluding lack of treatment capacity, failure of equipment, and improper operations) is either: i) inflow volume of raw water exceeding the design load, or ii) functional failure of biological process due to contamination with harmful substances. For the causes, the following four solutions are applicable and those are explained below.

- Upgrading of existing facility
- Cleaner Production (CP) Technology
- Segregation of drainage systems
- Pretreatment

(a) Upgrading of Existing Facility

Trouble caused by raw water inflow exceeding the design load can be solved by enlarging the equalization tank, if there is extra space in the site and if the overload is only temporary. If the overload occurs on a daily basis, the capacity of existing facility needs to be expanded. This can be done by installing additional equipment if extra space is available. If not, capacity upgrade of the existing equipment should be considered. Methods to fortify the biodegradation system (activated

sludge system) for treating organic wastewater are described below.

The capacity of an activated sludge process can be raised by retaining biomass at a higher level, for which the following methods are generally used.

- Extending sludge retention time (SRT)
- Incorporating moving bed biofilm reactor (MBBR) in the aeration tank
- Incorporating membrane bio reactor (MBR) in the aeration tank

No matter which of the above methods is chosen, a higher processing capacity will require more oxygen supply and higher efficiency of the aeration unit. Though extending SRT to raise mixed liquor suspended solids (MLSS) concentration can be done by simply changing the operating conditions, certain precautions for the operation are needed as separation of solids (activated sludge) from liquid (treated water) in the sedimentation tank may become difficult under certain conditions. MBBR, on the other hand, can retain large and stable amounts of biomass inside and on the surface of the media, thus allowing high-load operation. MBR can raise the MLSS concentration up to 20,000 mg/L by separating solids from liquid through membranes, thus enabling even higher-load operation than MBBR. Figure 7.4.3-4 shows the schematic diagrams of MBBR and MBR.

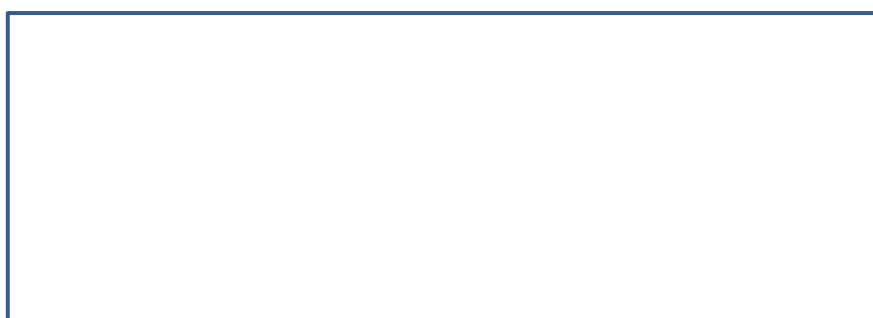


Source: http://www.triqua.eu/Triqua/fs3_site.nsf/htmlViewDocuments/44EBED064A451595C12575200056BE33, <http://www.anjaneyainternational.in/mbbr-media-1034965.html>, <http://www.water-technology.net/projects/jaspersmbr/jaspersmbr1.html>, http://www.ovivoaust.com.au/index.php?option=com_content&view=article&id=1491&Itemid=40537, http://www.apec-vc.or.jp/j/modules/tinyd00/index.php?id=36&kh_open_cid_00=39

Figure 7.4.3-4 Schematic Diagrams of MBBR and MBR

(b) Cleaner Production Technology

Techniques to reduce the pollutant load of wastewater are divided into two groups depending on whether they are used in the production process or post-production stages. Methods to minimize the inclusion of pollutants in wastewater are collectively referred to as the Cleaner Production (CP) Technology. Techniques to treat (remove/decompose) pollutants in wastewater in the post-production stages are called the End-of-Pipe (EOP) Technology. Figure 7.4.3-5 shows a schematic diagram of CP and EOP Technologies.



Note: WWTP Wastewater treatment plant

Source: Study team

Figure 7.4.3-5 CP and EOP Technologies

The CP Technology includes techniques to convert/upgrade production process (to improve production efficiency for reduction of the use of raw materials) and reuse/recycle residual materials and byproducts to prevent pollutants from entering wastewater. The switchover from mercury electrode considered by BIPC to ion-exchange membrane electrode, is an example of adopting the CP Technology to eliminate mercury in the wastewater discharge by converting the production process. The EOP Technology, on the other hand, is used in wastewater treatment facilities to treat (remove/decompose) pollutants in wastewater from the production process before releasing it to waterbodies.

While EOP often draws more interest in wastewater treatment, the CP Technology is effective in terms of the following two points:

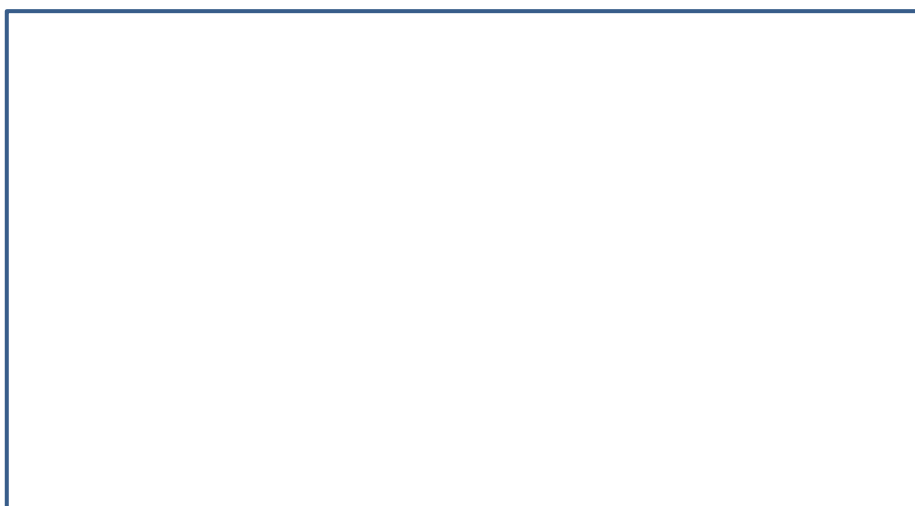
- In cases where the pollutant load can be reduced by incorporating the CP Technology from the design stage of a new wastewater treatment plant, the scale of the plant can be reduced.
- In cases where the pollutant load of wastewater exceeding the design limit of an existing wastewater treatment plant can be reduced by applying the CP Technology, the need to construct an additional treatment facility can be eliminated.

As the adoption of the CP Technology involves the conversion or alteration of the production process, it cannot be done by wastewater treatment engineers alone but by working closely with

production process engineers.

(c) Segregation of Drainage Systems

In a production process, there exist multiple drainage systems, each of which carries wastewater with varying characteristics (flow rate, contents). Wastewater from some systems may contain highly concentrated pollutants while that of others may carry harmful substances, which could obstruct the subsequent biological treatment process. When the volume of highly concentrated wastewater is small, treatment and disposal of such wastewater can be separated from the wastewater of other drainage systems. That can reduce the pollutant load on the wastewater treatment plant. Likewise, wastewater containing harmful substances to the biological process can be treated separately from that of other drainage systems, so that the negative impact on the biological process of the wastewater treatment plant can be averted. Figure 7.4.3-6 shows a schematic diagram of segregating the drainage systems.



Note: WWTP means wastewater treatment plant.

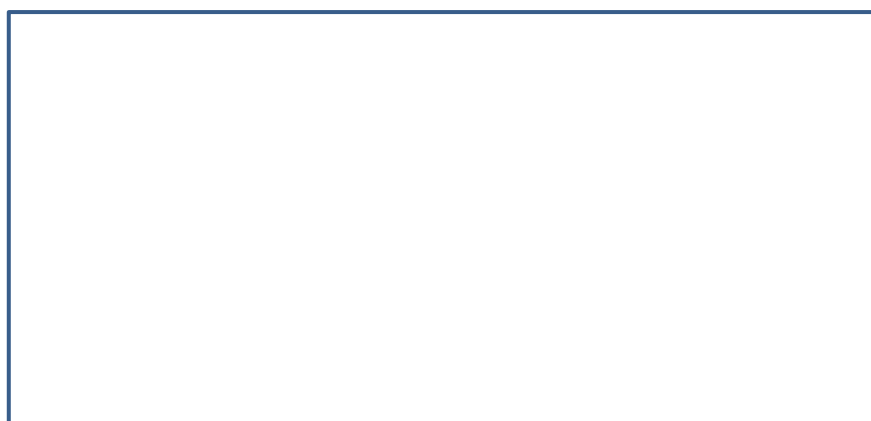
Source: Study team

Figure 7.4.3-6 Segregation of Drainage Systems

The idea of segregating the drainage systems is simple, yet it is an effective approach when the pollutant load of influent is exceeding the design value of the wastewater treatment plant or when its biological process is obstructed by harmful substances contained in the influent. However, implementation of this approach will require detailed information about the drainage systems, as well as close coordination between production process engineers and wastewater treatment engineers, as same as the case of the CP Technology. Needless to say, it is important to minimize the amount of the segregated drainage.

(d) Pretreatment

Biological treatment (activated sludge treatment) is widely used to degrade and remove organic pollutants excluding oil contents. However, this method cannot adequately treat wastewater if it contains harmful substances that hinder microorganisms from degrading organic pollutants. In such cases, such harmful substances need to be dealt with by applying segregation of drainage systems as described in (c) Segregation of Drainage Systems above or a pretreatment unit to remove or decompose the harmful contaminants. The pretreatment unit can be installed either before the biological process in the wastewater treatment facility or within the production plant that generates wastewater as shown in Figure 7.4.3-7.



Note: WWTP Wastewater treatment plant

Source: Study team

Figure 7.4.3-7 Position of Pretreatment Unit

For reference, the maximum allowable concentrations of harmful substances in activated sludge treatment are provided in Table 7.4.3-4. It should be noted, however, that when multiple substances are present, they could generate synergistic effects to obstruct the biological process even if the concentration of each substance is below the limit.

Table 7.4.3-4 Concentration Limits in Activated Sludge Treatment

Content	Concentration limit (mg/L)
Heavy metal (copper)	1
Aromatic compounds (phenol)	500
Ammonia	500
Salt	30,000

Source: Produced based on Tables 2 and 19 of IPS-E-730

Pretreatment methods applicable to the harmful substances that are creating problems in the pilot areas are summarized in Table 7.4.3-5.

Table 7.4.3-5 Pretreatment Methods to Control the Harmful Substances Causing Problems in Pilot Areas

	Dilution	Stripping	Ion Exchange	Chemical Oxidation
Aromatic compounds	X	X	n.a.	X
Ammonia	X	X	X	X
Salt	X	n.a.	X	n.a.

Note: X Applicable, n.a. Not applicable

Source: Study team

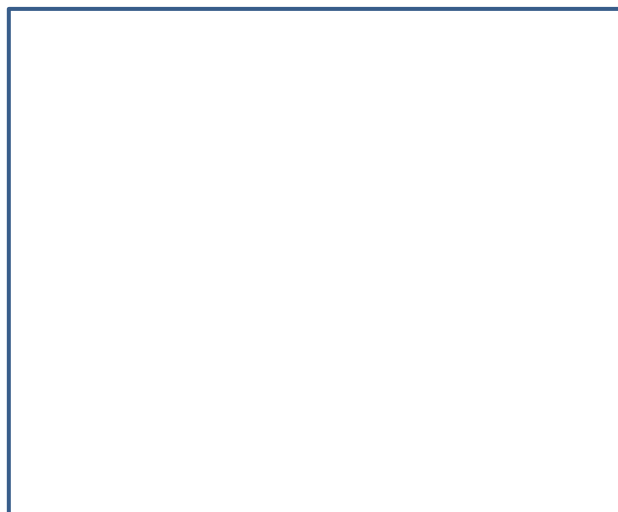
The pretreatment methods are briefly explained below.

Dilution

Dilution is a method to reduce the concentrations of harmful substances by adding industrial water or groundwater to wastewater. While dilution is effective against all harmful substances, how to secure an adequate supply volume of dilution water needs some consideration. In addition, precautions are needed to ensure that the increased amount of wastewater generated as a result of dilution will not overload the capacity of wastewater treatment facility.

Stripping

Stripping separates harmful substances from wastewater by heating or other physical process. It is effective and widely used in removing such volatile substances such as phenol and ammonia. Figure 7.4.3-8 shows a schematic diagram of ammonia stripping. The ammonia stripping is a process used to remove ammonia from wastewater by raising its pH to convert ammonium ions into ammonia gas and letting it vaporize by passing steam or air through the water. Generally, stripped ammonia is collected and is reused as a by-product. In this figure at right, stripped ammonia is converted by catalysis and released into the ambient air as nitrogen gas. Sulfuric acid is sometimes used to adsorb ammonia gas to recover it as ammonium sulfate.



Source: <http://kcr.kurita.co.jp/wtschool/032.html>

Figure 7.4.3-8 Ammonia Stripping

Ion Exchange

Ion exchange is a method to remove ionized harmful substances from wastewater by passing them through ion-exchange membranes. However, the operation cost is so high that it is not suitable for treating large volumes of wastewater.

Chemical Oxidation

Chemical oxidation is a process to decompose harmful organic compounds chemically by oxidation. Fenton process² and wet oxidization process³ are among the methods of chemical oxidization. At Karoon PC in Mahshahr area, chemical oxidization (oxidative decomposition of chlorophenol by Fenton process) is used to pre-treat aromatic compounds, and the effluent from this process is sent to the integrated wastewater treatment facility ET-1.

(2) Issues and Technical Solutions on Wastewater Treatment in Pilot Areas

Problems on wastewater treatment in each pilot area, as well as their possible solutions are discussed below.

1) Mahshahr

Table 7.4.3-6 summarizes the main issues and possible solutions of petrochemical plants in PETZONE (BIPC, Tondgouyan PC, Razi PC and Fajr PC).

² A method of oxidative decomposition of organic compounds by the hydroxyl radical which is generated by reacting hydrogen peroxide and iron ion

³ A method of oxidative decomposition of organic compounds in water using oxygen as oxidizer

Table 7.4.3-6 Issues and Possible Solutions in Wastewater Treatment

	BIPC		Tondgouyan PC
Issues	- Effluent COD is exceeding the permissible limit due to absence of COD treatment plant. - Huge amounts of organic pollutants are released into sea.	Effluent mercury level is not meeting the standard due to inadequate treatment at mercury processing plant.	- COD load of raw water is far exceeding the design value of the wastewater treatment plant. - Some portion of wastewater is discharged untreated, and, as a result, the effluent COD sometimes far exceeds the permissible level.
Adoption of CP Technology	X	X	X
Segregation of drainage systems	X	n.a.	X
Installation of Pretreatment	n.a.	n.a.	n.a.
Upgrading of existing equipment	n.a.	X	X
Installation of new equipment*	XX	n.a.	n.a.

	Razi PC	ET-1 (Fajr PC)	
Issues	Absence of treatment facility to treat wastewater from the ammonia plant.	Inflow of raw water not suitable for biological treatment (high salinity).	Inflow of raw water not suitable for biological treatment (aromatic compounds).
Adoption of CP Technology	X	X	X
Segregation of drainage systems	X	X	X
Installation of Pretreatment	X	X	X
Upgrading of existing equipment	n.a.	n.a.	n.a.
Installation of new equipment*	XX	n.a.	n.a.

Note: X Being considered, XX Planned to be implemented, n.a. not applicable

* Includes the construction of a new wastewater treatment plant.

Source: Study team

Technical solutions to wastewater treatment problems in each company are discussed below.

(a) BIPC

COD

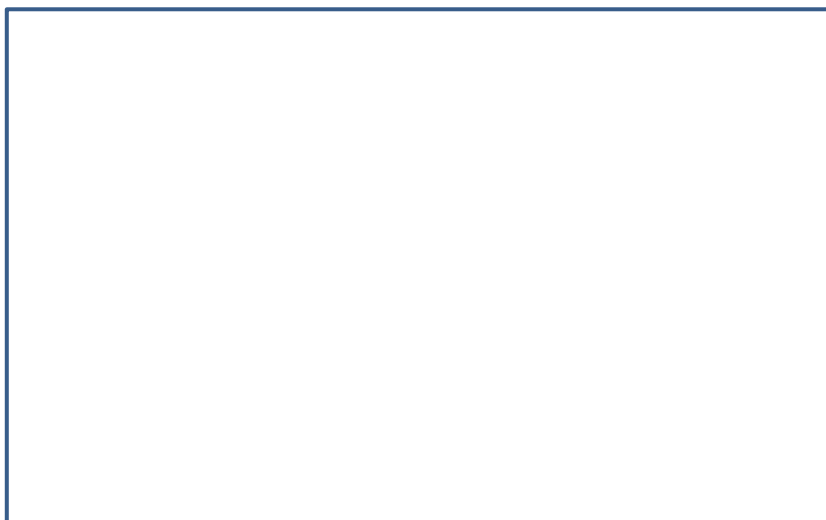
Because BIPC has a primary treatment system but not a secondary system (biological treatment), the COD level of its processed wastewater is exceeding the effluent standards. To eliminate COD, a secondary treatment process needs to be introduced. BIPC is planning to replace the aging existing

facility by constructing a new central wastewater treatment facility, which can treat wastewater completely. In this central wastewater treatment facility, they are considering adopting the MBBR and MBR process configuration, which is expected to solve the excessive COD problem. In its planning stage, it is desirable to verify or consider the following.

- COD treatment performance of the biological process using actual wastewater.
- Whether or not COD load can be reduced by adopting CP Technology.
- Installation of segregated drainage systems or pretreatment process (when wastewater has a high COD concentration or contains harmful substances to biological treatment)

Mercury

Wastewater from the seawater chlorination process of BIPC's chlor-alkali unit contains mercury, which is treated by the mercury removal equipment. However it seems functions inadequately and thus the mercury content of the effluent is exceeding the applicable limit. One fundamental solution to the mercury problems (release of mercury to the environment, generation of mercury-containing waste, etc.) is to switch the process from mercury electrodes to ion exchange membrane electrodes (see Figure 7.4.3-9). At present, this switchover to ion-exchange membrane electrodes is being considered by BIPC. A desirable temporary solution until the switchover is completed would be fortifying and upgrading the capability of the existing mercury removal equipment (e.g. adding more mercury-adsorbing material, increasing contact efficiency between mercury and the adsorbing material, and setting an appropriate retention time, etc.).



Source: ISBN 4-06-153392-4

Figure 7.4.3-9 Mercury Process & Ion Exchange Membrane Process

(b) Tondgouyan PC

At Tondgouyan PC, the COD load of raw water is exceeding the current capacity of the wastewater treatment facility, which, as a result, cannot treat wastewater adequately. Though the adoption of MBBR is presently being considered, MBBR alone may not be sufficient for given the high COD load that is far exceeding the design value. Therefore, it is important to consider the following:

- Reducing discharge of organic pollutants into wastewater by adopting CP Technology.
- Reducing load by installing segregation of drainage systems to send part of the wastewater to a different wastewater treatment facility.
- Expanding the anaerobic tank (install an additional tank).
- Introducing MBR (by doing so, the sedimentation tank can be utilized as a biological treatment tank).

(c) Razi PC

The ammonia plant of Razi PC is discharging untreated wastewater, which may contain ammonium ions at a level not meeting the effluent standards. Razi PC is currently in the design phase of a new wastewater treatment facility to replace the aged existing facility, which is expected to properly treat the wastewater from the ammonia plant. If the ammonia ion concentration in the wastewater is high and may negatively affect the biological treatment process, it will be necessary to consider adopting CP Technology or installing a pretreatment system. To treat ammonium ions in wastewater, the following treatment methods are available:

<Physiochemical Treatment>

- Ammonia stripping
- Breakpoint chlorination
- Ion exchange
- Catalytic decomposition

<Biological Treatment>

- Biological nitrification and denitrification

Ammonia stripping is generally used as pretreatment of petrochemical wastewaters with high ammonia concentration.

(d) ET-1 (Fajr PC)

High Salinity

Currently, Fajr PC dilutes wastewater to deal with its high salinity. In addition, sending the high-salt-concentration wastewater to ET-2 is being considered as an additional measure to reduce the salt load on ET-1, which will require a detailed inventory of drainage systems so that the high

salinity wastewater can be sent to ET-2 through a separate system. If an extremely high salinity is present in a small wastewater flow, it will be necessary to consider treating such wastewater separately. As an additional measure, the applicability of CP Technology should also be examined. If CP Technology or segregation of drainage systems is adopted in the integrated wastewater treatment facilities, close coordination among the related companies, especially between the companies sending wastewater and those receiving it, will be required. The companies generating high salinity wastewater should consider possible application of CP Technology and the installation of segregation of drainage systems.

Aromatic Compounds

Aromatic compounds need to be dealt with by considering similar solutions to those of high salinity wastewater (dilution of wastewater as pretreatment, installation of segregation of drainage systems and adoption of CP Technology), as well as by installing a pretreatment process (chemical oxidation). All of the above methods require close coordination among the companies concerned, and the company generating high salinity wastewater should take the lead in examining possibility of application of CP Technology, installation of segregation of drainage systems, and pretreatment.

2) Khark Island

On Khark Island, major wastewater-related issues and possible solutions of the wastewater treatment facility of IOOC's crude oil processing plants as well as IOTC's crude tank yard are summarized in Table 7.4.3-7.

Table 7.4.3-7 Issues and Possible Solutions in Wastewater Treatment

	Crude Oil Processing Plants (IOOC)	Tank Yard (IOTC)
Issues	- Because of increased produced water, the inflow to the oily water separator wastewater treatment facility is exceeding its design value. - Part of the raw wastewater is directly discharged to sea and its oil content may not meet the effluent standard. - Oily wastewater causes severe contamination of the soil in and around the catchment basins along the drainage ditches.	- The oily tank drain from crude tank bottoms is discharge to sea through simple oil-water separators and catchment basin. The oil contents of the discharge may not meet the effluent standard. - Oily wastewater causes severe contamination of the soil in and around the catchment basins and areas along the drainage ditches.
Adoption of CP Technology	n.a.	n.a.
Segregation of drainage systems	n.a.	n.a.
Installation of Pretreatment	n.a.	n.a.
Upgrading of existing equipment	X	n.a.
Installation of new equipment*	n.a.	XX
Other	X - Downhole control of water production - Expansion of produced water treatment system on offshore platforms - Underground injection for disposal - Underground injection for reservoir pressure maintenance or enhanced oil recovery (EOR)	X - Underground injection for disposal - Underground injection for reservoir pressure maintenance or enhanced oil recovery (EOR)

Note: X Being considered, XX Planned to be implemented, n.a. not applicable

* Includes the construction of a new wastewater treatment plant.

Source: Study team

Technical solutions to wastewater treatment issues faced by each company are discussed below.

(a) Wastewater Treatment of Crude Oil Processing Plants (IOOC)

Due to an increase of produced water, some portion of the raw influent wastewater that exceeds the processing capacity of the wastewater treatment facilities in the crude oil processing plants are discharged to sea and contaminating the soil in and around the catchment basins and the areas along the drainage ditches. In order to treat the entire wastewater from the oil processing plants, the wastewater treatment facilities need to be expanded as soon as possible under a plan that takes into account the further increase of produced water in the future. It may be necessary to implement additional measures to control water production associated with crude oil, such as making controls in production wells (shutting in the production wells with high water production, recompletion of the production wells, downhole fluid separation techniques, etc.) and expansion of produced water

treatment system on offshore production platforms.

Upgrading of the existing wastewater treatment facilities, as mentioned above, will enable treatment of oil contents in wastewater from crude oil processing plants, but dissolved contaminants such as hydrocarbons, residual chemical additives, trace metals, NORM, etc., where it is discharged without treatment, could pollute the environment.

As mentioned in Subsection 4.2.3. (2) 2) (c), it is practical among oil producing countries along the Persian Gulf in this decade to achieve “zero discharge” of oily wastewater from oil production activities to environment by underground injection for disposal and reuse of such wastewater for pressure maintenance of the oil and gas reservoirs or for EOR (water-flooding).

Accordingly, Iran is also expected to control the possible environmental impact on marine environment by adopting appropriate wastewater disposal injection techniques to treat oil contents together with dissolved contaminants in the wastewater in the future. The applicable underground injection technologies will be described in (3) Underground Injection of Produced Water.

(b) Tank Yard (IOTC)

Drain water from crude storage tanks is discharged to sea through simple oil-water separator pits and catchment basins, and thus such wastewater management causes the soil pollution in and around the catchment basins and the areas along the drainage ditches, similar to IOOC’s facility. To solve this problem, IOTC is considering the installation of equipment for treating drain water from storage tanks

In addition, it may become possible in the future to integrate the disposal facility for relatively small amount of treated drain water with the underground injection system, which IOOC is expected to install.

3) Assaluyeh

Problems encountered by SPGC’s gas refineries and Mobin PC in petrochemical zone, as well as their possible solutions are summarized in Table 7.4.3-8.

Table 7.4.3-8 Issues and Possible Solutions in Wastewater Treatment

	Gas Refineries (SPGC)	Mobin PC	
Issues	Some wastewater treatment facilities do not have equipment to treat soluble organic compounds and thus are releasing effluent that sometimes exceeds the permissible COD limit.	COD load of influent is rising, suggesting the necessity of the implementation countermeasures in the near future.	Inflow of raw water is not suitable for biological treatment (ammonia).
Adoption of CP Technology	n.a.	X	X
Segregation of drainage systems	X	X	X
Installation of Pretreatment	n.a.	n.a.	X
Upgrading of existing equipment	n.a.	X	n.a.
Installation of new equipment*	X	n.a.	n.a.

Note: X Being considered, n.a. not applicable

* Includes the construction of a new wastewater treatment plant.

Source: Study team

Technical solutions to issues in wastewater treatment faced by each company are discussed below.

(a) Gas Refineries (SPGC)

All phases of gas refineries are properly removing oil contents while the wastewater treatment facilities, except for those of phases 6, 7, and 8, do not have equipment (biodegradation system) to remove soluble organic compounds, thus releasing effluent sometimes exceeds the maximum permissible COD level. To counter this problem, the effectiveness of introducing the biological treatment system to phases 6, 7, and 8 should be examined.

If biological treatment units of phases 6, 7, and 8 have extra capacities, it would be possible to send wastewater containing high concentration of organic compounds to phases 6, 7, and 8 for treatment.

(b) Mobin PC

COD Overload

Mobin PC, which operates an integrated wastewater treatment facility in petrochemical zone, has implemented a pilot project using MBR to counter the COD overload problem. It will also be necessary to consider the adoption of CP Technology and the installation of segregation of drainage systems to see if they could reduce the inflow of organic pollutants into wastewater. In doing so, companies discharging wastewater and those treating wastewater, which are separate entities, need to work closely together. Normally, companies generating high COD effluent are responsible for implementing CP Technology and/or installing segregation of drainage systems.

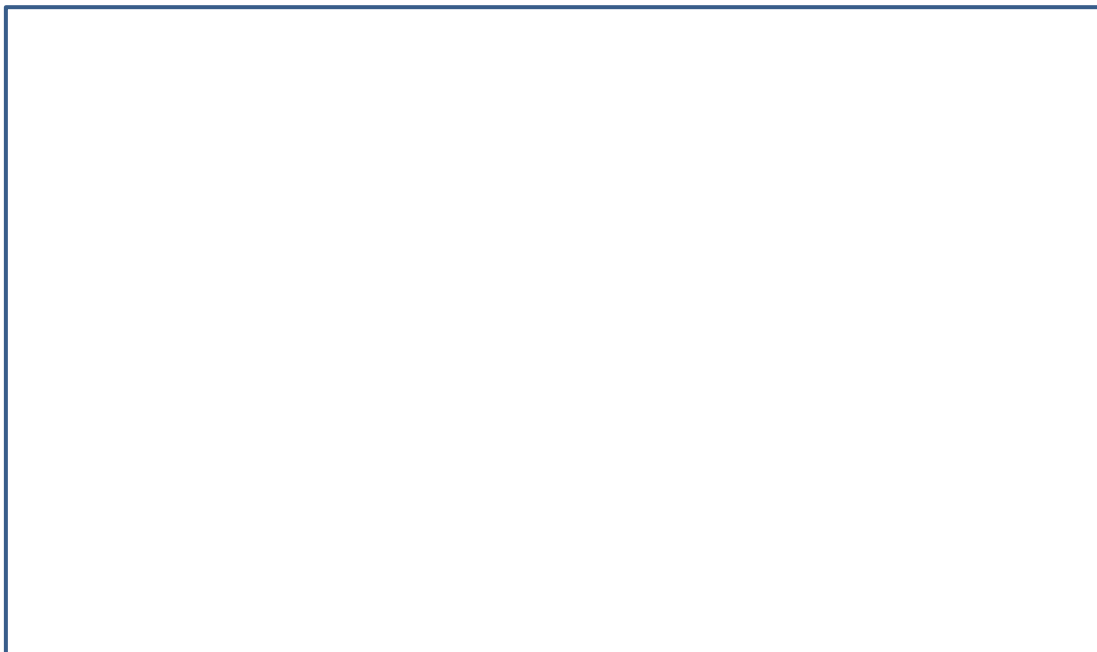
Treatment of Ammonia

Pretreatment, adoption of CP Technology, and installation of segregation of drainage systems should be considered for the control of ammonia. When considering these measures in an integrated wastewater treatment facility, companies discharging wastewater and those treating wastewater, which are separate entities, need to work closely together. Normally, companies discharging ammonia-containing effluent are responsible for considering such measures. Ammonia stripping is generally used as pretreatment of petrochemical wastewaters with high ammonia concentration.

(3) Underground Injection of Produced Water

1) Zero Emission Program

Disposal of produced water by underground injection is widely practiced not only by oil producing countries in Persian Gulf region, but also in the upstream sector of the petroleum industry worldwide as part of the “zero emission” program. A concept of the underground injection technology in zero emission program is shown in Figure 7.4.3-10.



Source: Study team

Figure 7.4.3-10 “Zero Emission” Program in the Petroleum Industry

As shown in the above figure, zero emission (discharge) of produced water can be achieved by injection into underground stratum for the following purposes.

- a) Injection into safe groundwater stratum for ultimate disposal
- b) Injection into oil reservoirs for pressure maintenance to enhance oil recovery (EOR)
- c) Injection along with seawater (water flooding) to enhance oil recovery (EOR)
- d) Combination of water flooding and CO₂ injection to enhance oil recovery (EOR)

An applicable method should be selected appropriately among these alternatives according to availabilities of the stratum and/or reservoirs suitable to disposal and EOR, features of the oil reservoirs, and the results of financial and technical feasibility analyses.

Description and characteristics of the above produced water injection methods are summarized in Table 7.4.3-9.

Table 7.4.3-9 Characteristics of Produced Water Injection Methods

Method	Description	Characteristics
a) Underground disposal	- Injecting the treated produced water into the safe groundwater stratum - Practiced by oil producing countries in the Persian Gulf region	- Requiring investigations of safe underground aquifer (to prevent impact on near surface aquifer) - The least expensive among the four methods, but not enhancing oil recovery
b) Reservoir pressure maintenance	Injecting the treated produced water into oil reservoirs, which enables reuse of produced water	- Requiring investigation and evaluation of oil reservoirs for pressure maintenance - Contributing to increase in recovery rate of the oil reservoirs
c) Water flooding	The most commonly used secondary recovery process that enables reuse of produced water and is effective for enhancement of crude production.	- Requiring detailed technical and financial feasibility studies accompanied by reservoir simulation - Recovering the investment cost, as it contributes to the enhancement of crude production
d) Water-and-gas (CO ₂) flooding	- The most attractive method as tertiary recovery technology. - Enhancing oil recovery more than single water flooding - Used in offshore oil fields only on a small experimental basis - Introduced to large-scale offshore oil operations in the near future	- Requiring advanced technical analyses including large-scale simulation of CO₂/water behaviors in reservoirs and investigation of stable CO₂ sources - Introducing in conjunction with carbon capture and storage (CCS) as CO₂ source - Recovering investment costs if the conditions of the oil reservoirs, CO₂ source, and other factors warrant financial feasibility

Source: Study team

The above zero emission methods are effective in conserving the environment. However, Method a) does not contribute to the enhancement of crude production, whereas Method b), c) and d) can meet the both requirements and are therefore preferred. Meanwhile, adoption of Method c) and d) must be considered from a long-term perspective, as it would require advanced techniques to evaluate oil reservoirs for applicability of the methods and analysis of the expected effects.

Because sufficient data are not presently available for evaluating oil reservoirs to determine the applicability of Method c) or d), it is assumed that Method a) and b) would be adopted for the

purpose of environmental protection at this stage, in which case, their approximate costs and schedules would be as shown in Tables 7.4.3-10 and 7.4.3-11 below.

In the offshore oil fields of Khark Island area, processes similar to Method b) and c) are already being used to the pressure maintenance of the oil reservoirs and the water flooding by injecting seawater in Dorood 3 field, which means that basic reservoir engineering techniques related to underground injection have already been established in Iran.

It is recommended that Method c) and d) be introduced jointly with the support of experienced companies and/or public technical institutes in advanced countries possessing high reservoir technologies.

2) Schedules and Approximate Costs

The schedules in the coming years for conducting the studies and design/construction works of Method a) and b), as well as their approximate costs, are shown in Table 7.4.3-10 and Table 7.4.3-11.

Table 7.4.3-10 Disposal of Produced Water by Underground Injection (Method a)

Work	Content	1 st year	2 nd year	3 rd year	4 th year	5 th year	6 th year	8 th year	Approx. cost (thousand USD)
Ground stratum survey	Study on the safety of water aquifer and injection pressure	■							100-200
Construction of produced water treatment and injection facilities	Conceptual study		■						200
	Basic design			■					20,000
	Detail design				■				20,000
	Construction				■	■	■		
Approx. total cost									40,000/site

Source: Study team

Note: The approximate cost includes the construction of a produced water treatment facility (50,000 barrel/day capacity), a new water injection platform and one subsea pipeline (about 1km in length). It does not include the drilling cost of the new injection well.

Table 7.4.3-11 Injection of Produced Water into Oil Reservoirs (Method b)

Work	Content	1 st year	2 nd year	3 rd year	4 th year	5 th year	6 th year	8 th year	Approx. cost (thousand USD)
Evaluation of oil reservoirs	Projection of future PW volumes and evaluation of oil reservoirs in relation to injection volume	■							100-200
Construction of produced water treatment and injection facilities	Conceptual study		■						200
	Basic design			■					20,000
	Detail design				■				40,000
	Construction				■	■	■		
Approx. total cost									60,000/site

Source: Study team

Note: The approximate cost includes the construction of a produced water treatment facility (50,000 barrel/day capacity),

a new water injection platform and one subsea pipeline (about 1km in length). It does not include the drilling cost of the new injection well.

(4) Future Outlook and Goals of Wastewater Treatment

A future outlook and actions of wastewater treatment in the pilot areas are summarized below.

1) Mahshahr

Future Outlook
● At BIPC and Razi PC, the aged wastewater treatment facilities are planned to be renewed and become able to treat wastewater to an adequate level. As a result, most of the wastewater-related issues are expected to be solved in the future. ● It is hoped that the mercury issue at BIPC will be solved quickly and smoothly, upon which the use and release of mercury into the environment by the chlor-alkali unit will be eliminated to zero. ● Tondgouyan PC needs to find solutions to the high COD load of raw water by considering not only EOP Technology but also CP Technology and the installation of segregation of drainage systems, in preparation for which the inventory of the drainage systems should be investigated preferably soon. ● The wastewater treatment issues at ET-1 originate in the companies discharging problematic wastewater, with which ET-1 needs to work closely together toward solving the problems. In the future, the wastewater generators will be required to make efforts not to discharge harmful wastewater into the integrated wastewater treatment facility. Preferably, they should start taking inventory of their drainage systems soon.
Actions to be taken
Short-term (1 – 2 years): • Examination of solutions to current and potential future issues in wastewater management • Preparation of a wastewater management plan
Mid-term (3 – 4 years): • Prevention of the release of mercury and other harmful substances into the environment according to the wastewater management plan • Significant Reduction of the pollutant load on the environment
Long-term (5 – 7 years): • Compliance with the applicable effluent standard

As for the actions for the short-term period, solutions to the issues, for which implementation plans have already been formulated such as those at BIPC and Razi PC, need to be verified if the plans are incorporating the anticipated production increase and if the wastewater will be treated properly by conducting a laboratory test using the actual wastewater. If no flaws are found in the plans, the wastewater issues will be solved by implementing the solutions according to the plans. Solutions to the issues of Tondgouyan PC and ET-1, on the other hand, should preferably be examined based on an accurate inventory of the drainage systems, selecting appropriate wastewater treatment methods based on the inventory identified and verifying the performance of each method by conducting a

preliminary test before applying the solutions.

The actions for the mid-term period in Mahshahr are to mitigate the current problems of BIPC, Razi PC, Tondgouyan PC and ET-1, which are releasing effluent with high environmental loads, and to reduce the discharge of mercury and other harmful substances into the environment.

The long-term goal is to ensure that all wastewaters from PETZONE satisfy the applicable effluent standards. In order to achieve the actions for mid-to-long-term period, it is important to properly carry out the actions for the short-term period, which are to compile information related to wastewater treatment, examine possible solutions to the issues, and develop a wastewater management plan.

2) Khark Island

Future Outlook
● If IOOC's crude oil processing plants do not implement measures to rectify the wastewater problems, the pollutant load on the sea area will likely continue rising along with the increasing volume of produced water year by year. Contamination of soil in the catchment basin and the areas along the drainage canal is also projected to spread. To counter these, first of all, the wastewater facilities to remove oil contents need to be expanded according to the estimated future increase of produced water and its management plan. While the wastewater is treated in compliance with the effluent standard, the residual oil contents and dissolved contaminants (organic compounds, chemical additives, etc.) in the treated wastewater are presently discharged into the environment (sea). Thus, for dealing with such issue, it will be required in the future to introduce the underground injection for ultimate disposal and/or effective reuse of the produced water from offshore oil fields instead of current sea discharge for protection of marine environment. ● IOTC is considering the installation of equipment for treating drain water from storage tanks. The treated drain water also needs to be ultimately disposed together with the produced water from IOOC's facilities by underground injection system to be provided by IOOC.
Actions to be taken
Short-term (1 – 2 years): <u>Wastewater Management</u> • Examination of solutions to current and expected future issues in wastewater management • Development of a total wastewater management plan in Khark Island <u>Underground Injection</u> • Investigation of oil reservoirs applicable to underground injection (disposal/reuse) • Conduction of reservoir study and analysis • Formulation of an underground injection plan • Conceptual design of wastewater treatment and injection facilities • Technical and financial feasibility study
Mid-term (3 –4 years): <u>Wastewater Management</u> • Compliance with the applicable effluent standard <u>Underground Injection</u> • Basic design of injection water treatment and injection facilities
Long-term (5 – 7 years): <u>Underground Injection</u> • Construction of injection water treatment and injection facilities • Implementation of underground injection of wastewater (Achievement of zero emission to sea)

Regarding wastewater treatment facilities of the crude processing plants, IOOC has initiated a study for expansion of individual wastewater treatment dealing with the increased produced water. On the other hand, renovation project of current tank drain treatment system is currently in progress by IOTC. However, improvement of entire wastewater treatment system in Khark Island as well as

an alternative of current treated water discharge to sea is not included in the planning at present.

In contrast, wastewater underground injection is practically adopted at offshore oil fields in the neighboring oil producing countries as ultimate treatment of produced water.

According to such recent trend in the region, it is assumed that underground injection of produced water is required in Iran to treat properly both of oil contents and dissolved contaminants in the wastewater in the near future. Though underground injection disposal is costly, it could be one of effective solutions to prevent the particular environmental impact caused by oil field development, especially from the perspective of preserving the Persian Gulf environment.

Produced water underground injection for EOR purposes has both environmental and economic advantages and is well worth considering. Introduction of underground injection, including that for EOR purposes, however, will require a preliminary geological and reservoir studies, evaluation of the oil and gas stratum, analysis of oil and water behaviors in reservoir by simulation modeling, and other studies that are largely different from those for conventional water treatment methods.

On Khark Island, it is recommended that oil contents should be dealt with by formulating an oil content control plan as the actions of the short-term period to eliminate the problem of oil contents. The mid-term goal is the achievement of compliance with the effluent standard. The long-term actions including underground injection are technically highly possible. Though disposal of wastewater through underground injection to deal with oil contents under the concentration of the effluent standard and dissolved contents will require different kinds of studies from those for other more common wastewater treatment methods as mentioned above, it should be considered positively from the perspective of conserving the rich environment of Khark Island and the Persian Gulf and an economic standpoint.

3) Assaluyeh

Future Outlook
● While wastewater treatment facilities of Assaluyeh district are relatively new compared to those of Mahshahr and Khark Island and have no major problems, wastewater problems may surface if the oil/gas plants continue to increase production as anticipated. ● As phases 6, 7, and 8 of gas refineries of SPGC adopted biological treatment and have since been stably controlling COD, introduction of the biological process to other phases should be considered upon verifying the effectiveness of the biological treatment equipment. ● Countermeasures to the COD overload problem of Mobin PC have already been studied, including the pilot test of MBR. It is also desirable to consider introducing CP Technology and installing separate drainage systems, which, however, will require close coordination with the companies discharging wastewater. ● Multiple solutions are available to the ammonia problem of Mobin PC. However, biological treatment is deemed unsuitable, considering the varying properties of wastewaters from different plants. Thus, physiochemical pretreatment, CP Technology, and separate drainage systems should be examined preferentially. As in the case with the COD overload problem, the ammonia issue needs to be dealt with in close coordination with the wastewater-discharging companies.
Actions to be taken
Short-term (1 – 2 years): • Examination of solutions to current and potential future issues in wastewater management • Preparation of a wastewater management plan
Mid-term (3 – 5 years): • Implementation of the wastewater management plan • Complying with the applicable effluent standard
Long-term (6 – 10 years): • Strength of the structure to inspect the compliance with the applicable effluent standards

The pollutant load of wastewater is expected to increase in future due to increasing production at each plant. Overload can be dealt with by expanding the existing wastewater treatment facilities. However, if such expansion is not possible due to space constraint, installation of higher-efficiency equipment, adoption of CP Technology, and segregation of drainage systems will probably need to be considered. For treating wastewater from SPGC's gas refineries, it would be desirable to install biological treatment units in all phases, except for phases 6, 7, and 8. If the biological treatment units of phases 6, 7, and 8 have extra capacities, it would also be possible to send wastewater containing high concentrations of organic compounds to phases 6, 7, and 8 from other phases for treatment. While the COD overload problem of Mobin PC can be dealt with by introducing MBR, methods to reduce pollutant load of wastewater should preferably be examined jointly with the companies generating the wastewater. As for the ammonia problem, though the ammonia-discharging companies are responsible for dealing with the problem, it would be more efficient if Mobin PC could work together with such companies by providing experience and

knowledge of wastewater treatment.

The actions for the short-term period are to examine possible solutions to the current problems, estimate the future production increase to work out countermeasures, and develop an appropriate wastewater management plan toward the achievement of the actions for the mid-term period. The action for the mid-term period aims to meet the effluent standards for all discharges according to the wastewater management plan.

(5) Actions of the Master Plan for Water Quality Conservation

The previous parts (2) Issues and Technical Solutions on Wastewater Treatment in Pilot Areas and (3) Underground Injection of Produced Water described the issues concerning wastewater treatment in the pilot areas, as well as their possible technical solutions. The future outlooks and actions of wastewater treatment in the pilot areas are outlined in the fourth part, (4) Future Outlook and Goals of Wastewater Treatment. Based on these, action items for the wastewater management are shown in Table 7.4.3-12. Likewise, action items for the underground injection of produced water are shown in Table 7.4.3-13.

Table 7.4.3-12 Actions for the Wastewater Management

	Actions	Mahshahr	Khark Island	Assaluyeh
1	Compilation of the issues on wastewater management	X		
2	Inventory survey of drainage systems	X		
3	Examination of solutions to current and potential future issues in wastewater management	X		
4	Discussion about wastewater management policy	X		
5	Preparation of a wastewater management plan	X		
6	Allocation of the budget	X		
7	Upgrade of the wastewater treatment facilities (New construction, Modification, Installation of optimum technologies)	X		

Note: X means the actions to be taken in the area.

Source: Study team

Table 7.4.3-13 Actions for the Underground Injection of Produced Water

	Actions	Khark Island
1	Compilation of the information about underground injection	X
2	Investigation of the injection sites (Survey of groundwater aquifer, and evaluating oil reservoirs)	X
3	Formulation of an underground injection plan	X
4	Allocation of the budget	X
5	Conceptual study, design of injection water treatment and injection facilities	X
	• Conceptual study	X
	• Basic design	X
	• Detail design	X
6	Construction of injection water treatment and injection facilities	X
7	Implementation of the underground injection of produced water	X

Note: X means the actions to be taken in the area.

Source: Study team

7.4.4. Oily Soil Cleanup and Remediation

As described in Subsection 4.2.2, the catchment basins and connected wastewater ditches as well as the adjacent areas are severely contaminated by the oil contained in the wastewaters from the upstream facility and flowing out from the basins, which is caused by the insufficient wastewater treatment systems currently operated in the island.

After completion of modification of the wastewater treatment systems, the present catchment basins shall be abandoned along with wastewater ditches. Accordingly, the oily catchment basins and oily contaminated surrounding areas shall be cleaned up and remedied properly for environmental conservation of the island.

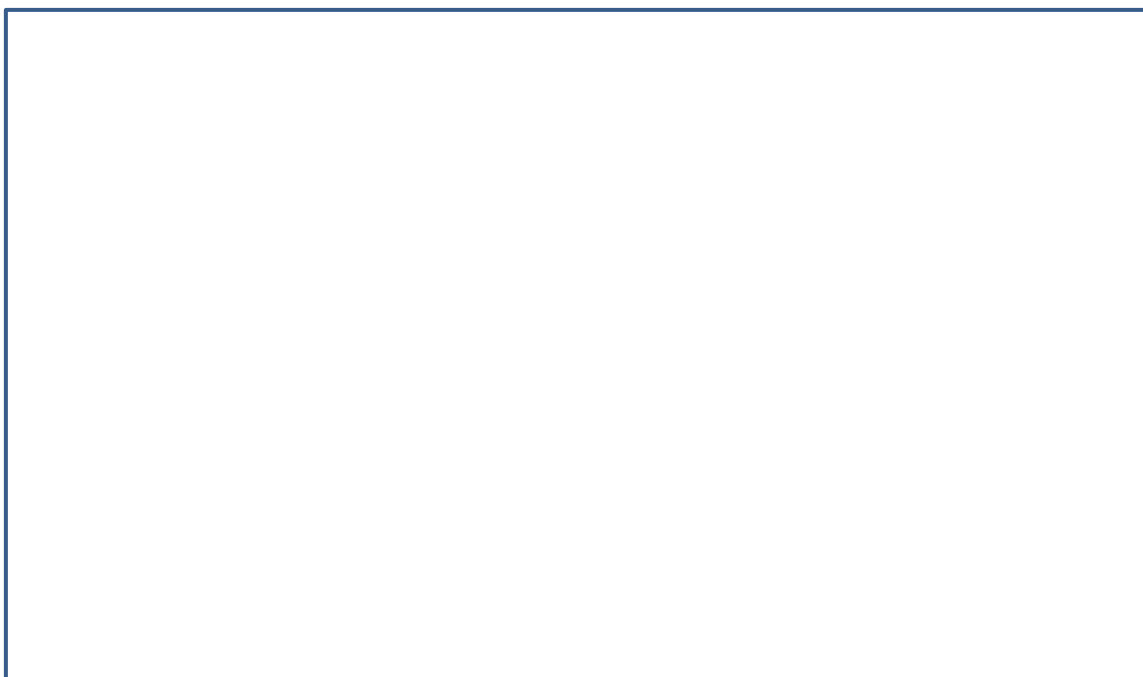
Therefore, the master plan is aimed for remediation of the oily contaminated areas using adequate cleanup method(s) of oily soil for future diversion of land use.

Subsection (1) describes applicable cleanup and remediation technologies, treatment methods and their characteristic, as well as treatment conditions and subsection (2) summarizes the procedures and items necessary to examine these applicable methods. Then, subsection (3) examines the applicable cleanup technology of oily soil and procedures for remediation of the contaminated areas in Khark Island

(1) Soil Cleanup and Remediation Technologies

The cleanup of oil contaminated soil (oily soil) aims to treat the pollutant (oil) in accordance with the environmental standards using methods such as separation, decomposition, neutralization and solidification (stabilization) the source of pollutant. The cleanup technologies of oily soil generally adopted are shown in Figure 7.4.4-1.

To carry out an effective treatment, it is indispensable to study whether the oily soil can be treated in a single method or in combination in consideration of the characteristics and composition of the oily soil and features of cleanup technologies. The features of technologies are described below. (Note that mechanical primary treatment procedures and methods for cleanup are not included.)



Source: Study team

Figure 7.4.4-1 Oily Soil Cleanup Technologies

1) Physical/Chemical Treatment

(a) Washing

The physical treatment is to wash the oily soil with water or hot water and separate the oil adheres to and penetrates the oily soil. The efficiency of separation is promoted by adding surfactant, stirring and heating. The separating ability is somewhat low (Residual oil >30%), but the treatment cost is comparatively advantageous to this method.

(b) Solvent Extraction

The chemical treatment is to dissolve and separate the oil content from contaminated soil with diesel oil or kerosene as a solvent. This method is suitable to process oily soil of 50% oil content or more, and the application with the washing method is very effective to promote the separating ability of oil. It is also effective to recover the oil. (Residual oil < 15%)

2) Thermal Treatment

(a) Low-temperature Thermal Desorption

Oily soil is heated at low temperature (90 - 300°C) in a furnace and low temperature volatile oil component is evaporated and separated from the soil. The separated volatile gas is recovered by

desorption and/or cooling condensation. This method is suitable for soil around 10 to 30% oil content, while it can be applicable to a wide range of oil content for treatment of oily soil. The process of oil recovery is comparatively simple and the equipment expense and operational cost are superior in comparison with the high-temperature heating method.

(b) High-temperature Thermal Desorption

Oily soil is heated at in high temperature (300°C or more) in a furnace, and high temperature volatile oil content is evaporated and separated from the soil. The separated volatile gas is recovered by desorption and/or cooling condensation. This method is suitable for oily soil with the oil content of high boiling point such as heavy oil. The process for oil recovery is complicated and the cost for facility investment and operation is comparatively high.

(c) Vacuum Distillation

Oily soil is heated (around 300°C), and the volatile oil is evaporated and separated at comparatively low temperature in vacuum distillation vessel (approx. 1 mb). The evaporated oil is recovered by cooling condensation. This method is applicable to oily soil with a wide range of oil content. However, the vacuum unit is needed in addition to the heating unit, thus the process for distillation and oil recovery becomes complicated. Consequently, the cost for facility investment and operation is comparatively high.

3) Combustion (Incineration)

Oil content in oily soil is processed by thermal cracking at high temperature and disposed by incineration. This method requires further treatment of combustion gas generating as secondary waste. Application of this method has been decreasing due to an environmental problem. However, in case of small-scale processing of heavily oil-contaminated soil, this method is able to demonstrate the high cost performance in comparison with other treatment methods.

4) Biological Treatment

(a) Slurry-phase Biological Process

After adding water to oily soil, the slurry is sent to the vessel, called “Bioreactor” to degrade the oil content with microorganism. This method is suitable to light contaminated soil of 5 to 10% oil content, but requires a comparative long period to clean up the soil. After treatment, it is possible to inject the treated slurry into the underground by pumping as the final disposal.

(b) Controlled Solid-Phase Biological Process

Oil content in contaminated soil is properly reduced in pre-processing to the applicable level of the

biological process, and the oil component is decomposed by microorganism in solid condition in a bioreactor while artificially controlling the temperature, moisture and the amount of the oxygen. This method is suitable to light oily soil of 5 to 10% oil content, but requires comparatively long period to clean up the soil.

(c) Landfarming

Oily soil is stirred with the surface soil. Since the ventilation in the soil is promoted by regular cultivation, a decomposition of oil content is promoted by the activation of microorganisms settling into the soil. It is expected to the higher decomposing effect by artificially supplying nourishment, moisture and air to improve an activation of the microorganisms.

In this method, a large treatment area and long processing time (several months - or more) are required. However, the treatment cost is reasonable in comparison with other methods. And also it is suitable for treatment against a large amount of contaminated soil.

5) Solidification and Stabilization

(a) Solidification Method

Oily soil is solidified and sealed up with cement so as not to seep for the oil component contained in the soil. Since the solidified cement is treated as wastes, this method is disadvantageous for the point of reducing of the waste volume. However, only this method has a big advantage, which is able to make the heavy metals harmless temporarily by solidifying with cement.

(b) Stabilization Method

Oil content in oily soil is adsorbed and remains in a chemical agent of calcium oxide as a principal ingredient. The oil content is stabilized into the chemical agent without elution. This method is suitable for the case to process the oily soil of 20-30% oil content in a short time. Moreover, this method is also available for stabilization of various kinds of heavy metals. However, the chemical price is comparatively expensive.

The comparison of performance (for desorption, decomposition and the cleanup efficiency of oil content) for each treatment method by oil content is shown in Figure 7.4.4-1.

Table 7.4.4-1 Comparison of Performance of Oily Soil Cleanup Technologies

Cleanup Technology \ Oil Content				
	80%	60%	40%	20%
Hot Water Washing			→	
Solvent Extraction			→	
Thermal Desorption			→	→
Bioremediation (bioreactor)				→
Bioremediation (landfarming)				→
Cement Solidification				→
Calcium Stabilization			→	→

Source: Study team

(2) Procedure to Make a Cleanup Plan

The objective of the oily soil cleanup will be set in line with the physical properties, oil contents and composition of the target oily soil, treatment amount, national and local environmental regulation, administrative guidelines of concerned authorities and standards of industry group and individual companies. Based on the objective, a cleanup plan will be prepared in consideration with the following items:

- Cleanup period
- Limitation of treatment space
- Condition of location for treatment facility (considering with convenience to infrastructures concerned)
- Necessity of oil recovery
- Application for reuse of treated soil
- Selection of applicable technology (considering with financial feasibility)
- Operation and maintenance of treatment facility

The basic conditions will be set in line with the company's philosophy and business plan for environmental protection and cleanup. Figure 7.4.4-2 shows the process of considering the basic conditions in preparation of the cleanup plan. The planning flow is shown in Figure 7.4.4-3.



Source: Study team

Figure 7. 4.4-2 Process of Considering the Basic Conditions in Preparation of the Cleanup Plan



Source: Study team

Figure 7.4.4-3 Flow of Formulating a Soil Cleanup Plan

(3) Procedures for Consideration of Khark Island

The previous Section 4.2.2(2) of Chapter 4 describes the present status of soil contamination around the catchment basins by oily wastewater discharged from the crude treatment facilities and crude oil storage tanks in Khark Island. According to such situation of the area, IOOC and IOTC are currently working on study for remediation of such conditions and improvement of environment of the island.

Oil producing countries in the Middle East have carried out many cleanup and remediation projects for evaporation ponds for treatment of industrial wastewater including produced water in onshore oil fields since 2000. Cleanup and remediation plans of the oil fields have been formulated in accordance with the results of surveys on the extents of oil pollution, and accumulated amounts of oil contaminants and other harmful contaminants (NORM, heavy metals, chemical substances and salt pollution), as well as penetration of the pollutants in the ground and groundwater, etc., in consideration of various circumstances including the landform, ecological system and social conditions in the region.

Points to note for planning and implementation of the soil remediation project are summarized below in accordance with the aforementioned six stages of the procedures in Table 7.4.4-3.

1) Specifying the Features of the Target Oil-contaminated Soil

The first step of the procedure is to specify the features of the target oil-contaminated soil. Major items to be specified are as follows:

- i) Properties of oily soil (oil type, soil composition and other harmful substances)
- ii) Types and quantity of contaminants in catchment basins (surface, middle, bottom layers)
- iii) Degree of diffusion to neighboring areas (on the ground, penetration depth, etc.)

The data and information about contamination of the target site shall be collected, followed by examining the scope of the cleanup. Figure 7.4.4-4 shows the case of oil contamination in Libya as an example to specifying the features and range of oil contamination. The features to be considered are not only the oil deposits but also contaminant accumulation on the pond sediment and infiltration of the contaminant into the underground. In addition, the most essential issue on the contamination by produced water from oil fields is to confirm if the unacceptable amount of NORM accumulates at the bottom of the basins. If NORM is identified, special measures such as securing the safety of workers, isolation and disposal of NORM must be taken. Therefore, the features of the target oil-contaminated soil must be specified prior to planning and execution of the cleanup project.



Source: Study team

Figure 7.4.4-4 Example of Oil Contamination of Evaporation Pond in Libya

2) Clarifying Basic Conditions to Formulate a Cleanup Plan

Prior to formulation of a cleanup plan, various preconditions must be clarified. The following are the basic preconditions for the cleanup plan:

- i) Cleanup of contaminated soil and recovery of contaminated areas
Appropriate treatment methods shall be used to remove (NORM and other harmful) contaminants affecting human bodies and the environment, and remedy contaminated areas.
- ii) Compliance with environmental and safety standards(domestic and international)
The environmental and safety standards of the country and the region concerned, as well as the international ones, shall be conformed when purifying contaminated soil and recovering contaminated areas.
- iii) Recovery and recycling of useful oil contents in oily soil
Effective use of petroleum resources through separation and recovery of oil content in contaminated soil shall be promoted.
- iv) Minimization of secondary oil contamination in the treatment process
Generation of secondary harmful substances, such as wastewater discharged in the treatment process and spread of oil contaminants, shall be minimized as much as possible. The treatment shall be appropriately conducted in accordance with the environmental standards.

In the case of Khark Island, the contaminated water in the catchment basins shall be removed and treated as a preliminary step of soil cleanup. Thus, a simplified facility for oily water removal and treatment should be built. Accordingly, a simple discharging plan must be drawn up and a new drainage line must be built to be connected to the existing drainage line.

v) Energy-saving

Consumption of energy such as electricity and fuel, water, chemicals and other resources shall be minimized.

vi) Appropriate implementation of management systems

The treatment process, quality, work environment, and the safety of workers and facilities shall be well controlled. Efforts will be made to minimize secondary contamination and ensure safe work in accordance with the soil purification/treatment process selected.

vii) Financial feasibility

Various conditions for the implementation of the cleanup project shall be satisfied in consideration of the cost effectiveness.

viii) Land use

A land use plan of IOOC and IOTC after the remediation shall be drawn up in conformity with environmental preservation and development plans in future. The plan must be consistent with an environmental management plan that will be formulated in future. Making decision in a long-term viewpoint is desirably in consideration of utilization as guard basin, injection of wastewater to the underground and so on.

3) Targeting the Oil-contaminated Soil, Treatment Volume and Capacity of Treatment Facility

The next step is to specify the target oily soil and quantify the basic conditions such as treatment volume and capacity of treatment facility. Those conditions shall be expressed in measurable terms after specifying the target oil-contaminated soil. It is noted that since the existing wastewater treatment facilities of IOOC and IOTC need to be operated continuously during the execution period of the project. Therefore, the applicable work period must be fixed in consideration of the amount of target oily soil and future land use plans.

4) Selecting Treatment Methods

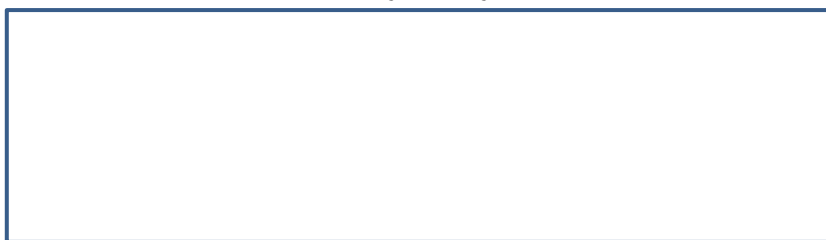
A single method or a combination of methods will be selected out of those shown in Figure 7.4.4-1. To apply any of those methods, the conditions shown in Figure 7.4.4-3, such as recovery of oil content, minimization of secondary waste generation, construction equipment and power supply,

technical capability of processing company and infrastructure such as access roads must be evaluated.

In the case of Khark Island in particular, since the location of the catchment basins is undulating, construction vehicles may have difficulty in reaching the site. Planning of access roads will have substantial impact on the work efficiency. An appropriate treatment method(s) satisfying those conditions must be selected. The following are the steps to select the treatment methods for the case of Khark Island:

(a) Identifying Distribution of Oily Soil Layers in the Catchment Basins

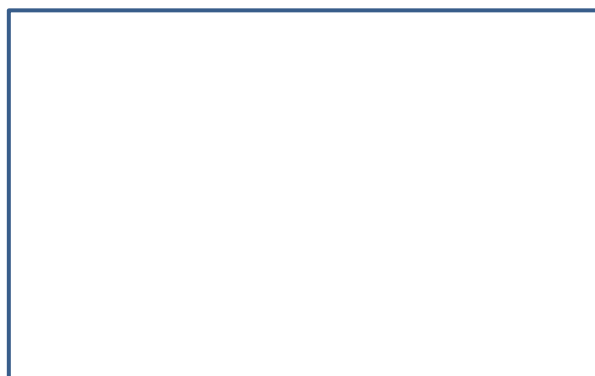
Figure 7.4.4.-5 illustrates the distribution of oily soil layers in the catchment basin.



Source: Study team

Figure 7.4.4.-5 Distribution of Oily Soil Layers in the Catchment Basin

As illustrated in the figure above, a large amount of oil and oil sludge accumulates on the bottom of the catchment basin. In the catchment basins of IOOC and IOTC, oil contents on surface layer are weathered and has turned into high-viscosity oil (10,000cSt or higher). The surface layer needs to be collected with construction equipment or pumped up with special pumps. Figure 7.4.4-6 shows a photograph of removal work of extremely high-viscosity oil with construction equipment. Such a cleanup method is expected to be partially needed for the work in Khark Island.



Source: Study team

Figure 7.4.4-6 Oil Removal with Construction Equipment

(b) Applicable Technologies

The major treatment methods currently applied to evaporation ponds of produced water in the oil fields are as follows:

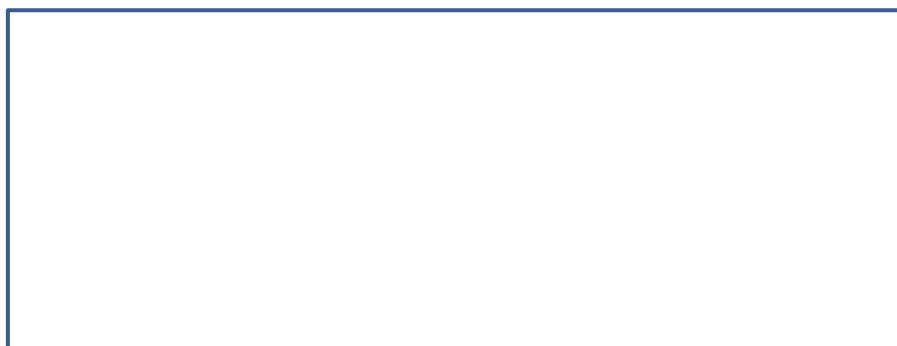
- i) Biological treatment
- ii) Physical and chemical treatment
- iii) Thermal treatment

The applicability of these methods varies depending on oil content of the target oily soil. An effective treatment method(s) must be selected according to classification of the oil content.

(c) Selection of Treatment Method

Treatment methods can be selected basically from three methods: biological treatment, physical and chemical treatment and thermal treatment. Those three methods have applicability to oily soil cleanup in accordance with the levels of oil content.

Based on this policy, the treatment process that will meet the efficiency and financial feasibility must be examined. The first step is to establish a concept of a treatment system. A decision shall be made on whether the oily soil is treated with a single method or a combination of method. Figure 7.4.4-7 shows three options of the treatment system.



Source: Study team

Figure 7.4.4-7 Combination of oily soil cleanup methods

Option 1 uses one treatment technology to treat the contaminated soil with all levels of oil content. Option 2 uses Method B for the soil with high oil content. Method C for the soil with medium oil content and Method D for the soil with low oil content. The cleanup works for the soils with different oil content are carried out simultaneously and independently. Option 3 treats the contaminated soil sequentially, shifting methods from X to Y and from Y to Z. These three treatment processes have their own characteristics. Table 7.4.4-2 gives the characteristics of each method and selective combinations.

Table 7.4.4-2 Characteristics of Single and Combined Methods

Process type	Advantages	Disadvantages
<u>Option 1</u> Single method <i>Adopted method:</i> <i>Biological treatment</i>	• Simple process • No need to classify the contaminated soil in terms of oil content • Easy to formulate a treatment plan	• Applicability is limited because the oil content varies depending on areas with contaminated soil. • Treatment cost becomes high if the selected method is inapplicable to oil content. • Contaminated soil with high oil content needs to be diluted with pure soil, requiring treatment of a larger amount of soil. • An increased amount of soil is likely to prolong the treatment term.
<u>Option 2</u> Combined methods (simultaneous treatment) <i>Adopted method:</i> <i>Biological treatment</i> <i>Physical/chemical treatment</i> <i>Thermal treatment</i>	• Easy to formulate a treatment plan because a number of methods are applied simultaneously but independently • High efficiency because an appropriate method is applied to the soil with appropriate oil content. • Reasonable treatment cost	• Necessity to classify the contaminated soil in terms of oil content
<u>Option 3</u> Combined methods (Sequential treatment) <i>Adopted method:</i> <i>Biological treatment</i> <i>Physical/chemical treatment</i> <i>Thermal treatment</i>	• High efficiency because appropriate technology is applied to the soil with appropriate oil content. • Reasonable treatment cost	• Necessity to classify the contaminated soil in terms of oil content • Difficult to formulate a treatment plan because a number of methods are sequentially used • It takes a long time.

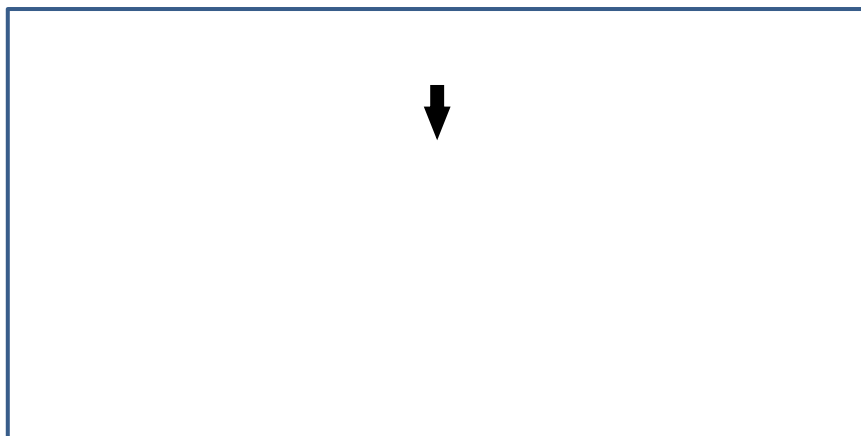
Source: Study team

When the cleanup work is conducted for oily soil in the catchment basins in Khark Island, it is effective to classify the soil in terms of oil content to gain the satisfactory performance of the treatment method selected. On the other hand, it is possible, as in Option 1, to mix contaminated soil of different oil content, reduce the content to the level appropriate to the technology adopted, and conduct the cleanup work. But this approach requires oil content control and heavy workloads in proportion to the amount of contaminated soil. In sum, it is desirable to classify the contaminated soil by oil content suitable for the selected method without oil content control so as to streamline the work. Therefore, Options 2 and 3 seem to be suitable for the oily soil cleanup in Khark Island. In Option 2, combined treatment methods are put into practice simultaneously and a right method applies to the contaminated soil with oil content suitable for the method. In this sense, the combined treatment methods are highly efficient and reasonable. Although the combined methods require classification of contaminated soil in terms of oil content, strict classification and oil content control are not necessary. Moreover, since each treatment process is independent and simultaneously implemented in this option, the treatment plan can be executed even if there is a

delay in the work at the process for any oil content.

Option 3 uses a combination of the treatment methods and treat the contaminated soil sequentially. As in Option 2, since a right method applies to the contaminated soil with oil content suitable for the method, this option is also considered to be reasonable. However, any delay at the previous stage directly affects the following stage and the treatment time may be prolonged.

In line with the discussion above, the most optimal combined method is shown in Figure 7.4.4-8.



Source: Study team

Figure 7.4.4-8 Selection of Oily Soil Cleanup Options

Since technologies are advantageous if they are well combined, appropriate ones will be selected and combined in consideration of economic efficiency, environment safety, a time required for purification and other aspects after the amount of soil and oil concentration are investigated.

5) Selecting Final Disposal Methods

Final disposal methods for residual wastes generated from the treatment process are classified as follows:

(a) Oily Wastewater

Wastewater recovered from catchment basins and spent wash water of physical and chemical treatment process shall be treated by the specific wastewater treatment system of IOOC and IOTC together with ordinal oily wastewater of the plants.

(b) Recovered Oil

Oil contents separated from high oily concentrated soil by the thermal treatment and/or washing process shall be recovered in primary storage tank. Then, after mixing with crude oil in compliance with specific rate, the mixture oil shall be transferred to crude oil storage tank for export.

(c) Treated Soil

Soil cleaned up shall be filled back to the original site or reused at other locations in accordance with the degree of quality.

(d) Untreated and Hazardous Soil

Soil containing high level of hazardous substances such as NORM and other contaminants must be separately stored and managed properly at the specific location in compliance with the related laws and regulations.

6) Conducting Final Evaluation

IOOC and IOTC shall comprehensively evaluate the plan to clean up the contaminated soil around the catchment basins and the surrounding area in accordance with the procedure abovementioned. The evaluation aspects include validity of treatment methods and schedule, safety, effects on oil facility operations, and potential environmental and social impacts as well as financial feasibility of the plan.

(4) Actions for Cleanup and Remediation of Oil-contaminated Soil

In accordance with the discussion, actions to be taken for cleanup and remediation of oil-contaminated soil are listed in Table 7.4.4-3.

Table 7.4.4-3 Actions for Cleanup and Remediation of Oil-contaminated Soil

	Actions
Action 1	Investigation of conditions of the oily contaminated areas
Action 2	Discussion of uses of the areas after remediation
Action 3	Decision of scope of work and project specifications
Action 4	Selection of applicable technologies
Action 5	Project planning
Action 6	Feasibility Study
Action 7	Preparation of project finances
Action 8	Project implementation
Action 9	Evaluation of residual environmental effects

The plan is to be commenced after completion of improvement projects for the existing wastewater treatment systems of IOOC and IOTC.

7.4.5 Waste Management

(1) Waste Management System

1) Solid Waste Management Procedure of Petroleum Industry in Iran

Various types of solid wastes particular to the petroleum industry are generated as a result of project activities in oil and gas development as well as operations of crude production facility, oil refinery plant and petrochemical plant. The national oil companies such as NIOC, MPC and others have specific management system for the wastes and affiliate operation companies are dedicatedly making efforts to control the generated wastes from the project activities and operations of their facilities.

Principal procedure of the waste management system applied to petroleum industry in Iran is shown below.

- i) Waste generation
- ii) Segregation and coding
- iii) Selection of storage locations and containers with clear labeling
- iv) Registration in manifest sheet and tracking of treatment progress
- v) Collection and transportation
- vi) Intermediate treatment for reuses/recycling
- vii) Ultimate landfill
- viii) Environmental monitoring of landfill site

The types and codes of each wastes generated from plants are recorded properly and the treated or disposed volumes and methods applied (i.e. recycle, sale to treatment contractor, landfill, temporary storage, etc.) are reported monthly to the mother company in accordance with the tracking data of manifest system.

2) International Practices for Waste Management

On the other hand, a practical waste management procedure of international oil and gas industry shows several approaches as follows:

- i) Inventory (types and volumes) of wastes generated from project activities and facilities operations
- ii) Assessment of potential HSE risks caused by the planned treatment measures for the wastes
- iii) Mitigation of the HSE risks by “3R”
 - Reduce generation

- Maximum **Reuse** or **Recycle**
- Minimum ultimate disposal volume
- iv) Segregation of “hazardous waste” from the general wastes
- v) Selection of effective treatment/ disposal methods
- vi) Proper implementation of management plan: storage, transportation and disposal or reuse/ recycle

Principle of waste management is that waste generators (oil companies) are responsible for the entire management process from generation to ultimate treatment/ disposal.

As described above, the waste management procedures and measures of oil industry in Iran are dedicatedly implemented in compliance with the guidelines and practices of the international oil industry. However, proper and effective management and treatment measures for several particular wastes discharged from oil development activities and oil related plants are not properly addressed so far, which make it a serious issue to be discussed among the responsible ministry and affiliate national oil companies.

Under supervision of the ministry, the national oil companies are required to establish proper management procedures for the various wastes generated from oil industries including such particular wastes. Furthermore, it is also required that the national companies will set up practicable targets for reduction of waste generation, reuse and recycle of variable wastes discharged from each oil industry and plant as well as discussion of action plans for achieving the goals.

On the other hand, since the types of industrial wastes discharged from oil facilities are in various forms, it is assumed to be difficult to treat and dispose ultimately all the wastes by only the current industrial framework of oil sector in Iran. In order to implement proper waste management of oil industry, preparation of technical and logistic infrastructures and utilization of these resources beyond boundaries of industrial sectors in the country are extremely effective. It is surely expected that such framework will contribute technical and commercial benefits among related industrial sectors.

Subsequent sections will focus on the needs of adequate management for particular solid wastes to oil industries, which are “Spent Catalysts” and “Oily Sludge” discharged from oil refineries and petrochemical plants, and “Drill Cuttings” discharged from well drilling operations accompanying oil and gas field development.

(2) Treatment of Spent Catalysts

1) Spent Catalysts

Various types of catalyst are used in production process equipment of oil refinery and petrochemical plants. The catalysts functions gradually deteriorate in accordance with operation of the equipment, so that, the deteriorated catalysts are regularly replaced with new ones. As a result,

large amount of spent catalysts is discharged from the plant as wastes, which comprised the most significant solid waste generated from the plants.

Since the purposes and functions of catalysts used in production process vary respectively, the materials composing the catalysts also varies. The main components of catalysts is Alumina or Silica-alumina in general, and depending on the particular process, the catalysts contain some kind of active elements such as zinc, iron, copper, cobalt, platinum, molybdenum, vanadium, etc. which are valuable or precious metals.

On the other hand, the spent catalysts contain several contaminants included in the process fluid such as hydrocarbons, sulfur, heavy metals (e.g. mercury, etc.) and so on. Accordingly, spent catalysts are usually categorized into hazardous waste.

2) Applicable Treatment Measures

Practical treatment methods for spent catalysts in oil industry are proposed below.

Option 1: Ultimate treatment

- Landfill (for inert spent catalysts)
- Recycle at cement factory for bi-raw material

Option 2: Reuse by regeneration at manufacturer

Option 3: Recovery of valuable and precious metals at special factory

In case that the material is inert (non-hazardous), it can be disposed ultimately at controlled type of landfill site. Since the components of catalysts and additives are similar to raw materials of cement, spent catalysts are treatable (recyclable) in cement production process as by-feedstock. This option is widely applied by many industrial countries including Japan.

The special catalysts containing valuable/ precious metals used for advanced production processes commands a high price. Therefore, such precious spent catalysts are practically sent back to the manufacturers for regeneration.

On the other hand, the spent catalysts with valuable/ precious metals are subject to recycle, and certain international markets for spent catalysts are available for recovery of valuable/ precious metals. It is to say, the spent catalysts can be sold out to special agents of the sector.

It is promoted by strong requirement and pressure to reduce the environmental impacts of manufacturing of catalysts and improper disposal of the spent catalysts, to use high price catalyst material, and to reduce the amount of wastes from the plant.

3) Discussion of applicable Treatment Options

Procedure for discussion of applicable treatment option for spent catalysts is shown below.

- i) Inventory (types and volumes) of spent catalysts discharged from each plant

- ii) Assessment of components and values of the wastes
- iii) Assessment of HSE risks associated with landfilling for ultimate disposal
- iv) Study on technical feasibility for recycle at cement factory in Iran
- v) Study on availability of reuse by regeneration at manufacturer of catalyst
- vi) Survey of international markets for selling out
- vii) Finance feasibility study on each option
- viii) Discussion of company policy for waste management

For selection of the most applicable treatment option, it is necessary to discuss dedicatedly the technical and financial feasibility considering inventory of the target wastes, potential HSE risks associated with the proposed treatment measure, availability of related industries as well as infrastructure necessary for implementation. Furthermore, in addition to the feasibility, it is also essential to select the most beneficial option to define the clear policy of the company, who is the generator of the waste, for waste management.

(3) Treatment of Oily Sludge

1) Oily Sludge

Oily sludge is a major consistent waste generated from production facilities of upstream sector (oil and gas development) and downstream sector (oil refinery and petrochemical industry). However, the process of generation and compositions of the waste are different among the sources. The oily sludge, in general, is adhered to or accumulated in process equipment, storage tanks, wastewater treatment equipment and pipes of the plant, and then, it is discharged from the sources at the time of opening for inspection of the equipment and pipes. Oily sludge containing high rate of oil is categorized into hazardous waste.

The oily sludge originated from upstream equipment consists of associated sand with crude oil from underground reservoir, scales and iron oxide adhered on the inner surfaces of production well tube, pipes, and production equipment as well as heavy compositions and produced water in crude oil. The composition and properties of the sludge vary respectively depending on the feature of oil reservoir, type of crude oil, and location and function of the equipment. Furthermore, the sludge includes other compositions of several chemical agents added in the process of crude production.

In addition to above, it is assumed that there is a possibility of Naturally Occurring Radioactive Material (NORM) in the scales and other deposits in the sludge.

On the other hand, oily sludge originated from oil refinery and petrochemical plant is comprised of heavy residue in the process fluids, iron oxide on inner surfaces of process equipment and pipes, fine fragments of process catalysts, process water, etc.

2) Treatment of Oily Sludge

The practical treatment measures for oily sludge are separated into two options in general.

Option 1: Elimination/ isolation of harmful/ hazardous materials

- Methods: centrifuge, washing, thermal desorption/ separation, incineration, solidification, bio-decomposition
- Ultimate disposal: landfill of residual solids

Option 2: Full recycling without treatment

- By-fuel/ feedstock of cement factory

Option 1 aims to eliminate or isolate harmful/ hazardous material from solid components of the sludge and this is used practically among many oil producing countries at present. Applicable methods include mechanical separation of oil by centrifuge, washing with solvent or hot water/ steam, thermal desorption using furnace, incineration of oil components, and isolation of sludge particles by solidification with cement and biological decomposition of oil contents.

These methods have their applicable ranges of oil concentration and shapes of the materials individually. Therefore, for achieving the targeted allowable residual oil content, adequate combination of several methods is required depending on the situation of application.

Since oily sludge contains high concentration of oil in it, reuse of such oil could be recovered from the sludge depending on the composition of oil. For discussion of applicable treatment system, it is effective to consider recovering oil from the sludge, which is widely implemented in oil industries.

Oily sludge generally has high concentration of oil and similar solid compositions to feedstock material of cement factory. Accordingly, Option 2 is that the oily sludge is effective to use for by-fuel and by-feedstock of cement factory, which is considered as ultimate treatment of the waste. This option is already applied in several advanced industrial countries including Japan, and its effectiveness has been efficiently proven.

3) Discussion of Applicable Methods

Procedure for discussion of applicable method for oily sludge treatment is described below.

- i) Inventory of oily sludge from each plant (types and volumes)
- ii) Shape and composition of oily sludge, concentration of hazardous materials
- iii) Potential HSE risks associated with treatment
- iv) Decision of treatment specification (target residual oil content) for landfilling
- v) Treatment conditions: time limitation, location and area, budget, oil recovery requirement, etc.
- vi) Discussion of applicable method
- vii) Study on technical feasibility (availability of capable contractor, cement factory, etc.)

- viii) Study on financial feasibility
- ix) Discussion of company policy for waste management

As mentioned earlier, the oily sludge with high concentration of oil is categorized into hazardous waste. Handling, transportation, storage and treatment of such waste are expected being associated with potential HSE risks, and accordingly, proper HSE management is essential in the whole treatment progress, which includes initial measurement of hazardous/ harmful materials and monitoring.

In addition, where NORM is detected, proper management for handling and storage of the waste is required in compliance with relevant laws and regulations in Iran.

(4) Treatment of Drill Cuttings

1) Drill Cuttings and Environmental Impacts

Volumes of drill cuttings discharged during drilling operation of petroleum wells are the largest waste generating source in the exploration phase of oil and gas development project, which is considered to be one of the major causes of potential marine pollution, since it will affect directly the marine environment, when it is discharged to sea.

Drill mud is injected and circulated into well bore for drilling of wells for the purpose of cooling and lubrication of drill bit, pressure balance of well, borehole stabilization and removing cuttings from well bore. There are two (2) types drill mud, which are oil base mud (OBM) and water based mud (WBM). They are appropriately selected depending on the drilling conditions of the targeted wells. The drill cuttings are discharged onto the drilling rig on the surface of sea during drilling operation. The drill cuttings discharged contain several compositions of drill mud used for the drilling operation.

At offshore well drilling in the past, the drill cuttings have been commonly disposed into sea as practical method and it was considered to be the largest cause of marine pollution of oil and gas development accordingly. Especially, environmental impact due to the drill cuttings containing OBM was significant.

According to such past situation, use of OBM was controlled and disposal of OBM drill cuttings was prohibited in the offshore oil and gas development fields in the world. Then, ROPME Kuwait Convention (1978) agreed among the countries along the Persian Gulf and stipulated similar protection measures against marine environment in offshore oil and gas development.

In Iran, WBM is mainly used for drilling operation in accordance with the convention for protection of marine pollution, and then considering marine environment, the drill cuttings are disposed into sea when it is evaluated insignificant to cause environmental impact. On the other hand, where a significant environmental impact by offshore disposal is expected, and the OBM is used for drilling, such drill cuttings are recovered and transported to onshore for proper treatment

in compliance with the company's waste management plan.

Iran has large scale offshore oil and gas development plans with massive well drilling champagnes. For promotion of marine environmental protection against large offshore development, it is important to further discuss how to control and manage the drilling wastes (cuttings) discharged from future drilling operations.

2) Management of Drill Cuttings

The issues to be discussed for proper management of drill cuttings are described below.

- Increased future discharge volumes of drill cuttings
- Potential environmental impacts due to offshore disposal of drill cuttings (combined or cumulative impacts)
- Introduction of advanced drilling technologies (directional drilling, etc.) and increase of OBM uses
- Assessment of HSE risks and environmental impacts accompanied by handling and treatment of drill cuttings
- Probable increase of costs for transportation, management and treatment of drill cuttings

Volumes of drill cuttings discharged from each well drilling are estimated according to size and depth of the well, which is 300 – 500 m³ from 2,000 – 4,000 well depth in general. Number of wells to be drilled is decided based on the field development plan and it is easily expected that the volumes of drill cuttings discharged from the field development will be extremely large.

In addition, in case of an expansion project which the site is located in the developed field with several wells, or new field development field located adjacent to other future development field, such project is expected to create probable combined or cumulative impacts other than the impact arising from individual development project.

Furthermore, according to recent advancement of drilling technologies such as directional drilling and horizontal drilling, requirement to use higher functional OBM will be increased and the volumes of oily drill cuttings are expectedly increased accordingly.

Major material of drill cuttings is rock fragments adhered with several components of used drill mud. Basic components of drill mud are Bentnite clay and Barium sulfite (Barite) mixed with sea water (approximately 75w%) for WBM and mineral oil (approximately 45w%) for OBM. Several kinds of chemical are added to drill mud such as scale inhibitor, viscosifier, emulsifier pH controller, etc.

Three groups of OBM are available according to the type of oil mixed to mud, which are Group 1 mineral oil (diesel oil): high toxicity, Group 2 low aromatic oil: low toxicity and Group 3 synthetic hydrocarbon (i.e. ester, olefins, synthetic paraffin): non-toxicity. Suitable type of OBM is selected properly depending on the function required for the mud and environmental consideration.

There is a possibility that an underground stratum containing Normally Occurring Radioactive Material (NORM) exists, so that, it is assumed that the drill cuttings could include NORM.

It is expected that possible environmental impacts caused by disposal of drill cuttings into sea are turbid and polluted water quality, sedimentation/ deposition of waste on sea bed, disturbance to marine life such as benthos, algae/ sea grass, corals, etc.

As described above, since drill cuttings may have hazardous/ harmful materials depending on the type of drill mud used for drilling operation, probable HSE risks are expectedly accompanied from handling, storage, and disposal into sea, treatment and ultimate disposal on land. Associated with promotion of offshore oil and gas development, it is also expected to increase costs required for the particular waste management due to increased drill cuttings, diversified HSE risks and increased mitigation costs and others. Accordingly, further discussion of effective methods for proper treatment and ultimate disposal are required for optimum management of drill cuttings.

3) Treatment and Ultimate Disposal of Drill Cuttings

Optional methods for treatment and ultimate disposal of drill cuttings discharged from offshore oil and gas development project are practically proposed as follows.

- Option 1:** Sea disposal of the whole drill cuttings
- Option 2:** Sea disposal of WBM drill cuttings and low-toxic/ non-toxic OBM drill cuttings, and on-land treatment of high toxic OBM drill cuttings
- Option 3:** Recovery and on-land treatment of the whole drill cuttings
- Option 4:** Underground re-injection (disposal) of the whole drill cuttings

For sea disposal, the drill cuttings are discharged into sea directly just below the drilling rig. However, if there is any environmentally sensitive marine habitat such as coral reefs in the adjacent area to the drilling site, the drill cuttings are transferred and/or discharge into other area not affected by the operation. In order to prevent or mitigate probable environmental impact caused by sea disposal of drill cuttings, the use of non-toxic and low toxic OBM are recently increased among drilling companies in the world according to the proven effects of such method.

On the other hand, where a significant impact on marine ecology in the surrounding area is expected due to sea disposal of drill cuttings, the whole drill cuttings shall be transferred to onshore for ultimate disposal of the wastes regardless of the type of drill mud to be used.

The drill cuttings sent to onshore shall be treated and disposed properly similar to oily contaminated sludge in compliance with the specific waste management plan of the company as well as applicable regulations in the region. For ultimate disposal, controlled type of landfill site is acceptable practically.

Oil and gas development in remote sea areas is promoted in the world in this decade. Accordingly, the increased costs of management of drill cuttings including transportation and treatment on land

are the large pending issues for the project. In addition, due to increased wastes from offshore field, environmental loads of ultimate disposal on land are also the issue to be considered seriously. According to such recent situation, underground re-injection (disposal) at the development site has been implemented successfully in several oil producing countries. This is an effective ultimate disposal into the underground stratum through abandoned oil wells

4) Discussion of Applicable Treatment Methods

Procedure for discussion of applicable treatment method(s) for drill cuttings oriented by offshore oil and gas development are shown below.

- i) Identification of oil/ gas field development plan and well drilling plans
- ii) Inventory of drill cuttings discharged in each development site (types and volumes)
- iii) Identification of components and toxicity of the wastes
- iv) Survey on environmental baseline of the development site
- v) Assessment of potential HSE risks associated with handling, storage and treatment (sea disposal)
- vi) Study on mitigation measures for probable HSE risks
- vii) Study on applicable treatment and disposal method(s)
- viii) Technical feasibility study of the method(s)
- ix) Financial feasibility study of the method(s)
- x) Discussion of company policy for drill cuttings management

For assessment of environmental impact of disposal of drill cuttings into sea, drill cuttings modeling study is widely introduced for similar projects, which predicts probable range of dispersion of cuttings in the water column and patterns of deposition on sea floors.

Proper treatment of drill cuttings is one of the major HSE issues to be considered seriously which is associated with drilling operations so that it shall be the essential item subject to environmental impact assessment (EIA) for the offshore oil and gas development project.

Furthermore, for large scale of development project, it is effective that proper discussion of proper marine environmental protection be carried out to tackle this issue with the regional strategic environmental assessment (SEA) but not on individual project, because large number of wells would be created in several development sites in multi- phased for long term.

(5) Actions for Implementation of Waste Management (Treatment)

The above sections describe the management procedures and applicable treatment methods for the specific wastes generated from petroleum industry in the pilot areas for implementation of the master plan. The actions to be taken for promotion of proper and effective waste treatment are listed in Table 7.4.5-1.

Table 7.4.5-1 Actions for Waste Management

	Actions
Action 1	Inventory of wastes from each plant (types and volumes)
Action 2	Assessment of components and values of the wastes (for recycle/reuse)
Action 3	Assessment of physical and chemical properties
	- Shape and chemical compositions
	- Hazard/ toxicity
Action 4	Decision of ultimate treatment methods (recycle/reuse/disposal)
Action 5	Assessment of HSE risks associated with treatment/ disposal
Action 6	Discussion of treatment specification (e.g. target residual oil content)
Action 7	Discussion of treatment conditions
	- Time limits, location/area, budget, extraction of valuables, etc.
Action 8	Decision of treatment method(s)
Action 9	Technical and financial feasibility study
Action 10	Decision of treatment method based on company's policy
Action 11	Preparation of finance (budget)
Action 12	Procurement/ installation of treatment equipment
Action 13	Implementation and monitoring
Action 14	Evaluation of performance

7.5. Environmental Monitoring

This section discusses environmental monitoring, which is one of the important tools for environmental management. In this section, social environment factors as well as natural environment factors are handled as an environmental monitoring.

7.5.1. Objectives of Environmental Monitoring

Environmental monitoring plays an important role in understanding the appropriateness of institutional or technical matters of environmental management. That is, an environmental management will be sustainable by continuous improvement of institutional or technical matters based on the monitoring/evaluation of the planned institutional or technical improvement of the environment. The objectives of the environmental monitoring are listed as follows:

- Protection of human health and ecosystem, which leads to the protection of the area, the country and the earth
- Confirmation of environmental control based on the operation following regulations/standards
- Continuing of stable operation
- Prompt action, including relevant sectors, to the discovery of an abnormal data
- Information disclosure to the area/the third party to maintain the corporate image

It is considered that the environmental monitoring can be divided into two (2) major categories as shown in Table 7.5.1-1: continuous and periodical monitoring. Since both of them have advantages and disadvantages, it is necessary to understand the characteristics of each monitoring category to balance those for effective monitoring.

Table 7.5.1-1 Categorization of Environmental Monitoring

Monitoring	Description	Advantage	Disadvantage	Applicable target
Continuous monitoring	- Data is observed continuously by automated equipment.	- Effective for detection of abnormal data. - Possible for labor saving by automation.	- Parameters and covered area are limited. - Facility investment is necessary. - Maintenance and its cost are necessary.	- Plant monitoring - Discharge outlet - Monitoring at major point in the area - Monitoring for important location
Periodical monitoring	- Data is obtained manually and periodically.	- Wide area and parameters can be monitored.	- Labor cost is necessary. - It takes time to get the result due to chemical analysis.	- Monitoring in the wide area - Natural environment - Ecosystem - Human health

Source: Study team

It is necessary to clarify the followings upon conducting the monitoring:

- Monitoring methodologies, parameters, locations and frequencies
- Determination of environmental impacts of the project and environmental performance index related to its mitigation measures
- Determination of detection limit and threshold value for counter measures
- Responsible organizations for both monitoring and supervision on detection of abnormal data

General monitoring parameters are listed in Table 7.5.1-2.

Table 7.5.1-2 General Parameters for Environmental Monitoring

Factor	Category	Parameter
Natural environment	Pollution control	Air quality
		Water quality
		Wastes
		Noise/Vibration
		Odor
	Natural environment	Ecosystem
		Precious species
Social environment	Permits	Measures based on the laws Measures based on the comments by related sectors
	Social environment	Complaint
		Health problem
		Public announcement

Source: Study team

7.5.2. Present Situation of Environmental Monitoring

(1) Monitoring System

Table 7.5.2-1 summarizes the present situation and challenges of the environmental monitoring at each pilot area.

Comprehensively evaluating, the major challenge of each pilot area:

- Facility upgrades/improvement for environmental measures is necessary.

is realized. Therefore, it is considered that the monitoring structures and systems should be strengthened.

However, the following is considered as present issues on the monitoring systems:

- There is a pilot area where the number of monitoring locations can be considered not sufficient.
- There is a pilot area where the monitoring parameters must be reviewed. Monitoring of

social environment is necessary.

- There is a pilot area where the monitoring shall be conducted uniformly.
- The structure to disclose information and communicate within the company and with the outside must be established.
- Preparation of manual for monitoring implementation and evaluation of the results is necessary.
- The structure to respond excess of standard value must be strengthened.

Table 7.5.2-1 Present Situation and Challenges of Monitoring in Each Pilot Area

Factor	Category	Parameter	Mahshahr	Khark Island	Assaluyeh
Present situation of monitoring	Natural environment	Air	Continuous monitoring 1 location, 6 parameters	Continuous monitoring 4 locations	n.a.
			Simplified measurement 10 locations, 4 parameters, almost every day	4 locations, 5 parameters	20 locations, 6 parameters
			Flaring condition	n.a.	Exhaust gas from the flare stack, burning appliances
		Noise	16 locations, 48 times/year	n.a.	n.a.
		Vibration	n.a.	n.a.	n.a.
		Water	41 locations, 7 parameters, regularly	n.a.	Industrial waste water, rainwater drainage, 6 locations
		Wastes	Location, volume, disposal way, disposal volume	n.a.	Contents, volume, weight, disposal way (recycle, sell-out, incineration, dumping, temporal storage), number and remaining
		Temporal storage	n.a.	n.a.	n.a.
		Final disposal site	Leachate water, every month	n.a.	Segregation by encoding wastes
		Ecosystem	-	-	-
	Social environment	Complaint	n.a.	n.a.	n.a.
		Health problem	n.a.	n.a.	n.a.
	Monitoring by another organization		Monitoring by DOE Water quality 10 locations Sediment quality 6 locations (upgrade to 9 locations is planned)	n.a.	n.a.

Factor	Category	Parameter	Mahshahr	Khark Island	Assaluyeh
Major environmental challenges			• Discharge of untreated or improperly treated water • Pollution of water and sediment in adjacent area • Environmental impact to wildlife protected area • Treatment of waste disposal, disposable catalyst • Funnel fume, noise • Outgoing correspondence of environmental messages	• Report from each production zone is 1 time/year • Inadequacy of wastewater treatment facility • Insufficient capability of wastewater treatment facility • Dispersion of flare gas • Treatment of drilling wastes • Volume of production water is exceeding the capacity of water treatment facility • Increase of drilling wastes on offshore development is concerned. • Soil pollution around oil and water pond is concerned.	• Air pollution in entire area • Dispersion of excessive flare gas • Serious air pollution by the above mentioned. • Improper discharge of plant water (occasionally) • Treatment of wastes and disposable catalyst • Study of tidal current, distribution of water temperature and pollutants in the Naiband bay.
Challenge related to monitoring structure			n.a.	Unified monitoring is not conducted and the data is individually managed.	• Air monitoring data is not reported to MOP. • Monitoring data from each company is not shared.

Note: n.a. not available

Source: Study team

(2) Reporting Framework of the Monitoring Data

Understandings regarding reporting framework of the monitoring data at present obtained through the project activities and periodical report at each pilot area are summarized in Table 7.5.2-2 (refer to Chapter 3 and Chapter 4 for the details).

Although the information obtained is not sufficient, management system of the reports from the companies in each pilot area seem to vary by each pilot area, as such PSEZ manages the entire pilot area in Mahshahr while the national companies independently manage in another area.

This might cause inefficiency on management of the reports, leading to oversight of hazard and to delay of prevention/measures of an accident.

Table 7.5.2-2 Present Situation of Reporting Framework of Monitoring Data

Item	Mahshahr	Khark Island	Assaluyeh
Management of the pilot area	PSEZ manages.	IOOC, IOTC, KPC manages independently.	PSEEZ: in charge of Pars1and Pars2 PNOSC: Subordinate company of NPC, in charge of petrochemical area in PSEEZ SPGC: subordinate company of NIGC, in charge of gas refining area
Management of the facilities of the companies in the area	Each petrochemical company->PSEZ->NPC->MO P Once/month PSEZ is a subordinate company of NPC and is responsible for monthly quarterly and yearly reports.	Reports come from each production zone once a year under IOOC. The national company, NIOC, reports the monthly reports from subsidiary companies to the corporate president every quarter and year.	-
Report	Parameters and its unit vary. Reliability of reported values is low.		

Source: Study team

(3) Reporting Format of the Monitoring Data

- Issues identified in the report format by reviewing the periodical reports of each pilot area are listed below.
- Only the number of occurrence in several ranges of obtained data is reported. It is easy to understand the present situation, while time-dependent change is not indicated in the reports. This might delay the detection of abnormal and lead to ambiguity of the effect of environmental measures.
- Tables showing the environmental result and standard values are the same, which might cause confusion.
- Generally the volume of the reports is so big and the reports pass through several organizations under the present management systems. This might lead to missing an abnormal data.

7.5.3. Integrated Environmental Monitoring Plan

Based on the discussion above, it is considered that the environmental monitoring shall be integrated as much as possible to share and manage information with simplified reporting format and structure for future sustainable and effective management.

Comprehensive monitoring plan is discussed in this section, considering each pilot area as the target area of the monitoring plan. However, it is premised on that significant improvement in the

current monitoring systems of each company in the target areas is not necessary, while the companies still have obligation to monitoring and reporting in line with its own or area-wide regulations.

(1) Monitoring System

It is preferable that a monitoring is conducted uniformly in the simplified manner as much as possible and is managed by the simplified organization.

Table 7.5.3-1 shows the outline of expected general monitoring system. This is, however, the minimum specifications for the future and this does not mean to deny the current monitoring systems.

Major parameters at important locations of air quality shall be continuously recorded by real-time monitoring systems using telemeters system. The continuous monitoring data of the remote stations shall be integrated into one single monitoring system, targeting quick response upon detection of an abnormal data by integrated system that is able to monitor several points at one location continuously.

Figure 7.5.3-1 shows an example of real-time monitoring. Each company shall follow the current system to monitor the discharged water. The zone management company shall strengthen the management structure and make a shift to real-time monitoring earlier as much as possible.

Although some parameters of water quality can be monitored in the sea area by real-time systems, these will be considered as options for the future because it needs much cost for initial investment and maintenance. In addition, it is important to regularly calibrate the measuring equipment used for the monitoring (e.g. twice a year), such as chemical analysis, standard solution and standard equipment including the real-time systems and maintain the calibration records.

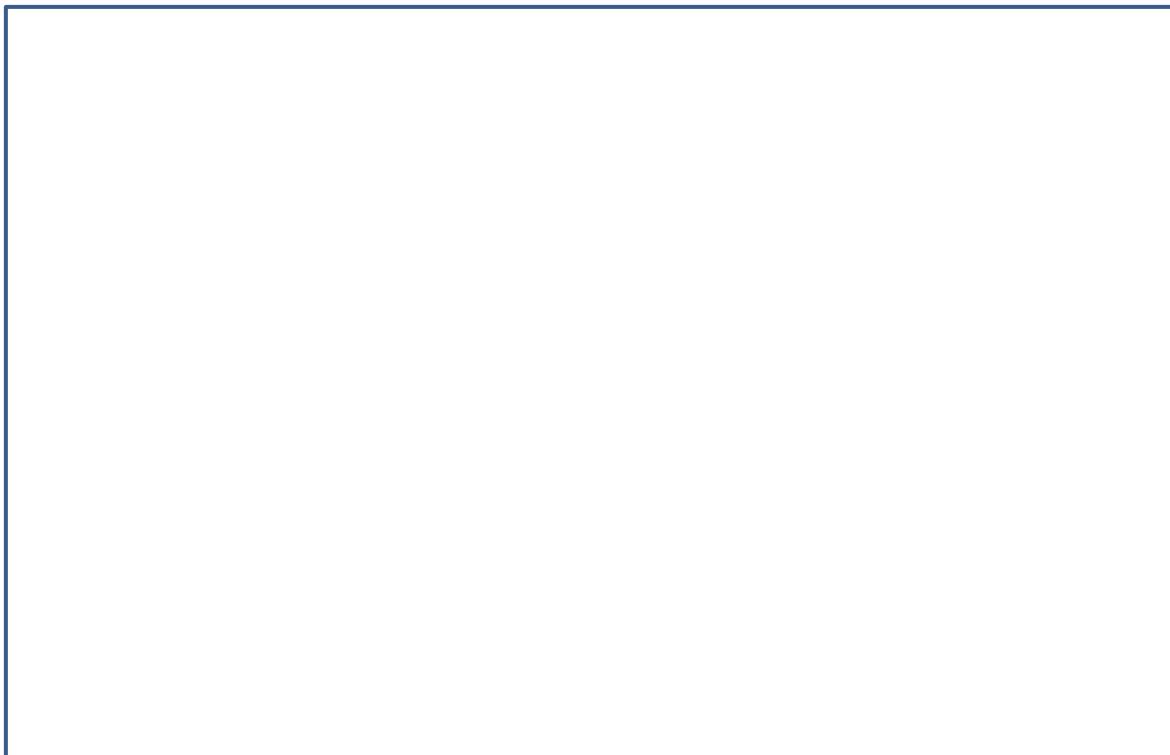
Social environment aspect is also included in the monitoring parameters. While the complaint and health problem in the operation phase is considered at the moment, monitoring the status of land acquisition and compensation for relocation shall also be included in a case relocation of residents is necessary upon construction of a new site or expansion of the existing sites.

Table 7.5.3-1 General Monitoring Plan

Category	Item	Proposal				
		Method	Frequency	Number of locations	Target	Parameters
Natural environment	Air	Real time monitoring	Continuous measurement	2	Zone, residential area	PM, NO _x , SO _x , CO, VOC
		Manual measurement	1 time/week	10	Boundary	NO _x , SO _x , VOC, PM
		Flaring	Every day	-	Zone	Flaring (visual), Flow rate, Pressure, temperature (if available)
	Noise	Measurement by noise level meter	1time/month	5	Boundary	Leq ^{*1}
	Water (discharge outlet)	Sampling, analysis	Every day	-	Outlet	COD, pH, Turb., Oil
	Waste	Record	Every day	-	Factory	Location, volume, disposal way
	Waste temporary storage	Storage condition	1time/month	4	Storage area	Storage condition, breakage, leakage
			1time/year			Heavy metal, general parameters in soil
	Waste disposal area	Sampling/analysis of leachate	1time/month	4	Monitoring wells	COD, heavy metals
Social environment	Complaint	Interview from residents	1time/year	-	Surrounded area	Questionnaire, interview
	Health hazard	Interview from residents/workers	1time/year	-	Zone, surrounded area	Questionnaire, interview
Cooperation with other organization	Coastal area	Sampling/analysis of water/sediment	1time/year	10	Surrounded water area	Distribution of water/salinity, general parameters, heavy metals
	Ecosystem	Observation of ecosystem (no of species and transition)	1time/year	-	Protected area	Principal species

Note: *1 Leq; Equivalent Noise Level

Source: Study team

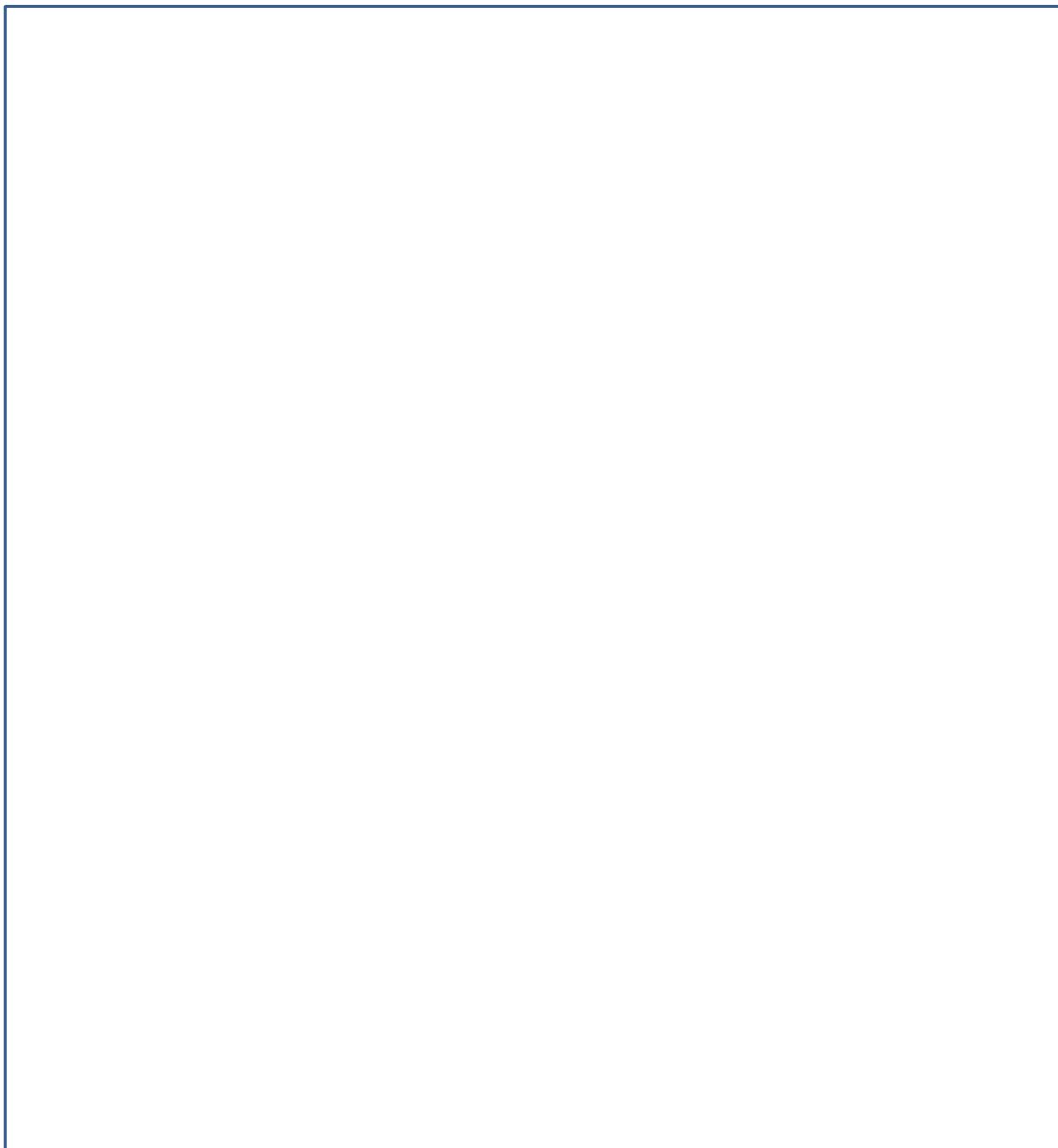


Source: Study team

Figure 7.5.3-1 Example of Real-Time Monitoring

(2) Centralization of Monitoring Stations

A certain monitoring case, such as the case in Khark Island area in which there are several monitoring systems operated by different bodies, is observed. In that case, some inefficiencies from the viewpoint of the superordinate organization, such as similar indices monitored respectively at closer locations, can be found. Centralizing those systems can realize the efficient environmental monitoring from the labor-saving and financial perspectives. The purpose of centralization is to integrate the several real-time monitoring systems operated separately in one area and to achieve the environmental monitoring and data sharing at one single location. Figure 7.5.3-2 illustrates the centralization of the existing real-time monitoring systems.



Source: Study team

Figure 7.5.3-2 Image of Centralization of Existing Monitoring Station and Data Sharing

Upon selection of monitoring stations, opinions of the operating companies shall be considered to identify the impact on the entire zone and the effect of countermeasures implemented.

Generally, monitoring stations shall be distributed at the boundary between the target area and another area, so-called a lot line. This idea is based on the theory that no influence is considered unless the monitoring data exceed the standard at the boundary. However, the diffusion pass of emission gas is complicated and as it is possible that high concentrated air mass might be delivered to a distant location, monitoring at residential area is important to understand the impact on human beings (see Figure 7.5.3-3).



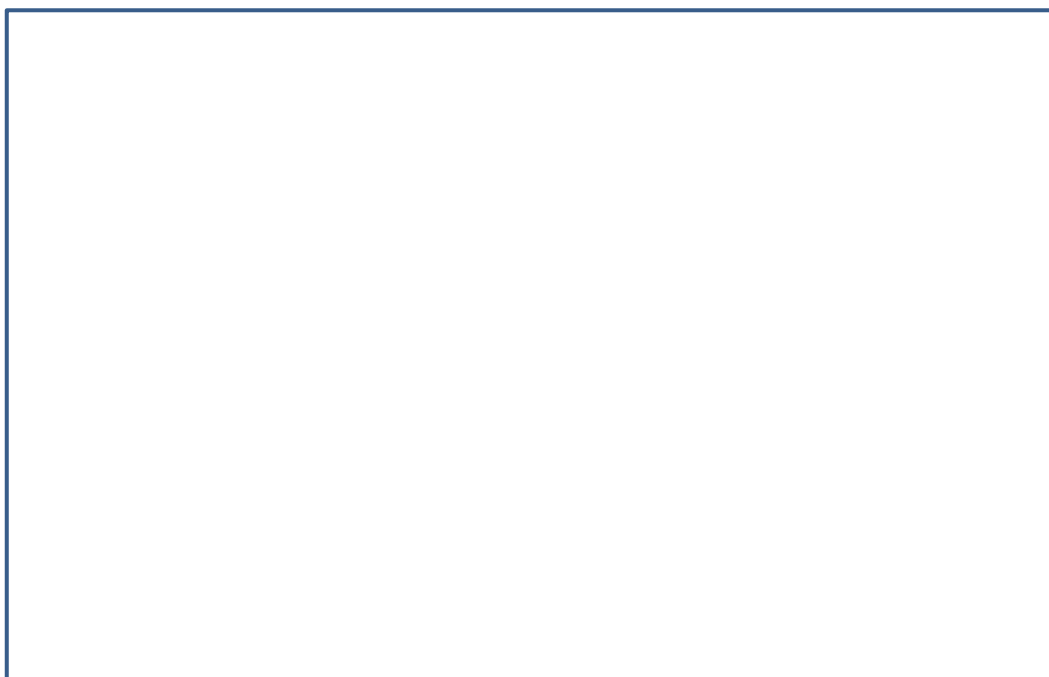
Source: Study team

Figure 7.5.3-3 Image of Distribution of Monitoring Locations

(3) Reporting System of Monitoring Data

Since the procedure of the current reporting system is complicated, the similar multiple reports might make it difficult to understand the current environmental status.

As the final receiver of a report is the MOP, it is important to simplify the report format, which is passed through many organizations. Thus, with the same viewpoint, the organizational structure related to the monitoring shall be simplified and systematized as much as possible. In Subsection 7.3.1 of this report, the zone management system is proposed, and based on this idea, a management system shown in below will be carried out (corresponding to the Zone Management Company specified in Figure 7.5.3-4).



Source: Study team

Figure 7.5.3-4 Control under Zone Management

(4) Reporting Format of Monitoring Data

1) Continuous Monitoring

The objective of the continuous monitoring is to detect an abnormal data early and respond to it. Therefore, an appropriate system for early warning on the detection of abnormal data and implementation of necessary measures, occasionally consulting with the zone management company, is necessary.

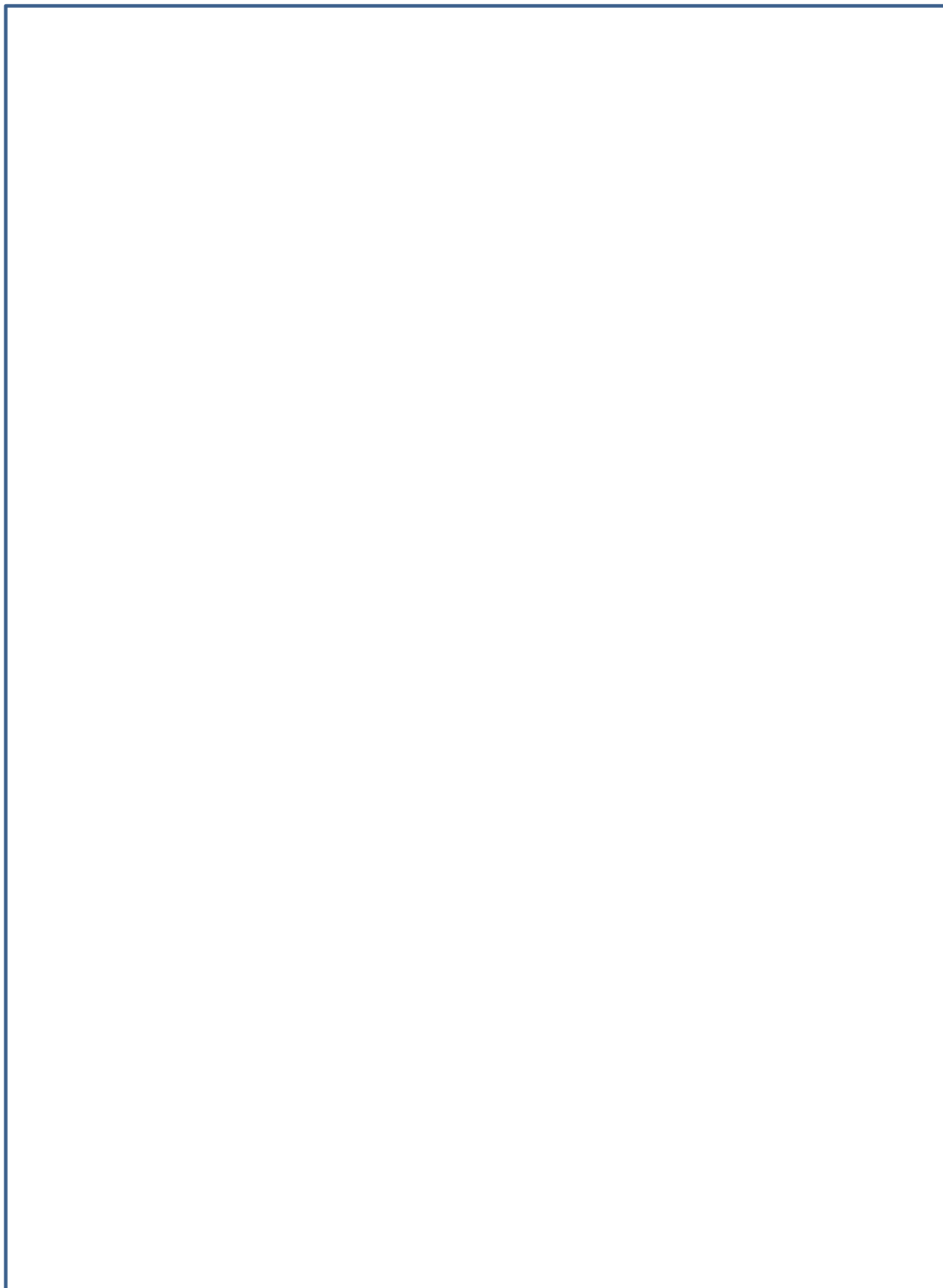
From that point of view, the reporting format and procedure shall be simplified as much as possible. Also, it is the most important that segregation of roles of each department is clarified in a written manual, such as pre-determined tasks (e.g. Contact persons, report contents, reporter, decision maker for operation shutdown).

Figure 7.5.3-5 shows reporting flow on emergency situations and Table 7.5.3-2 shows the contents of reporting based on the flow. Also specific format plans are shown in Appendix 7.5-1.

Table 7.5.3-2 Contents of Reporting on Continuous Monitoring

	First report	Report for operation shutdown	Preliminary report	Final report
Timing	Immediate after detection of abnormal data	On decision of operation shutdown	On determination of measures	Final report
Reporter	Each company	Target company	Zone management company	National company
Receiver	Zone management company	Zone management company	National company	MOP
Objective	Immediate announce of abnormal data	Announcement of operation shutdown	Report on developments and details of measures	Final report
Mode	Phone communication	Phone communication	Document	Document
Contents	• Degree of abnormal data • Necessity of measures including emergency evacuation	• Reason of shutdown • Expected duration • Measures	• Identification of pollution source • Cause or determination method of the cause • Necessity of operation shutdown related to the pollution source • Damages including health • Further measures	• Developments • Confirmation results of measures • Criteria of the operation restart • Prevention measures of further accident

Source: Study team



Note: *) In case of serious accident including long-term shutdown
Source: Study team

Figure 7.5.3-5 Reporting Flow on Emergency Situation

In addition, the reporting procedure on normal situation shall follow the format of the 2) Periodical Monitoring.

2) Periodical Monitoring

Reporting of periodical monitoring could be simplified by using unified format and information as much as possible, leading to effective consolidation of information.

The frequency of the reporting will be daily, weekly, monthly and annually, and Table 7.5.3-3 summarizes the contents of each report respectively. Also specific format plans are shown in Appendix 7.5-1.

Table 7.5.3-3 Category of Reporting for Periodical Monitoring and Contents

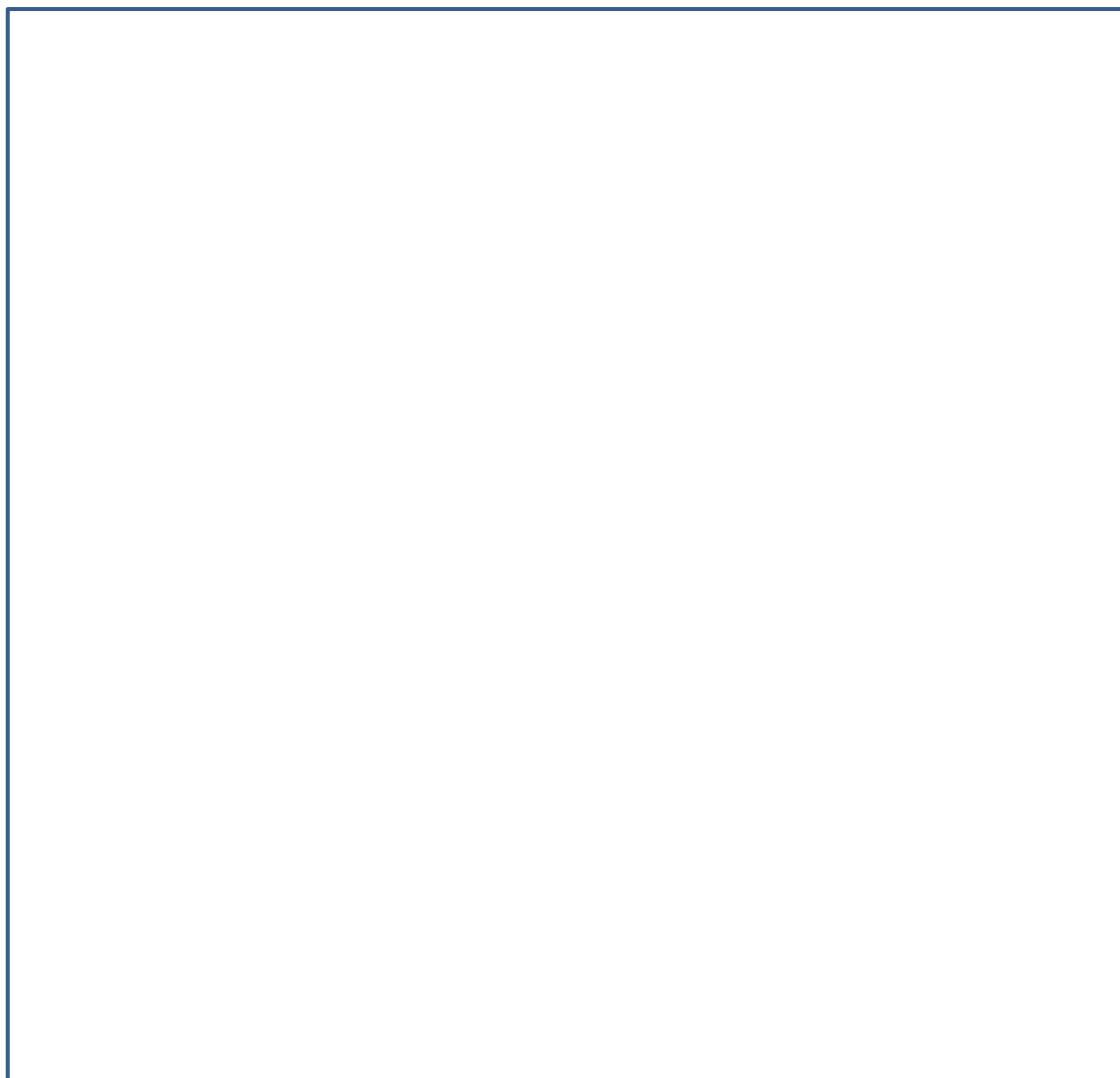
	Daily report	Weekly report	Monthly report	Annual report
Frequency	1 time/day	1 time/week	1 time/month	1 time/year
Reporter	Each company	Zone management company	National company	National company
Whom to report	Zone management company	National company	MOP	MOP
Objectives	Occurrence or non-occurrence of abnormal data	Confirmation of the abnormal data and measures for it	Peculiar items of the month Understanding of environmental change based on the comparison between the result from the same month of the previous year	Understanding of annual trend
Contents	Water quality (waste water) Air quality Flaring Wastes	Data analysis/evaluation • Survey result • Statics • Comparison between standard • Abnormal data • Cause/measure of/to the abnormal data • Abstract of the result of continuous monitoring	Data analysis/evaluation • Evaluation of the measures • Present issues • Statics • Comparison between standard • Comparison between previous year • Horizontal distribution	Result of the year, comprehensive evaluation • Evaluation to achieving goal of the year • Challenges to the next year and the achieving goal • Statics • Comparison between standard • Monthly change • Annual change • Summary of abnormal data of the year • Complaints, measures • Health problems, issue • Overview of measures

Source: Study team

Tables and figures shall be used in the report as much as possible to provide brief and specific explanation, and writing text shall be short as much as possible.

Figure of time series to express the temporal change and figure of horizontal distribution to express spatial difference are useful respectively. Both figures can be drawn easily by using commercial software. Figure 7.5.3-6 shows examples. Also as an example of practical monitoring report, the survey report in Mahshahr is stored as an appendix (refer to Subsection 4.1.2 (2) 4) for the summary of the result).

Using figures and tables makes understanding of current situation easier. This will help to examine specific measures and evaluate effectiveness of the measures.



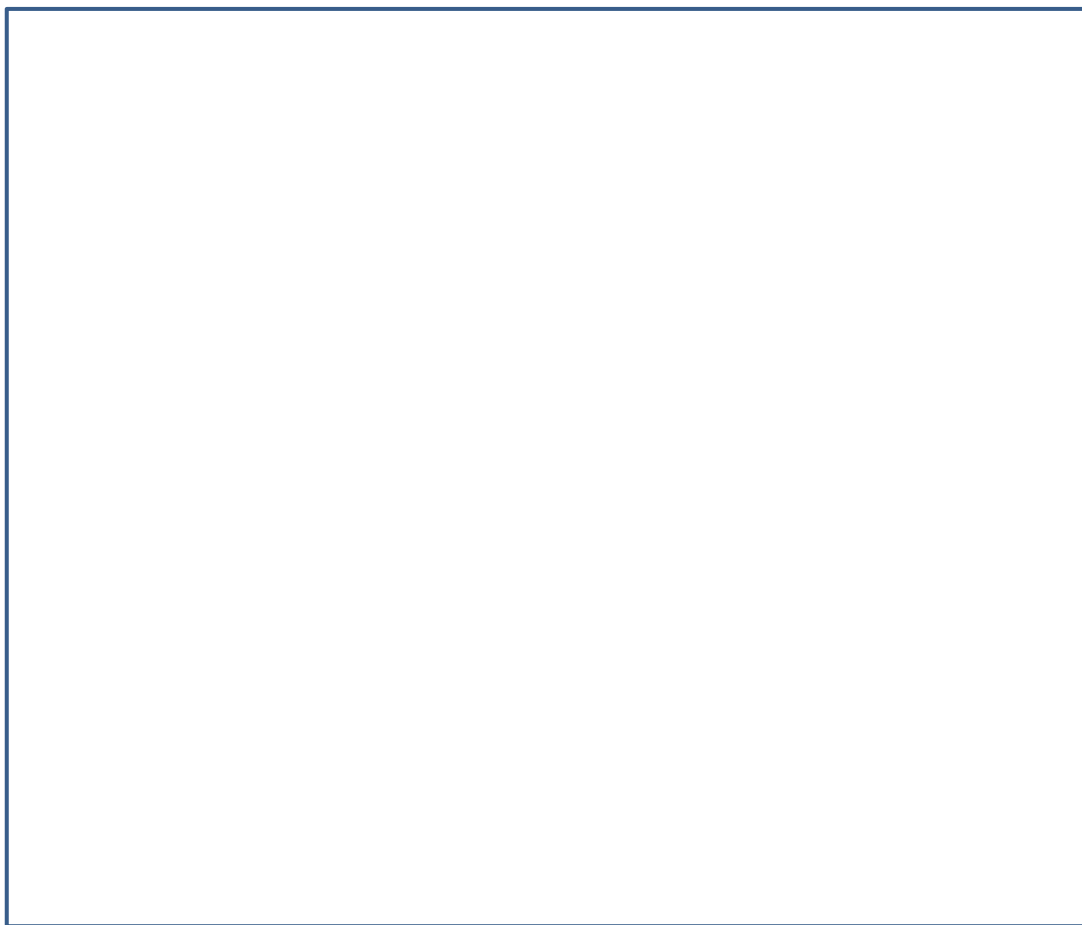


Figure 7.5.3-6 Example of Time Series and Horizontal Distribution

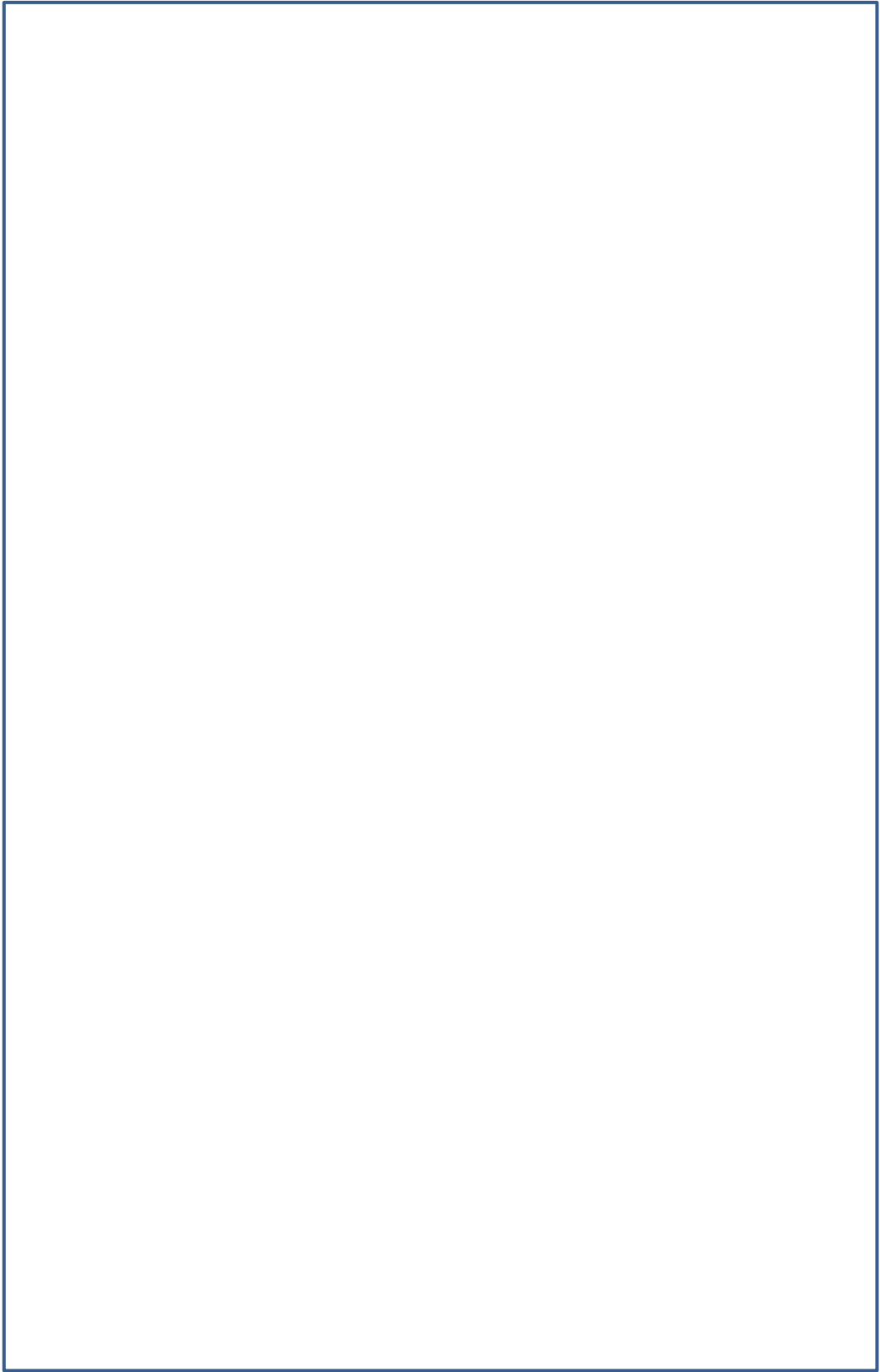
(5) Discussion for Utilization of Monitoring Data (Measures in the Emergency Situation)

While it is important to simplify the reporting format mentioned above, it is also important to establish a process for detection of abnormal data in the area. Figure 7.5.3-7 shows an example of procedure to browse the periodical monitoring data. In this example, there are three (3) processes to judge the abnormality of a monitoring data before the report reaches to the upper organization, and it includes the procedure to investigate the cause of the abnormality or re-survey when abnormality is identified.

In addition, the effective management would be possible by determination of the ***achievable goal*** for the next period and strategy for the goal (e.g. Improvement of the facility, introduction of new technology) based on the monitoring results during the certain period.

Furthermore, it is important to hold a regular review meeting shown in Figure 7.5.3-7 (a meeting to evaluate and discuss the monitoring data: Environmental Management Committee (tentative title), consisting of related departments and companies, in order to maintain the monitoring system mentioned above. By this procedure, the sustainable process such as sharing data, making the strategy to the present issues based on the discussion, implementing the strategy and evaluating the effect of the strategy by the monitoring results would be maintained.

In addition, overall review of the monitoring results and decision of environmental strategy shall be the main task of the MOP in the monitoring systems.



Note: The numbers correspond to the numbers of the responsibilities shown in Table 7.5.4-2, Table 7.5.4-6 and Table 7.5.4-10.
Source: Study team

Figure 7.5.3-7 Judgment Process of Monitoring Data

7.5.4. Monitoring Plan in Each Pilot Area

Based on the discussion above, the monitoring plan managed by the zone manager in each pilot area is proposed here.

The 5th 5-Year Plan in Iran stipulates that automated monitoring systems and data online access to the DOE shall be developed by March 2014 (Paragraph B of Article 192). According to the interview with the MOP, the national companies are requested to meet the requirement. However, the ambiguity of the 5-Year Plan causes confusion to each company on whether the requirement only targets the air quality or it includes the wastewater. According to the interview with the MOP, the NPC has prepared a guideline of the online monitoring for air quality. Other than that, no information was obtained.

While the status mentioned above is considered in this section, the future plan introduced in the later section is based on the realistic plan because some delay to the requirement of the 5-Year Plan might be considered. In addition, establishment of a data sharing system between the DOE and the zone management company in each area is also a necessary pre-condition when the online system to the DOE is available.

(1) Mahshahr

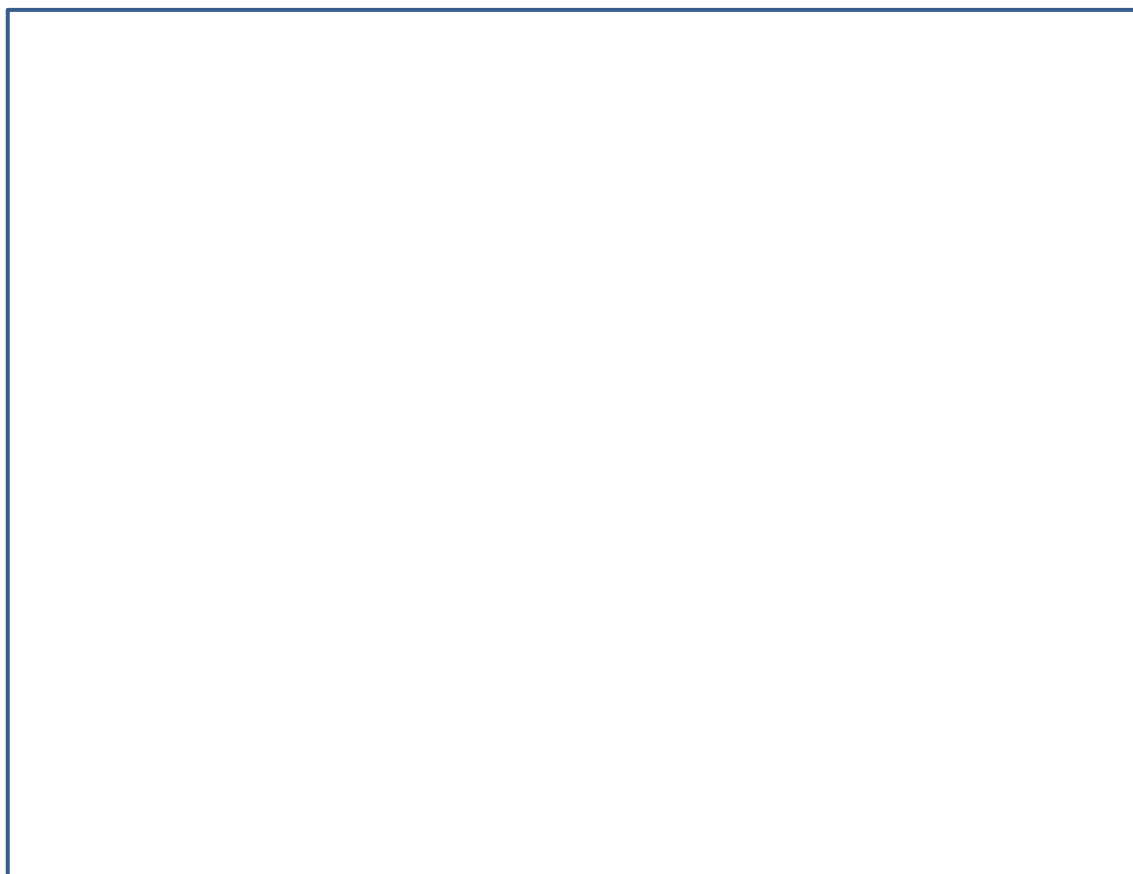
1) Monitoring Implementation Structure

Proposed monitoring implementation structure and demarcation of responsibilities in Mahshahr based on the project study are shown in Figure 7.5.4-1 and Table 7.5.4-1 respectively.

As mentioned in Subsection 7.5.2 (2), PSEZ is managing the PETZONE in Mahshahr. And a shipping facility for oil products (Mahshahr Terminal) is located about 8km east of the PETZONE owned by Abadan Oil Refinery (under control of the NIORDC). Therefore, the monitoring plan in this area is supposed to be carried out in collaboration with two (2) areas, the PETZONE and the Mahshahr terminal.

A risk-management committee has been established in the PETZONE, managed by the PSEZ, to conduct risk assessment regarding HSE. Establishment of a data-review committee aiming the environmental management (Environmental Management Committee) in the risk-management committee is proposed for sharing environmental information, for discussion of environmental management strategy and for countermeasures to emergency situations (see Figure 7.5.4-1).

Although the DOE (environmental supervisor of the area) and the PMO (port authority of the area) are not included in the organizational structure of the MOP, both are included in the monitoring system because it is important to cooperate between different organizations from the viewpoint of effective environmental management in the area.



Note: Blue color shows privatized company.

Source: Study team

Figure 7.5.4-1 Monitoring Implementation Structure in Mahshahr

Table 7.5.4-1 Demarcation of Responsibilities on Monitoring in Mahshahr

No	Task		Responsible Organization				
			MOP	NPC, NIOR DC	PSEZ Abadan	DOE	PMO
1	Monitoring	Land area			x		
2		Port area, surrounded area					x
3		Outside of the port area, protected area				x	
4		Interview, questionnaire			x		
5	Consolidation of the information from each company				x		
6	Judgment of abnormal data, report				x		
7	Regular evaluation meeting				x	(x)	(x)
8	Establishment of control strategy			x	x	(x)	(x)
9	Effectiveness confirmation of environmental measures			x	x	(x)	(x)
10	Plan of environmental improvement measures			x	x		
11	Setup of the next achieving goal			x	x		
12	Overall review and policy decision		x				

Note: (x) means cooperation.

Each task number corresponds to the number shown in Figure 7.5.3-7.

Source: Study team

2) Environmental Management Plan

Environmental impact factors in Mahshahr and environmental management plan regarding the monitoring based on the factors are summarized in Table 7.5.4-2.

Table 7.5.4-2 Environmental Management Plan regarding the Monitoring

No	Impact factor	Current potential issue	Standard, index	Management plan regarding monitoring
1	Air pollution	1) Emission of funnel fume (PM10) 2) Concern to air environment in the area	1), 2) - Air standard	1), 2) -Continuous monitoring of basic parameters -Regular monitoring with multi parameters and at multi locations -Setup of numerical target -Health monitoring of employees -Evaluation of the monitoring results
2	Water pollution	1) Discharge of wastewater, which exceeds the standard 2) Impact of heavy metals to aquatic biota and human body	1) Wastewater standard 2) Water quality standard 3) Recognition to aquatic biota by residents	1) Monitoring at discharge outlet 2) Monitoring of ambient water quality and sediment quality 3) Interview to fishermen and residents 1),2),3)Evaluation of the monitoring results
3	Waste	1) Harmful waste	1) Regulation of waste management	1) Regular monitoring at dumping site Evaluation of the monitoring results
4	Noise	1) Noise from flare stack 2) Excess of noise standard at accommodation for employee	1), 2) - Noise standard	1), 2) -Monitoring at area boundary and accommodation for employee -Interview to employee -Evaluation of the monitoring results
5	Ecosystem	1) Loss of mangrove 2) Impact to benthic biota and fish 3) Impact to biota in the protected area	1) Change of the area 2) Change of the protected area 3) Complaint from the people	1), 2), 3) -Monitoring cooperated by the DOE -Interview to fishermen -Interview to residents -Evaluation of the monitoring results

Source: Study team

3) Monitoring Plan

Immediate monitoring plan and the distribution plan for the monitoring locations based on the environmental management plan discussed above are proposed in Table 7.5.4-3 and Figure 7.5.4-2, respectively. The reasons for selection of the monitoring locations are listed in Appendix 7.5-3. Since air environment in Mahshahr is not serious, the number of monitoring locations for air (periodical monitoring) and noise is set up as five (5).

While the implementation body in the industrial zone is managed by the PSEZ, monitoring at outside of the zone will be subject to the cooperation with other organizations such as the DOE and the PMO. Since no information about Mahshahr terminal area is obtained, distribution plan in the area is omitted.

Table 7.5.4-3 Monitoring Plan (Mahshahr)

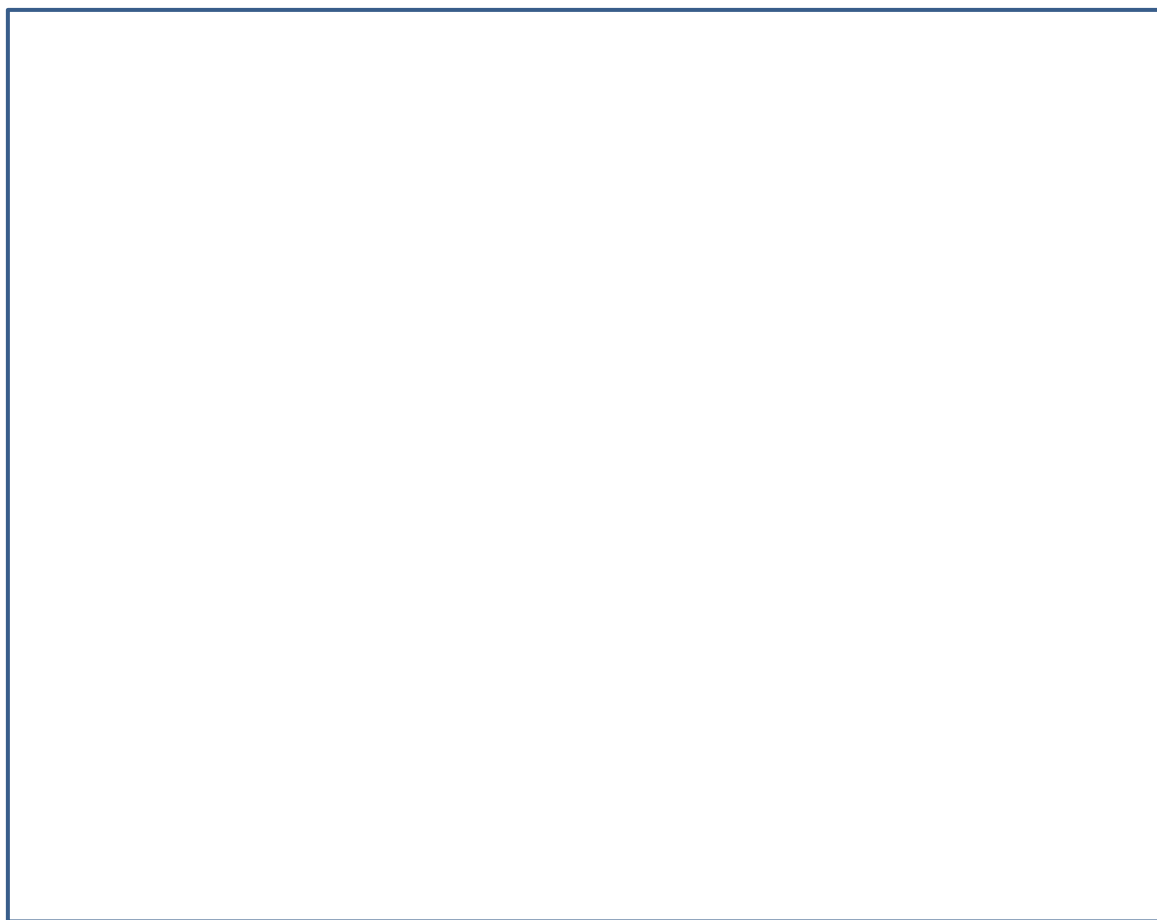
Category	Item	Proposal						
		Method	Frequency	Number of locations	Target	Parameters	Implementation body	Supervision body
Natural Environment	Air	Real time monitoring	Continuous measurement	4	Zone, residential area	PM, NO _x , SO _x , CO, VOC	PSEZ, DOE	PSEZ, DOE
		Manual measurement	1 time/week	4	Boundary	NO _x , SO _x , VOC, PM	PSEZ	PSEZ
				1	Accommodation area			
		Flaring	Every day	-	Zone	Flaring (visual), Flow rate, Pressure, temperature (if available)	Each company	PSEZ
	Noise	Measurement by noise level meter	1time/month	5	Boundary	Leq ^{*1}	PSEZ	PSEZ
	Water (discharge outlet)	Sampling, analysis	Every day	-	Outlet	COD, pH, Turb., Oil	Each company	PSEZ
	Waste	Record	Every day	-	Generation source	Location, volume, disposal way	Each company	PSEZ
	Waste temporary storage	Storage condition	1time/month	-	Storage area	Storage condition, breakage, leakage ^{*2, 3}	PSEZ	PSEZ
			1time/year			Heavy metal, general parameters in soil ^{*3}		
	Waste disposal area	Sampling/ analysis of leachate	1time/month	4	Monitoring wells	COD, heavy metals ^{*3}	PSEZ	PSEZ
Social Environment	Complaint	Interview from residents	1time/year	-	Surrounded area	Questionnaire, interview	PSEZ	PSEZ
	Health hazard	Interview from residents/workers	1time/year	-	Zone, surrounded area	Questionnaire, interview	PSEZ	PSEZ
Cooperation with other organization	Water (Sea area)	Sampling/ analysis of water/sediment	1time/year	10	Surrounded water area	Distribution of water/salinity, general parameters, heavy metals	PSEZ, DOE, PMO	PSEZ
	Ecosystem	Observation of ecosystem (number of species and transition)	1time/year	-	Protected area	Principal species	PSEZ, DOE	PSEZ

Note: *1 Leq: Equivalent Noise Level

*2 In case breakage or leakage is found, water quality (general parameters, heavy metals) of ground water of wells in the surrounded area shall be monitored.

*3 Proposed parameters for water quality, sediment quality and soil and its reasons are listed in Appendix 7.5-2.

Source: Study team



Source of the picture: Google Earth

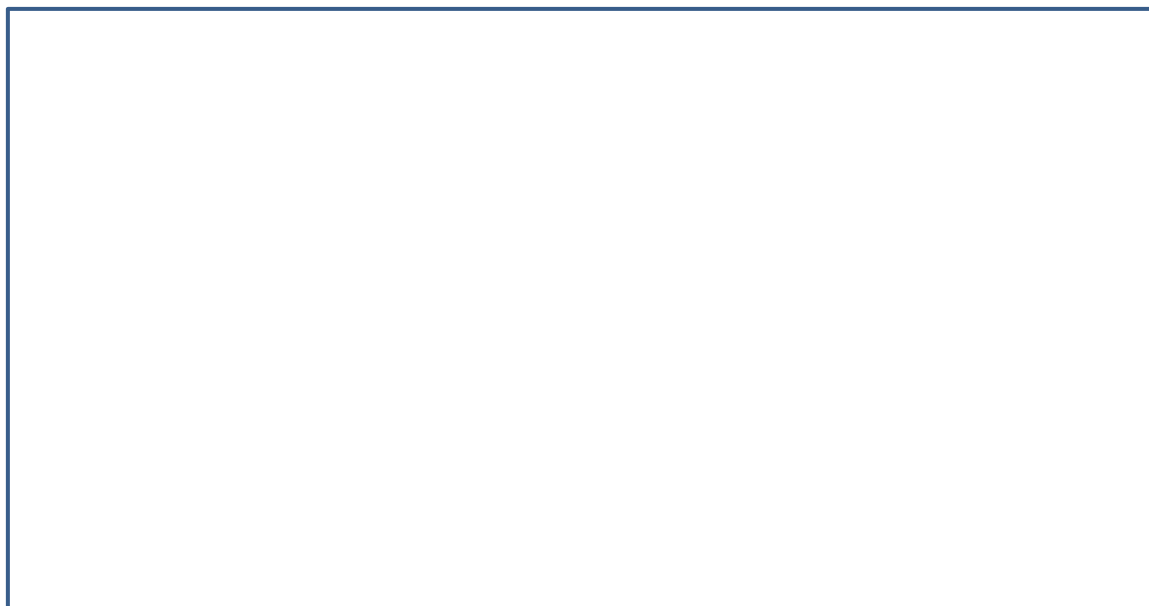
Legend: ● Air quality (Continuous) ● Air quality (Periodical), Noise ● Water quality/Sediment quality ● Biota

Figure 7.5.4-2 Distribution of the Monitoring Locations (plan)

4) Future Plan

The implementation system of monitoring plan proposed through 1) to 3) above shall be established in 2-3 years. The online data, which will be installed and sent to the DOE based on the requirement by the 5-Year Plan, shall also be shared between zone management company and the DOE.

As a future plan, the study on proper distribution of the monitoring locations based on the monitoring results, automation and integration of air monitoring and automation and integration of wastewater monitoring are proposed, aiming real-time data sharing (see Figure 7.5.4-3). Table 7.5.4-4 shows its schedule and the approximate cost.



Source: Study team

Figure 7.5.4-3 Future Plan Regarding Monitoring

Table 7.5.4-4 Time Schedule and Approximate Cost

Item	Challenge	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Cost (thousand USD)
Establishment of monitoring structure	Determination of location and equipment	■							308
	Installment of additional continuous monitoring station		■						25
	Online with DOE		■						31
	Procurement of monitoring equipment		■						37
	Reinforcement of the structure	■	■	■					-
	Strengthening of cooperation with other organization	■	■	■					-
Automation of periodical air monitoring	Selection of equipment				■				284
	Installation, proficiency					■			243
	Online					■			607
	Reinforcement of the structure				■	■	■		-
	Study for proper distribution of the locations					■			-
Automation of wastewater monitoring	Selection of equipment						■		1,214
	Installation, proficiency							■	122
	Online							■	81
	Reinforcement of the structure						■	■	-
	Study for proper distribution of the locations							■	-
Total									2,952

Source: Study team

Rate: 24718.6 IRR/USD, 31st Oct. 2013 at <http://www.oanda.com/lang/ja/currency/historical-rates/>

(2) Khark Island

1) Monitoring Implementation Structure

Proposed monitoring implementation structure and demarcation of responsibilities in Khark Island based on the project study are shown in Figure 7.5.4-4 and Table 7.5.4-5 respectively.

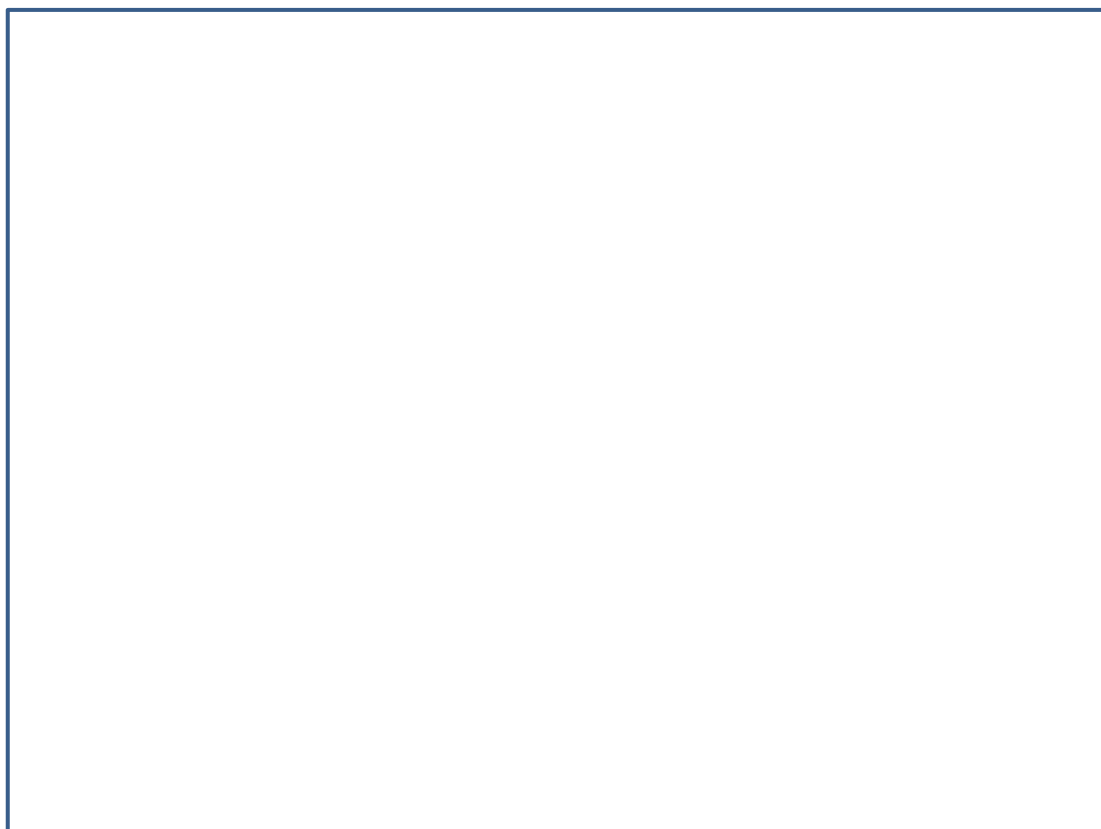
As mentioned in Subsection 7.5.2 (2), IOOC, IOTC and KPC independently manage the complex area in Khark Island. The monitoring plan proposed by the Study team aims to improve management efficiency, to strengthen risk prevision and to accelerate emergency care by integrated management of the area.

Therefore, forming a zone management, which manages the Khark Island area consisted of IOOC, IOTC and privatized KPC, under the supervision of NIOC is proposed on the premise of retention of the current structure. As for the offshore area, each oil field office shall control each platform in the area and IOOC in Khark Island shall supervise the each oil field.

As like the Mahshahr area, a risk-management committee consisted of the zone management, IOOC, IOTC and KPC shall be established and a data-review committee aiming the environmental management (Environmental Management Committee) in the risk-management committee shall be set up for sharing environmental information, for discussion of environmental management strategy and for countermeasures to emergency situations (see Figure 7.5.4-4).

IOOC, IOTC and KPC shall implement the environmental management in cooperation with the zone management, undertaking obligations for reporting monitoring data and taking measures on abnormal situation. In that case, the roles of the zone management company and the operating companies should be clarified. The roles of relevant departments in the company should also be reviewed and clarified.

Although the DOE (environmental supervisor of the area) and the PMO (port authority of the area) are not included in the organizational structure of the MOP, both are included in the monitoring systems because it is important to cooperate between the different organizations from the viewpoint of effective environmental management in the area.



Note: Blue color shows privatized company.

Source: Study team

Figure 7.5.4-4 Monitoring Implementation Structure in Khark Island

Table 7.5.4-5 Demarcation of Responsibilities on Monitoring in Khark Island

No	Task		Responsible Organization				
			MOP	NIOC	Zone management company	DOE	PMO
1	Monitoring	Land area			x		
2		Port area, surrounded area			x		x
3		Outside of the port area, protected area				x	
4		Interview, questionnaire			x		
5	Consolidation of the information from each company				x		
6	Judgment of abnormal data, report				x		
7	Regular evaluation meeting				x	(x)	(x)
8	Establishment of control strategy			x	x	(x)	(x)
9	Effectiveness confirmation of environmental measures			x	x	(x)	(x)
10	Plan of environmental improvement measures			x	x		
11	Setup of the next achieving goal			x	x		
12	Overall review and policy decision		x				

Note: (x) means cooperation.

Each task number corresponds to the number shown in Figure 7.5.3-7.

Source: Study team

2) Environmental Management Plan

Environmental impact factors in Khark Island and environmental management plan regarding the monitoring based on the factors are summarized in Table 7.5.4-6. Since cleanup of the retention ponds and enhancement of wastewater treatment facilities are the most prioritized challenges in Khark Island, the proposed monitoring plan considers the solution of the issues.

Table 7.5.4-6 Environmental Management Plan regarding the Monitoring

N o	Impact Factor	Current Potential Issue	Standard, Index	Management Plan regarding Monitoring
1	Air pollution	1) Black smoke from flare stack	1), 2) - Air standard	1), 2) - Continuous monitoring of basic parameters - Regular monitoring with multi parameters and at multi locations - Setup of numerical target - Health monitoring of employees - Evaluation of the monitoring results
2	Water pollution	1) Discharge of untreated wastewater, insufficient capacity of wastewater treatment 2) Impact of heavy metals to aquatic biota and human body	1) Wastewater standard (including standard for platform) 2) Water quality standard 3) Recognition to aquatic biota by residents	1) Monitoring at discharge outlet 2) Monitoring at outlet discharge to the sea Monitoring of ambient water quality and sediment quality including platform area Establishment of monitoring structure during cleanup of retention pond and improvement of wastewater treatment facility 3) Interview to fishermen and residents 1), 2), 3) Evaluation of the monitoring results
3	Oil pollution	1) Soil pollution around the retention pond 2) Possibility of pollution by NORM*1	1) Soil standard	1) Monitoring around the retention pond and evaluation
4	Waste	1) Harmful waste	1) Regulation of waste management	1) Regular monitoring at dumping site Evaluation of the monitoring results
5	Noise	1) Noise from flare stack 2) Excess of noise standard at accommodation for employee	1), 2) - Noise standard	1), 2) - Monitoring at area boundary and accommodation for employee - Interview to employee - Evaluation of the monitoring results
6	Ecosystem	1) Impact to coral reef 2) Impact to benthic biota and fish 3) Impact to biota in the protected area	1) Change of the area 2) Change of the protected area 3) Complaint from the people	1), 2), 3) - Monitoring cooperated by the DOE - Interview to fishermen - Interview to residents - Evaluation of the monitoring results

Note: *1 NORM: Naturally Occurring Radioactive Material

Source: Study team

3) Monitoring Plan

Immediate monitoring plan and the distribution plan for the monitoring locations based on the environmental management plan discussed above are proposed in Table 7.5.4-7 and Figure 7.5.4-5, respectively. The reasons for selection of the monitoring locations are listed in Appendix 7.5-3.

Since air environment in Khark Island is not serious, the number of monitoring locations for air (periodical monitoring) and noise is setup as five (5). While the implementation body in the industrial zone is managed by the zone management company, monitoring at outside of the zone will be subject to the cooperation with other organizations such as the DOE and the PMO.

Table 7.5.4-7 Monitoring Plan

Category	Item	Proposal						
		Method	Frequency	Number of locations	Target	Parameters	Implementation body	Supervision body
Natural environment	Air	Real time monitoring	Continuous measurement	5	Zone, residential area	PM, NO _x , SO _x , CO, VOC	Zone management company, DOE	Zone management company, DOE
		Manual measurement	1 time/week	5	Boundary	NO _x , SO _x , VOC, PM	Zone management company	Zone management company
		Flaring	Every day	-	Zone	Flaring (visual), Flow rate, Pressure, temperature (if available)	Each company, Zone management company	Zone management company
	Noise	Measurement by noise level meter	1time/month	5	Boundary	Leq ^{*1}	Zone management company	Zone management company
	Water (discharge outlet)	Sampling, analysis	Every day	-	Outlet	COD, pH, Turb., Oil	Each company	Zone management company
		Sampling, analysis	1 time/month	-	Discharge point to the sea	COD, pH, Turb., Oil, Heavy metals ^{*5}	Zone management company	Zone management company
	Soil	Sampling, analysis	1 time/year	5 ^{*2}	Around the retention pond, polluted area	Heavy metals ^{*5} , Oil, NORM ^{*3}	Zone management company	Zone management company
	Waste	Record	Every day	-	generation source	Location, volume, disposal way	Each company	Zone management company
	Waste temporary storage	Storage condition	1time/month	-	Storage area	Storage condition, breakage, leakage ^{*4,5}	Zone management company	Zone management company
			1 time/year			Heavy metal, general parameters in soil ^{*5}		
Social environment	Complaint	Interview from residents	1time/year	-	Surrounded area	Questionnaire, interview	Zone management company	Zone management company
	Health hazard	Interview from residents/workers	1time/year	-	Zone, surrounded area	Questionnaire, interview	Zone management company	Zone management company

Category	Item	Proposal						
		Method	Frequency	Number of locations	Target	Parameters	Implement ation body	Supervision body
Cooperation with other organization	Water (Sea area)	Sampling/ analysis of water/ sediment	1 times/year	10	Surrounded water area	Distribution of water/salinity, general parameters, heavy metals ^{*5}	Zone management company, DOE, PMO, IOOC	Zone management company, DOE, PMO
			1 times/year	1	Around platform	General parameters, heavy metals ^{*5}		
		Sampling, analysis	1 times/year	5	Resident wells	General parameters, heavy metals ^{*5}	Zone management company, DOE	Zone management company, DOE
	Ecosystem	Observation of ecosystem (number of species and transition)	1 times/year	-	Protected area	Principal species	Zone management company, DOE	Zone management company, DOE

Note: *1 Leq: Equivalent Noise Level

*2 The number of sampling locations shall be increased on the study phase for the polluted area.

*3 NORM: Naturally Occurring Radioactive Material

*4 In case breakage or leakage is found, water quality (general parameters, heavy metals) of ground water of wells in the surrounded area shall be monitored.

*5 Proposed parameters for water quality, sediment quality and soil and its reasons are listed in Appendix 7.5-2.

Source: Study team



Source of the picture: Google Earth

Legend: ● Air quality (Continuous) ● Air quality (Periodical), Noise ● Water quality/Sediment quality ● Biota

Figure 7.5.4-5 Distribution of the Monitoring Locations (plan)

4) Future Plan

The implementation system of monitoring plan proposed through 1) to 3) above shall be established in 3-4 years, since the establishment of the new organization might take time. The current online systems, which are working independently, shall be consolidated for integrated management. Since underground injection of produced water on oil production is planned, online monitoring of flare line is also recommended. The online data, which will be installed and sent to the DOE based on the requirement by the Fifth Five-Year Development Plan, shall also be shared between the zone management company and the DOE.

As a future plan, the study on proper distribution of the monitoring locations based on the monitoring results, automation and integration of wastewater monitoring at land facilities together with cleanup of the retention ponds and improvement of wastewater treatment facilities are proposed, and aiming real-time data sharing including the information from each offshore platform (see Figure 7.5.4-6). Table 7.5.4-8 shows its schedule and the approximate cost.



Source: Study team

Figure 7.5.4-6 Future Plan Regarding Monitoring

Table 7.5.4-8 Time Schedule and Approximate Cost

Item	Challenge	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Cost (thousand USD)
Establishment of monitoring structure, Integration of current air online monitoring	Determination of location and equipment	■							13
	Integration and expansion of the current system, automation of flare line		■						138
	Online with DOE			■					57
	Procurement of monitoring equipment		■						26
	Reinforcement of the structure	■	■	■	■	■			-
	Strengthening of cooperation with other organization		■	■	■				-
Automation of wastewater monitoring	Selection of equipment					■			1,093
	Installation, proficiency						■		607
	Online						■		526
	Reinforcement of the structure					■	■	■	-
	Study for proper distribution of the locations						■		-
Sharing of information from platforms	Study of methodology						■		21
	Procurement of equipment							■	25
	Online							■	1,821
	Reinforcement of the structure						■	■	-
	Study for proper distribution of the locations							■	-
Total									4,327

Source: Study team

Rate: 24718.6 IRR/USD, 31st Oct. 2013 at <http://www.oanda.com/lang/ja/currency/historical-rates/>

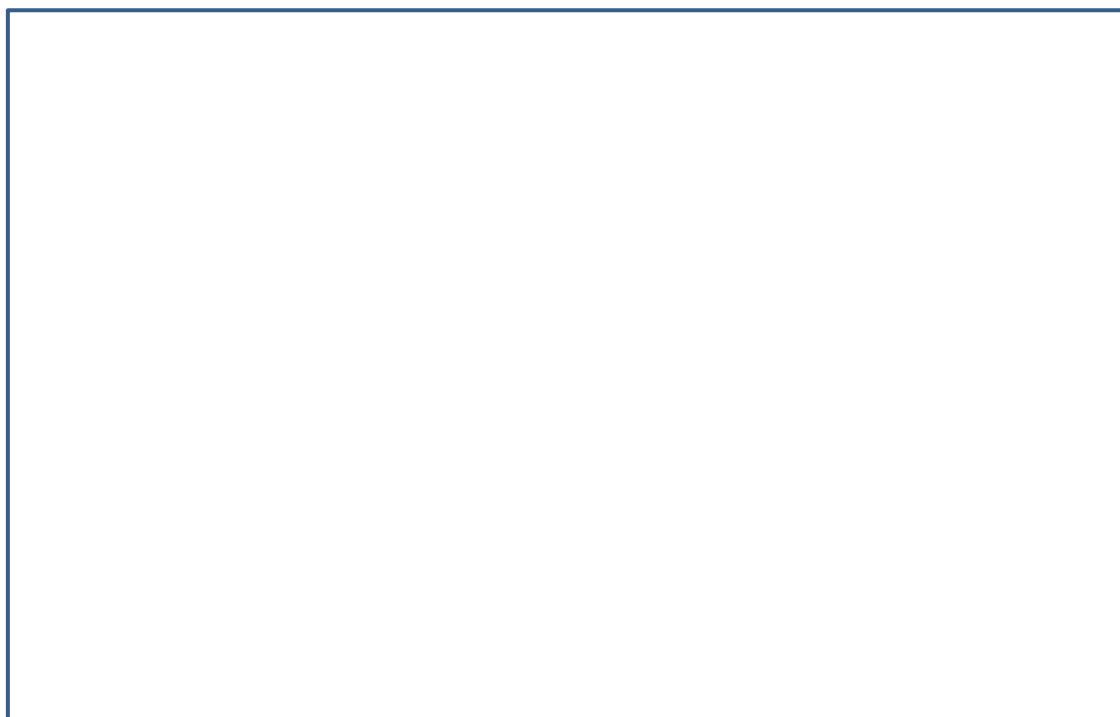
(3) Assaluyeh

1) Monitoring Implementation Structure

Proposed monitoring implementation structure and demarcation of responsibilities in Assaluyeh based on the project study are shown in Figure 7.5.4-7 and Table 7.5.4-9 respectively.

As mentioned in Subsection 7.5.2 (2), SPGC (NIGC's subsidiary) is managing the gas refinery zone and PNOSC (NPC's subsidiary) is managing the petrochemical zone, while PSEEZ controls the whole area in Assaluyeh. In this monitoring plan a structure, in which whole area is controlled by PSEEZ and PNOSC and SPGC control each operational zone, is proposed on the premise of maintenance of the current monitoring structure as much as possible.

As like the Mahshahr area, a risk-management committee, which implements risk management related to HSE, shall be formed by the zone management company, SPGC and PNOSC. And a data-review committee aiming the environmental management (Environmental Management Committee) in the risk-management committee shall be set up for sharing environmental information, for discussion of environmental management strategy and for countermeasures to emergency situations (see Figure 7.5.4-7). Although the DOE (environmental supervisor of the area) and the PMO (port authority of the area) are not included in the organizational structure of the MOP, both are included in the monitoring system because it is important to cooperate between different organizations from the viewpoint of effective environmental management in the area.



Source: Study team

Figure 7.5.4-7 Monitoring Implementation Structure in Assaluyeh

Table 7.5.4-9 Demarcation of Responsibilities on Monitoring in Assaluyeh

No	Task		Responsible Organization				
			MOP	NIOC, NPC, NIGC	PSEEZ (PNOSC, SPGC)	DOE	PMO
1	Monitoring	Land area			x		
2		Port area, surrounded area					x
3		Outside of the port area, protected area				x	
4		Interview, questionnaire			x		
5	Consolidation of the information from each company				x		
6	Judgment of abnormal data, report				x		
7	Regular evaluation meeting				x	(x)	(x)
8	Establishment of control strategy			x	x	(x)	(x)
9	Effectiveness confirmation of environmental measures			x	x	(x)	(x)
10	Plan of environmental improvement measures			x	x		
11	Setup of the next achieving goal			x	x		
12	Overall review and policy decision		x				

Note: (x) means cooperation.

Each task number corresponds to the number shown in Figure 7.5.3-7.

Source: Study team

2) Environmental Management Plan

Environmental impact factors in Assaluyeh and environmental management plan regarding the monitoring based on the factors are summarized in Table 7.5.4-10.

Table 7.5.4-10 Environmental Management Plan regarding the Monitoring

No.	Impact Factor	Current Potential Issue	Standard, Index	Management Plan regarding Monitoring
1	Air pollution	1) Emission of funnel fume (PM10) 2) Concern to air environment in the area	1), 2) - Air standard	1), 2) - Continuous monitoring of basic parameters - Regular monitoring with multi parameters and at multi locations - Setup of numerical target - Health monitoring of employees - Evaluation of the monitoring results
2	Water pollution	1) Concern of increase of wastewater load by future development 2) Impact to ecosystem in the surrounded area	1) Wastewater standard 2) Water quality standard 3) Recognition to aquatic biota by residents	1) Monitoring at discharge outlet 2) Monitoring of ambient water quality and sediment quality 3) Interview to fishermen and residents 1), 2), 3) Evaluation of the monitoring results
3	Waste	1) Harmful waste	1) Regulation of waste management	1) Regular monitoring at dumping site Evaluation of the monitoring results
4	Noise	1) Noise from flare stack 2) Excess of noise standard at accommodation for employee	1), 2) - Noise standard	1), 2) - Monitoring at area boundary and accommodation for employee - Interview to employee - Evaluation of the monitoring results

5	Ecosystem	1) Loss of mangrove 2) Impact to coral reef 3) Impact to benthic biota and fish 4) Impact to biota in the protected area 5) Impact to habitat environment (sea grass bed)	1) Change of the area 2) Change of the protected area 3) Complaint from the people	1), 2), 3), 4), 5) - Monitoring cooperated by the DOE - Interview to fishermen - Interview to residents - Evaluation of the monitoring results

Source: Study team

3) Monitoring Plan

Immediate monitoring plan and the distribution plan for the monitoring locations based on the environmental management plan discussed above are proposed in Table 7.5.4-11 and Figure 7.5.4-8, respectively. The reasons for selection of the monitoring locations are listed in Appendix 7.5-3.

While the implementation body in the industrial zone is managed by PSEEZ, monitoring at outside of the zone will be subject to the cooperation with other organizations such as the DOE and the PMO.

Table 7.5.4-11 Monitoring Plan (Assaluyeh)

Category	Item	Proposal						
		Method	Frequency	Number of locations	Target	Parameters	Implementation body	Supervision body
Natural environment	Air	Real time monitoring	Continuous measurement	3	Zone, residential area	PM, NO _x , SO _x , CO, VOC	PSEEZ, DOE	PSEEZ, DOE
		Manual measurement	1 time/week	10	Boundary	NO _x , SO _x , VOC, PM	PSEEZ	PSEEZ
		Flaring	Every day	-	Zone	Flaring (visual), Flow rate, Pressure, temperature (if available)	PSEEZ	PSEEZ
	Noise	Measurement by noise level meter	1 time/month	5	Boundary	Leq*1	PSEEZ	PSEEZ
	Water (discharge outlet)	Sampling, analysis	Every day	-	Outlet	COD, pH, Turb., Oil	Each company	PSEEZ
			1 time/week		Treated wastewater in the observation basin before dilution		PSEEZ	
	Waste	Record	Every day	-	generation source	Location, volume, disposal way	Each company	PSEEZ

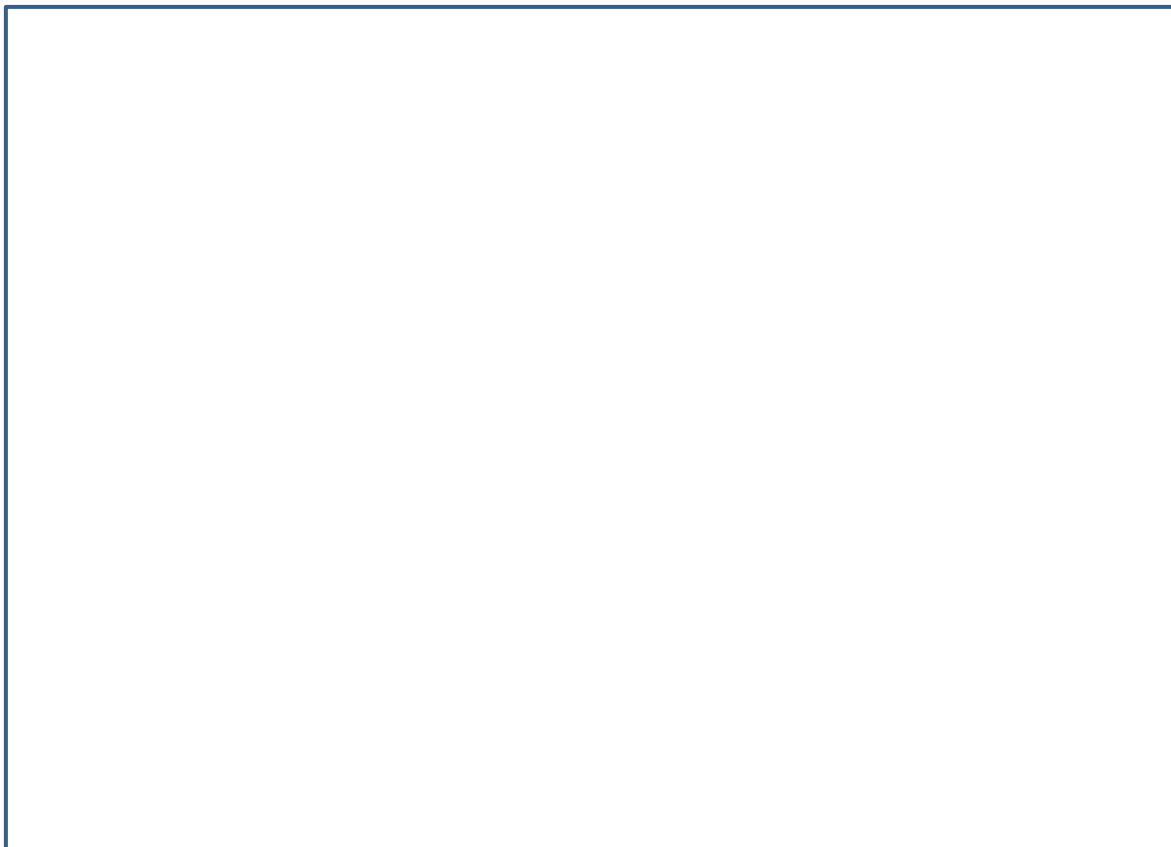
Category	Item	Proposal						
		Method	Frequency	Number of locations	Target	Parameters	Implementation body	Supervision body
	Waste temporary storage	Storage condition	1time/month	-	Storage area	Storage condition, breakage, leakage ^{*2, 3}	PSEEZ	PSEEZ
			1time/year			Heavy metal, general parameters in soil ^{*3}		
	Waste disposal area	Sampling/analysis of leachate	1time/month	4	Monitoring wells	COD, heavy metals ^{*3}	PSEEZ	PSEEZ
Social environment	Complaint	Interview from residents	1time/year	-	Surrounded area	Questionnaire, interview	PSEEZ	PSEEZ
	Health hazard	Interview from residents/workers	1time/year	-	Zone, surrounded area	Questionnaire, interview	PSEEZ	PSEEZ
Cooperation with other organization	Water (Sea area)	Sampling/analysis of water/sediment	1time/year	10	Surrounded water area	Distribution of water/salinity, general parameters, heavy metals	PSEEZ, DOE, PMO	PSEEZ, DOE, PMO
	Ecosystem	Observation of ecosystem (number of species and transition)	1time/year	-	Protected area	Principal species	PSEZ, DOE	PSEEZ, DOE

Note: *1 Leq: Equivalent Noise Level

*2 In case breakage or leakage is found, water quality (general parameters, heavy metals) of ground water of wells in the surrounded area shall be monitored.

*3 Proposed parameters for water quality, sediment quality and soil and its reasons are listed in Appendix7.5-2.

Source: Study team



Source of the picture: Google Earth

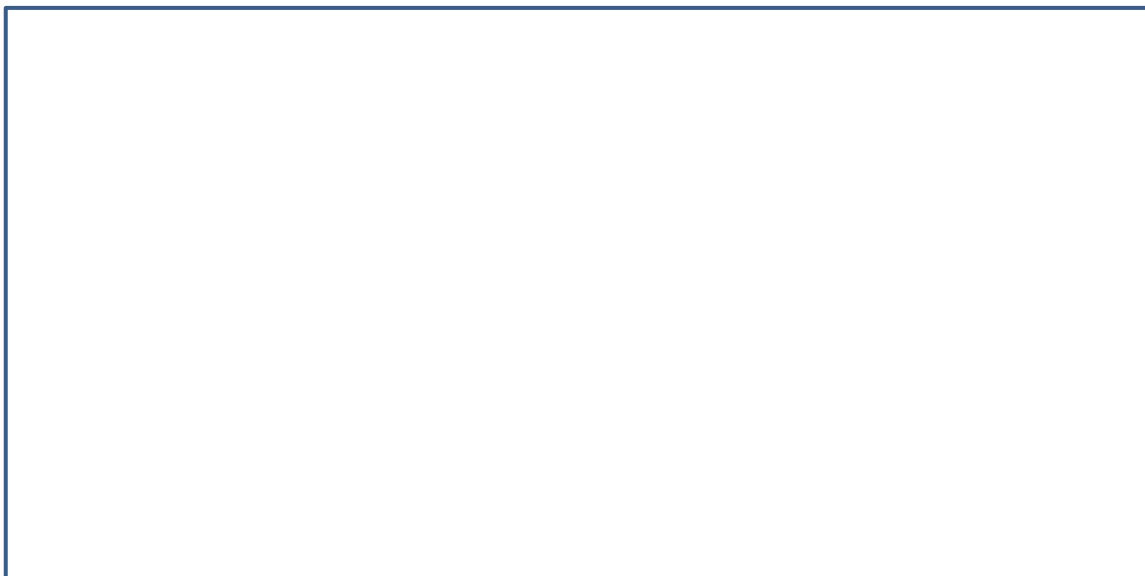
Legend: ● Air quality (Continuous) ● Air quality (Periodical) ● Noise ● Water quality/Sediment quality ● Biota

Figure 7.5.4-8 Distribution of the Monitoring Locations (plan)

4) Future Plan

The implementation system of monitoring plan proposed through 1) to 3) above shall be established in 2-3 years. Especially, the continuous monitoring for air is considered an urgent matter. The online data, which will be installed and sent to the DOE based on the requirement by the Fifth Five-Year Development Plan, shall also be shared between the zone management company and the DOE.

As a future plan, the study on the proper distribution of the monitoring locations based on the monitoring results, automation and integration of wastewater monitoring are proposed aiming real-time data sharing (see Figure 7.5.4-9). In addition, since the increase of environmental impact is concerned in Assaluyeh area due to expansion of the industrial area, prompt introduction of the total emission control system is recommended. Table 7.5.4-12 shows its schedule and the approximate cost.



Source: Study team

Figure 7.5.4-9 Future Plan Regarding Monitoring

Table 7.5.4-12 Time Schedule and Approximate Cost

Item	Challenge	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Cost (thousand USD)
Establishment of monitoring structure Establishment of continuous monitoring for air	Determination of location and equipment	■							365
	Installment of continuous monitoring station		■						37
	Online with DOE		■						45
	Procurement of monitoring equipment		■						37
	Reinforcement of the structure	■	■	■	■				-
	Strengthening of cooperation with other organization	■	■	■	■				-
Automation of wastewater monitoring	Selection of equipment				■				1,093
	Installation, proficiency					■			61
	Online					■			567
	Reinforcement of the structure				■	■	■		-
	Study for proper distribution of the locations					■			-
Introduction of total emission control system	Investigation study						■		122
	Evaluation, analysis						■	■	61
	Online						■	■	85
	Reinforcement of the structure						■	■	-
	Study for proper distribution of the locations							■	-
Total									2,473

Source: Study team

Rate: 24718.6 IRR/USD, 31st Oct. 2013 at <http://www.oanda.com/lang/ja/currency/historical-rates/>

8. Master Plan for Emergency Response for Oil-Related Disasters

8.1. Introduction

If oil spills associated with oil and gas development activities in Persian Gulf or its coastal areas occurred unexpectedly, it could directly affect the marine environment in not only the project sea area, but also the whole Gulf region. Accordingly, operators of the development activities, together with preventive measures, are responsible to provide proper response to the oil spills for minimizing probable environmental and social impacts arising from the event.

In Iran, National Oil Spill Contingency Plan (NOSCP) has been formulated by Port and Marine Organization (PMO), which covers all the oil spill incidents caused by any economic activities in marine and coastal areas commencing with ship operations.

The primary strategy for NOSCP is in the form of a “Tiered Response” consisting of three (3) tiers depending on the scale of the oil spill/ probable extent of marine pollutions, which defines the responsible organizations for respective tiers such as Tier 1 (small oil spill) to the operator of spill source facility, Tier 2 (medium oil spill) to the provincial PMO branch and Tie 3 (large oil spill) to PMO with support of MEMAC.

According to such framework for emergency response, operators of source facility of the oil spills are required to take proper initial response for any oil spill and whole response operations for Tier 1 oil spill. And then, the OSRPs to be provided by operators of the facilities shall be integrated into NOSCP as essential part of the national emergency scheme.

Based on the framework and basic response strategy of NOSCP, Ministry of Petroleum (MOP), the superior authority on oil and gas industry, declared a primary strategy for strengthening oil spill response scheme of oil and gas industry as follows.

- Establishment of functional Tier 1 OSRP at each offshore and coastal operational facility
- Deployment of resources necessary for effective response operation at site
- Technical and financial support for preparedness
- Close coordination with PMO for achievement of the purpose

Current status of oil spill preparedness of responsible operation companies in each pilot area is summarized below.

(i) Mahshahr

- Oil spill response scheme collaborating with provincial PMO branch has been established and it is functional. Response operation is entrusted to PMO.

(ii) Khark Island

IOOC:

- Corporate basic OSRP covering whole offshore operational areas has been developed.
- Preparation of local OSRPs for each facility in Khark district is currently in progress.

IOTC:

- OSRP with response equipment for crude shipping terminal areas has established and authorized by PMO.

(iii) Assaluyeh

TTPC:

- OSRP for loading berths of petrochemical products has established which capable of 15 tons oil spill. (NOSCP requires being capable of 50 tons oil spill.)

SPGC:

- OSRP for condensate loading berths (SPM) has not been ready yet.

This chapter discusses applicable procedure and method for development and enhancement of the OSRP of respective pilot areas as well as the roles of MOP.

8.2. Basic Strategy for Oil Spill Response

8.2.1. National Oil Spill Contingency Plan (NOSCP)

The National Oil Spill Contingency Plan (NOSCP), aiming to minimize probable environmental and social impacts associated with potential oil spills in the territorial sea area and rivers, specifies the country's framework and procedure for response to emergency situations for achieving the purpose. The oil spill response plans (OSRP) related to oil and gas industry shall take important roles of the national contingency scheme, of which the response strategy and procedure shall be properly complied with the NOSCP.

The basic policy and strategy for emergency response to possible oil spills are described as follows.

(1) Authority of NOSCP

The government of Iran ratified the international convention of Oil Pollution Preparedness, Response and Cooperation (OPRC) 1990 in 1997, which provide the framework for international cooperation in combating major incidents of marine pollution by oil spills.

Accordingly, the Port and Marine Organization (PMO) was nominated legally as the National Responsible Authority for the OPRC convention. Then, the PMO have subsequently developed the National Oil Spill Contingency Plan (NOSCP) as per requirement of the convention. The section in charge of development and implementation of NOSCP is the Department of Safety

and Marine Environment Protection of PMO. The department is also responsible for emergency rescue of human at any disaster at the sea area

(2) NOSCP

The primary strategy for emergency response operation is in the form of a “Tiered Response” consisting of three (3) tiers depending on the scale of the oil spill/ probable extent of marine pollutions as follows.

	<u>Tier</u>		<u>Spill volume</u>	<u>Responsible organization</u>
•	Tier 1	Small oil spill	(less than 50 tons)	Operator (company)
•	Tier 2	Medium oil spill	(50~500 tons)	Provincial OSR Organization
•	Tier 3	Large oil spill	(above 500 tons)	PMO with MEMAC

The operator of the facility (spill source) shall respond with his response resources for Tier 1 small oil spill (less than 50 tons). The regional OSR team headed by the provincial PMO shall take necessary response actions for Tier 2 medium oil spill (50~ 500 tons) with his resources together with the operator.

In case of Tier 3 large oil spill (above 500 tons), the oil slicks could be extended widely and invade the territorial waters of the neighboring countries. For this tier, the response team of PMO shall carry out protective works with the support of MEMAC in accordance with the procedure predetermined in the regional mutual aid program among Gulf countries.

(3) Emergency Contact Points

PMO sets up five (5) national contact points for emergency events that could occur in the territorial waters in the Persian Gulf and one (1) contact point in the Gulf of Oman. The operation of these contact points is the responsibility of the provincial offices of the Department of Safety and Marine Environment Protection of PMO.

These emergency contact points are registered and announced formally to the international organizations related to ship operations such as International Maritime Organization (IMO), International Tanker Owners Pollution Federation (ITOPF) and others. These facilities function as provincial oil spill response center with response equipment stockpile of the province.

8.2.2. OSRP for Oil and Gas Development Facility

The OSRPs of oil and gas related facilities shall take important roles in the scheme of NOSCP in Iran and the organization, procedure, methods of them shall be complied with the requirements of the NOSCP. Applicable policy for development/ enhancement of OSRPs for oil

and gas development facilities shall be discussed as follows

(1) Purposes

Purposes of the OSRPs are to:

- Ensure the health and safety of the personnel involved in the response operations and actions and the public affected by the event
- Minimize the potential environmental and social impacts of the oil spill with the overall net benefit to the environment of the affected area in mind
- Define the practicable procedure for response to the incident and in achieving the purpose properly and effectively
- Ensure the proper response operation is in compliance with the laws and regulation of Iran
- Facilitate communication and cooperation between the operator and the relevant authorities as well as the concerned bodies
- Protect and recover the properties/ operations of the company and stakeholders

(2) Coverage Areas

The OSRPs shall encompass the operational area of the facility and adjacent sea areas including the sea area along subsea pipeline routes between related facilities as well as facility and mainland.

In addition, in case of other area, such as adjacent or duplicated to other organization's operational area, the responsible area is to be defined discussing with relevant superior company and/ or PMO.

(3) Oil Spills to be dealt

The OSRPs shall deal with any oil released accidentally from facilities and related ships in the coverage sea areas.

Other oil spills such as the oil released from other ships passing through the coverage area or oil slicks travelled from other area shall be addressed for response action upon request of the source ship or the operator of source facility.

(4) Scope of Response Activities

Operator of the facility shall take necessary initial response to any oil spills from the facility or ship in the operational area in accordance with the specific procedures.

In case of Tier 1 oil spill (less than 50 tons), the operator shall conduct solely all the response

activities with his response resources. In case Tier 2 or Tier 3 oil spills, the operator shall notice the situations to higher response organizations of NOSCP and take necessary response activities in accordance with the commands of the responsible organization.

On the other hand, depending on the location of the operational facility (extremely remote from PMO base), the operator shall consider to deal with Tier 2 oil spills discussing with PMO.

(5) Applicable Legislation and Guidelines

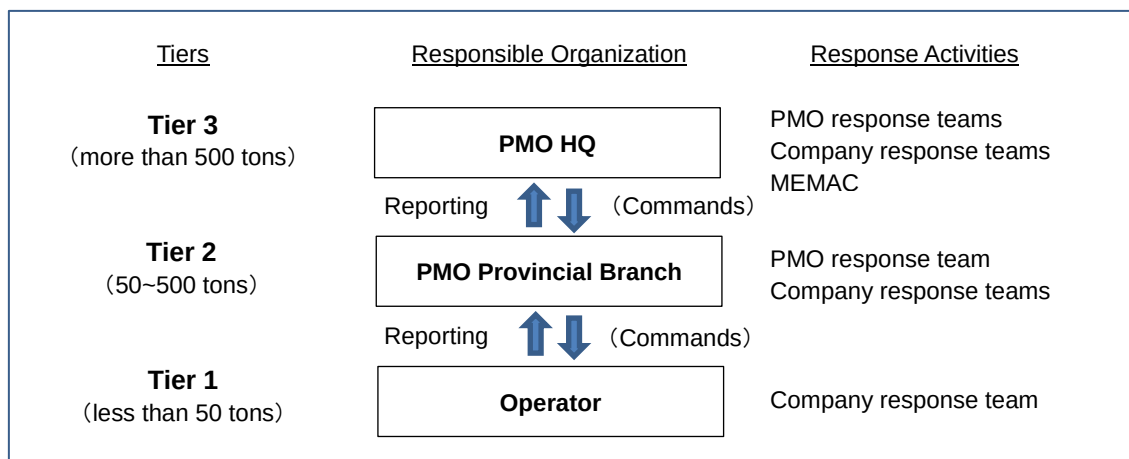
The OSRPs shall be developed dedicatedly in compliance with/ or reference to followings.

- Domestic laws for health and safety, environmental protection, oil and gas development, port, ship operations, etc.
- International conventions for environmental protection, pollution prevention, safety, oil spill response, etc.
 - Convention on the International Marine Organization, 1948 (IMO Convention 48)
 - International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)
 - International Convention for Safety of Life at Sea (SOLAS Convention)
 - International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990 (OPRC Convention)
- Regional convention among countries along Persian Gulf
 - ROPME Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution (1978)
 - Agreements/ Protocols regarding co-operative responses for the oil spill incidents
- OSRP guideline and instructions of PMO
- International guidelines for OSRP (IPIECA, ITOPF, etc.)

8.3. Oil Spill Response System

8.3.1. NOSCP

The basic strategy for oil spill response of NOSCP is “Tiered Response” according to spill volume, extent and significance of environmental impact. NOSCP defines emergency response scheme consisting of responsible response organization and response teams to be mobilized for the respective tiers as shown in Figure 8.3.1-1.



Source: Study team

Figure 8.3.1-1 General Scheme of NOSCP

Tier 1

Small oil spill response (less than 50 tons). The operator of the source facility of oil spill is responsible to solely conduct whole response operation with his resources. Emergency response team shall report the event to the provincial PMO branch, which is high emergency response organization of NOSCP.

In case that the event is expected to escalate to Tier 2, the emergency response team shall notify the provincial PMO branch of the new situation and shall be placed under the command of PMO.

Tier 2

Medium oil spill response (50 – 500 tons). Provincial PMO branch is responsible to mobilize emergency response teams of PMO and other facilities in the region and command entire response operations for the event. The PMO branch shall report the situation of oil spill to PMO head quarter, which is the higher emergency response organization of NOSCP.

In case that the event is expected to escalate to Tier 3, the emergency response team shall notify PMO headquarter of the new situation of the event and the right of response command is transferred to PMO headquarter accordingly.

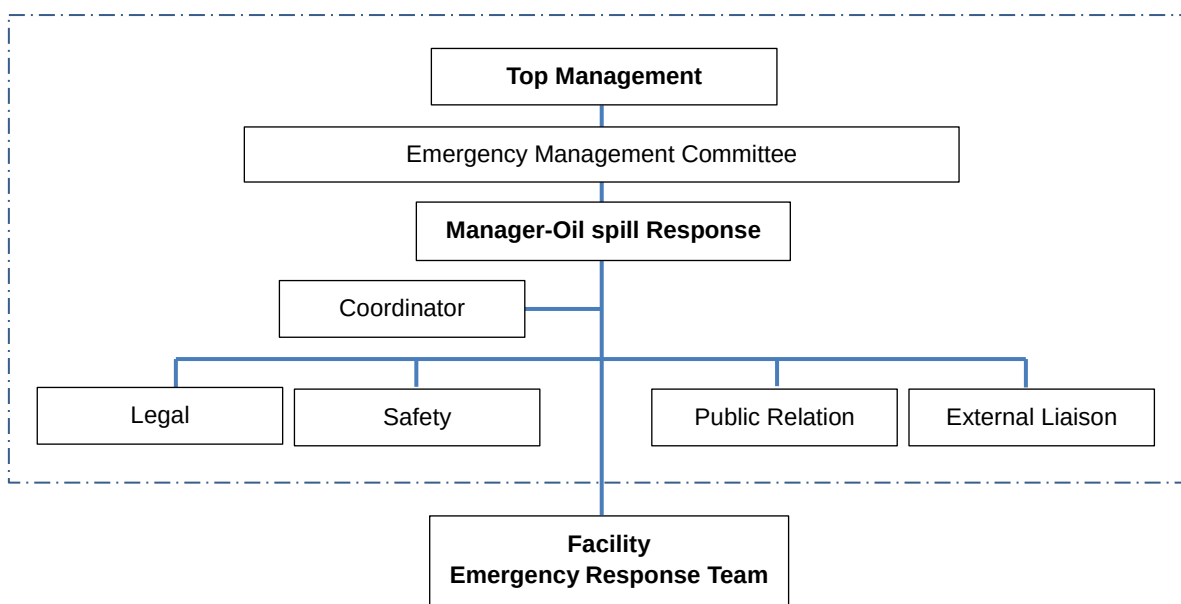
Tier 3

Large oil spill response (larger than 500 tons). Emergency command team of PMO headquarter is responsible to mobilize capable emergency response teams of PMO and facility operators in adjacent regions and control the entire response operations of the event. Each provincial PMO branch shall supervise response activities in the province respectively.

On the other hand, in case that oil slick is expected to traverse boundary of the neighboring country, the emergency command team shall inform MEMAC such situation immediately in accordance with agreed mutual aid procedure among the Gulf countries for necessary support.

8.3.2. Emergency Response Organization of Facility Operator

Operation company of oil and gas industry shall assign a manager in charge of oil spill incident in the company's emergency response organization headed by the top management in headquarter. (See Figure 8.3.2-1.) In addition, several specialists for legal, safety, public relation, external liaison and coordination shall be positioned in the response management team for assistance of the manager of oil spill response, if not available in the company's emergency response organization.



Source: Study team

Figure 8.3.2-1 Oil Spill Emergency Management Organization of Company

Roles of the key personnel of the oil spill emergency management organization in headquarter of the company are listed below.

Manager, oil spill response

- Understand full picture and situation of the oil spill event
- Manage whole response operation
- Decide applicable response tier and escalated tier
- Supervise response operation of emergency response team at the facility

Legal specialist

- Advise legal issues related to emergency response operations to Manager-oil spill response

Safety specialist

- Advise health and safety provisions for response personnel at site and community in the affected area

Public relation specialist

- Inform community in the affected area of the event situation and response activities to be taken
- Treat grievance of stakeholder(s) for effects/ damage caused by the oil spill

External liaison specialist

- Communicate whole response operations to related organizations, stakeholders and local community in affected area

Coordinator

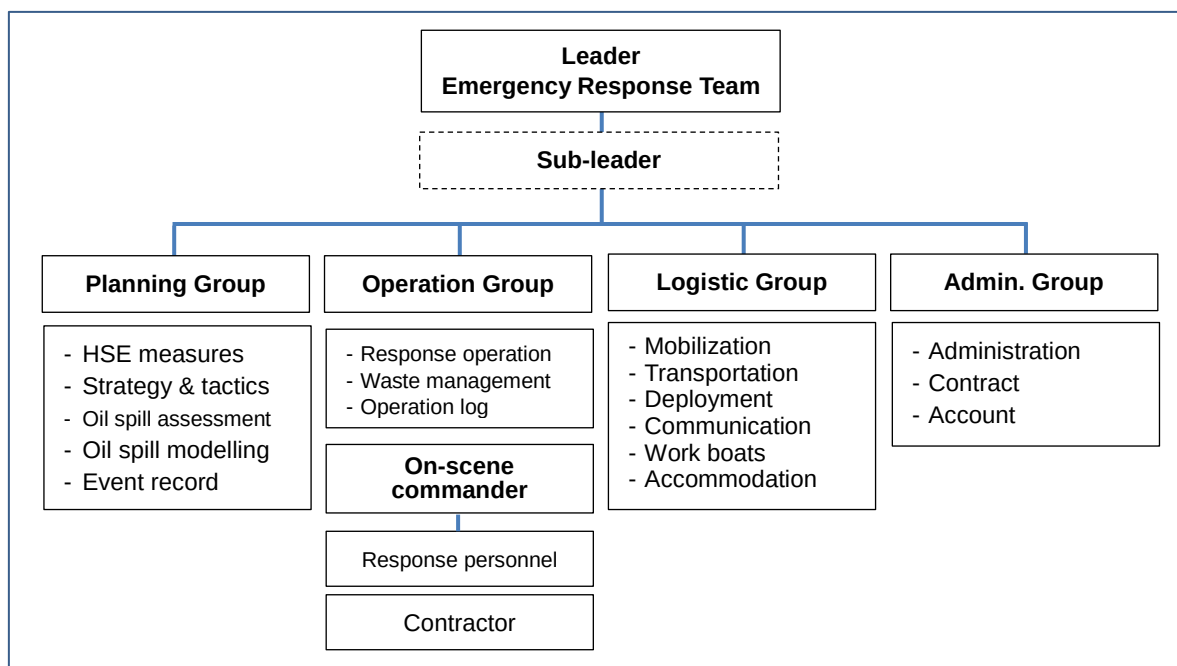
- Support manager-oil spill response for management of entire response operations
- Coordinate response operations with related organization and authorities
- Sufficient knowledge and experience of oil spill response are required.

(1) Emergency Response Team of Facility

An emergency response team which directly responds to possible oil spill at site shall be organized at each oil and gas development facility. The emergency response team shall be provided necessary functions for responding effectively and properly to the emergency event as follows.

- Notification and reporting of the emergencies
- Collecting information and assessment of the event
- Planning of the response strategy and tactics/ measures
- Coordination with the concerned organizations and authorities including external support
- Mobilization and deployment of the response resources including equipment, materials, manpower and finance
- Effective response operations
- Control and management for the actions and operations
- Communication and reporting

The typical organization of the emergency response team with such functions for the facility is shown in Figure 8.3.2-2.



Source: Study team

Figure 8.3.2-2 Emergency Response Organization of Facility

Emergency response team of facility at event site consists of a leader of the team and functional groups in charge of planning, response operation, logistics and administration necessary for effective response activities at response site. The operation group is comprised of On-scene Commander responsible to supervise response operations at site and response personnel and contractors.

The allocations of the emergency response team members are pre-nominated among the personnel for routine operation of the facility, who could be called up to the site immediately.

Practical roles and responsibilities for the key personnel and groups comprising the emergency response team are described as follows.

Leader-Emergency response team

- Safety of operational personnel and keep the integrity of the facility
- Maintaining steady operation of the facility and minimizing risks of potential incident
- Focal point for all communications for response operations
- Collection of the exact information of the event and evaluate the situation
- Remedial actions for stop or minimizing the spill, if possible
- Emergency alert and evacuation from the facility as necessary
- Selecting response strategy, setting the objectives and developing response plans
- Supervising the response activities
- Operational and financial authority for effective response operations

In general, the operation manager of the facility shall assume the role of this position.

Sub-leader-Emergency response team

- Assisting EMT Commander
- Monitoring changes of oil spill situation and responses undertaking
- Operational coordination with relevant authorities and other EMTs for Tier 2
- Assuming any responsibility delegated by the team leader
- Acting the team leader, if he is not available

Planning Group

- Collection and assessment of Information about the incident and operational performance
- Planning of the response strategy and effective protective measures
- Ensuring a complete and accurate record of the event and response operations undertaken
- Monitoring and assessment of the effectiveness of the response operations
- Feedback from/ to the response operations for further effective measures
- Management/ control of documents for response operations

Operation Group

- Ensuring personnel safety is the first priority
- Execution of effective response operations in the field including deployment, protection, recovery cleanup, waste management, etc.
- Control of operational resources and activities in the field in line with response objectives

On-scene Commander

- The first contact point from the spill site/ observer
- Primary verification for the event
- Relaying of all the incident information to the team leader
- Monitoring of changes of event situation

Logistic Group

- Obtaining the personnel for response operations
- Preparation/ procurement of the equipment, facilities and materials required for response operations
- Transportation of operational resources for response operations
- Development of the specific communication system for response activities
- Organization of accommodation, foods, water, etc. necessary for operational personnel
- Arrangement and coordination with external support resources

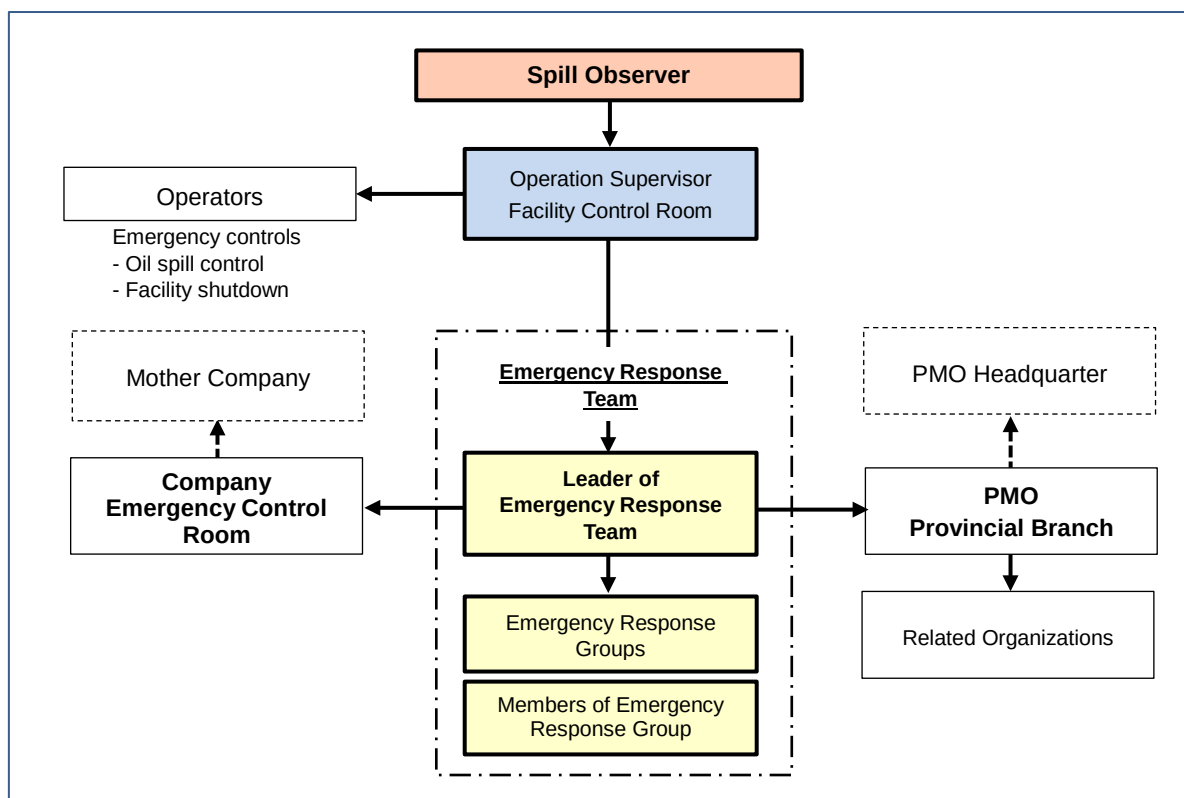
Administration Group

- Administration of entire operations
- Contracts with contractors and suppliers for support works, material procurement necessary for operations as required
- Monitoring and accounting the costs for operations
- Management or coordinate of claims/ grievances from stakeholders as required

8.3.3. Emergency Information System

(1) Emergency Information Procedure

The initial reporting/ notification procedure for the oil spill from the facility/ vessel due to defect/ failure of equipment aboard the facility or the vessel (tanker, tug boat, service boat, etc.) in the operational area is described as follows. (Refer to Figure 8.3.3-1)



Source: Study team

Figure 8.3.3-1 Emergency Initial Information Procedure (Typical)

Observer

- 1) Report the findings to the site/ facility supervisor according to the specific emergency notification procedure.

Operation supervisor

- 2) Collect necessary information to grasp the situation of the event from the observer. (e.g. exact location, source and cause of the spill, kind and volume of spilled oil, spill condition, numbers of person injured, damage of facility/ equipment, etc.)
- 3) Inform leader of emergency response team of the event and its situation.
- 4) Initiate operational action for control of the spill/ shutdown of the facility in accordance with

the predetermined emergency operational procedure.

Leader of Emergency response team

5) Call out key members of emergency response team.

Then, notify the event and situation to Emergency Control Room of the company and provincial PMO branch.

6) Leader of Emergency response team

Assess the situation of the event together with Planning Group based on the information collected, and decide applicable response Tier discussing with the emergency control room of the company. Then, inform provincial PMO branch of the tier.

Leader of Emergency response team, Planning group

7) For Tier 1, decide response strategy, tactics and protective measure including safety provision considering situation of spilled oil and marine and weather conditions. Then, command the operation to each operational group.

8) Leader of Emergency response team

For Tier 2 or 3, carefully monitor situations of the event and fate of spilled oil on water and conduct appropriate response operations as per the commands given by the provincial PMO branch.

(2) Collecting Information

Under the direction of the team leader, the Planning Group shall confirm the information reported initially by the observer and/ or operator and collect further information necessary to provide applicable response tactics/ measures for the event as well as health and safety provision for operational personnel.

The information to be collected in an initial stage of the response activity includes below items.

- Date and time, location/ area of incident
- Spill source and cause of event
- Injury of personnel, fire/ explosion
- Damage of facility/ equipment
- Effect of facility operation
- Oil spill situation
 - Type of oil, spill volume
 - Spill status: transient, continuous, stopped, will stop soon
 - Volatile or harmful gas
 - Oil drift: direction, extent (current and future)
- Weather and sea conditions
 - Climate, wind direction and speed, ambient temperature, visibility, weather

forecast

- Water current, waves, tide

It is very important to collect exact information in the earlier stage in order to understand the situation of the oil spill exactly. Accordingly, preparation of a simplified check sheet listing all the necessary information items is effective for this purpose.

8.3.4. External Supports

In general, response operation for Tier 1 oil spill shall be solely conducted by an emergency response team of the source facility or the operation company. On the other hand, in case that a number of companies or organizations are operating in the same sea area, response operation can be made rapidly and effectively by collaboration and mutual support, or entrustment to a capable response team in the area for minimum redundant preparedness.

In a surrounding sea area of Khark Island, two (2) companies, i.e. IOOC and IOTC, are operating their facilities and both companies respectively have their individual OSRPs dealing with potential oil spills from their facilities. Under such situations, for further effective response to oil spills in this area, it is required to include practicable response scheme of collaboration/ mutual support in the OSRPs.

In Mahshahr area, where the provincial PMO branch is located, it is provided with sufficient response resources capable to combat oil spills occurred in the area. Therefore, a scheme of entrustment for emergency response to any oil spill in the area has been already prepared between TTPC (Tank & Terminal Petroleum Company), the operator of loading facilities of PETZONE, and PMO.

The operators of offshore oil and gas production platforms are required to provide functional specific OSRP to Tier 1 oil spill from the facilities. On the other hand, the production platforms in a remote sea area are required to prepare further OSRPs capable to respond to both Tier 1 and Tier 2 oil spill due to the particular site condition.

For this purpose, strengthening emergency response capability of the facility is achieved by enhancement of response organization and resources and supports from the emergency response teams of other facilities in the same facilities or contracted external oil spill response agency. Accordingly, for preparation of OSRP necessary for Tier 2 oil spill of offshore production facility, it is required to enhance the emergency response scheme by prior agreements/ contract with relevant other facility operators and contracted organization.

8.4. Evaluation of Environmental and Social Impacts

(1) Oil Spill Modeling

The purpose of oil spill protection is to minimize probable impacts and damages on marine and coastal environment and socio-economic activities in the affected area caused by unexpected oil spill event.

For environmental and social consideration, effective recovery and/or treatment of the spilled oil as soon as possible in earlier stage is essential for minimizing possible pollutions of the coastal areas.

According to some related information, if booming and oil recovery operations could be started within 1 hour from the incident, it would abate the expenses for protection by appropriately US\$300 per 1 barrel of spilled oil. However, if such necessary response operation is started 2 hours later, the expenses for the purpose would be raised at more than four times of the former. Therefore, proper planning for effective oil spill response should be established considering the probable escalation of financial loads on the protective operations to spilled oil as a result from delay of response operation.

Various protective measures to marine oil spill are available and the most suitable and effective measure(s) should be selected properly depending on situations of the event, i.e. types of spilled oil, drifting behaviour, sea and weather conditions, etc. Therefore, for planning of effective response operations, it is required first to recognize the situation of oil spread/ drift and change of oil properties on water, and then, to predict fates of the oil which would vary with time.

For prediction of probable fate of spilled oil on sea surface, various oil spill models are utilized widely by oil industry and other industrial sectors in the world.

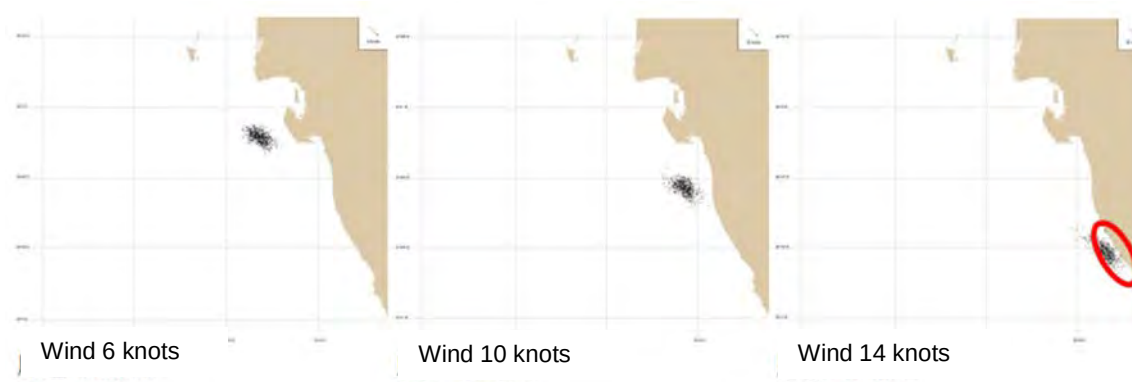
For this project, a combined model of GNOME and ADIOS2 was selected suitably for oil spill modelling for prediction of probable trajectories and changes of characteristics of spilled oil. The outcomes of the several case studies using the above models were presented in 5.4.2. Through the use of the applications, it has been confirmed that the findings of such modelling studies (predictions of oil trajectory using GNOME and oil weathering using ADIOS2) are usable for development of oil spill response plans for the respective pilot areas subject to the project.

Samples of modelling output (trajectories of spilled oil from Aboozar field and East loading terminal of Khark Island) are shown below.



Source: Study team

**Figure 8.4-1 Aboozar Oil Field, Spilled Oil Trajectory after 5 Days,
(Nov-Jan. North-east wind)**

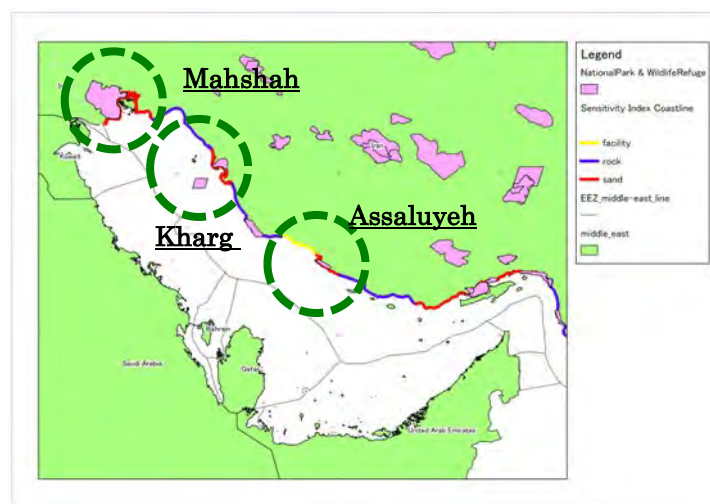


Source: Study team

**Figure 8.4-2 East Loading Terminal of Khark Island, Spilled Oil Trajectory after 5 Days
(Feb- Oct, North-west wind)**

The results of trajectory analysis can be used for discussion of priority site(s) expected being affected by the event for protection with reference to the environmental sensitivity index (ESI) maps of the coastal region. It is assumed that ESI maps are available in the related database in a shape of Geographical Information System (GIS) in Iran. GNOME is provided with an input process scheme into GIS and it is possible to indicate the findings of GNOME on the GIS figures.

According to recent promotion of open software, various GIS applications are also available to access freely. It is expected that a combination of GNOME and GIS could be helpful in planning for a more effective protective operation to sensitive areas along the possibly affected shorelines. Reference is made to Figure 8.4-3 environmental sensitive index on GIS map.



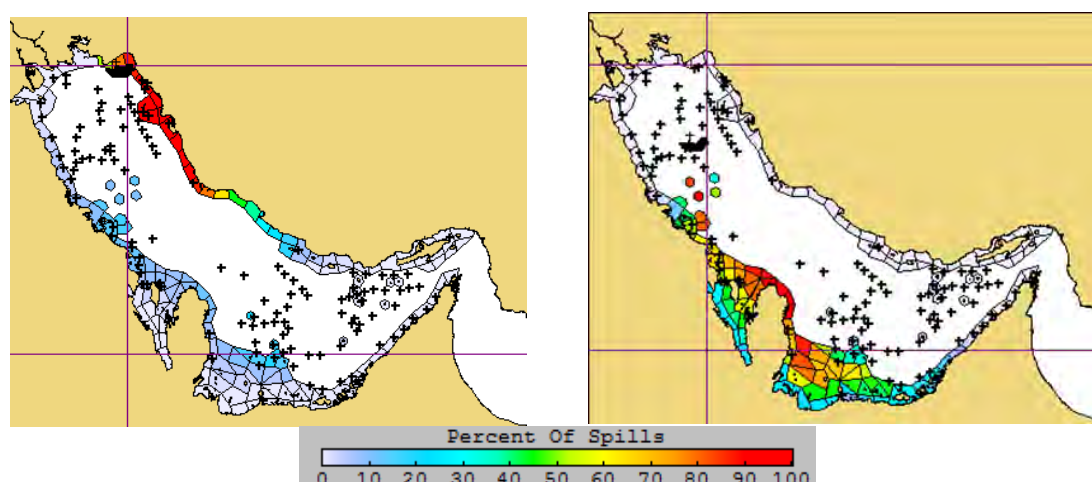
Source: Study team

Figure 8.4-3 Environmental Sensitivity Index on GIS Map in the Persian Gulf

It is assumed that the relevant environmental sensitivity index (ESI) maps along the coast of the Persian Gulf have already been prepared by DOE. Further serious discussion of protective plans to coastal areas utilising such EIS information is expected.

(2) Prediction of Probable Environmental and Social Impacts

In the project, in addition to analysis of trajectory and weathering of spilled oil (50 tons of medium crude) from the major crude production platforms in the northern Persian Gulf, probability (%) of oil drifts to coastal lines were also examined for prediction of oil spill impacts on the sensitive areas by the model of Trajectory Analysis Planner (TAP). The findings are summarized in Figure 8.4-4 and 8.4-5. (Refer to 5.4.2 (2) for details.)



Source: Study team

Figure 8.4-4 Oil Spill from Bahregan Sar (Feb - Oct. 60 days)

Source: Study team

Figure 8.4-5 Oil Spill from Foroozan (Feb - Oct. 60 days)

The findings of modelling vary with the scenarios such as locations of spill sources (Bahrgan Sar, Nowruz, Aboozar, Foroozan) and seasons (November – January, February – October). The worst cases predicted by the study are 70-80% probability of oiling along the shorelines from the northern closed-off section of the Gulf to the middle of Bushehr, and 30-75% probability of oil drifts to the opposite shorelines of the Gulf including the coasts of Saudi Arabia, Bahrain, Qatar and UAE. Furthermore, the modeling predicts 50-90% probability of oil drifts to the natural protected areas such as Heleh, Mond, Saraj, Faror Island, Hara and others as well as 80% probability of drift to Khark Island, which is one of the pilot areas of the project. Meanwhile, the modeling predicts low probability of impacts on the other pilot areas of Mahshahr and Assaluyeh.

According to the above findings, oil spills, if it happened at the crude production platform and related facility in the northern Persian Gulf, is expected to affect in certain extent the coastal areas from the northern closed-off of the Gulf to Bushehr district, which include not only the natural reserves, but also socio-economic locations such as fishing grounds and ports.

Through the oil spill modelling studies, it was confirmed that a preparation of proper and effective oil spill response plans (OSRPs) is required so as to minimize the probable environmental and social effects caused by the potential oil spill incident from the offshore crude production facility in the region. Accordingly, it is essential to establish the facility/ area specific oil spill response plans describing the sensitive areas subject to protection, priority for protection, response measures and procedures, etc.

8.5. Basic Oil Spill Response Strategy and Measures

8.5.1. Assessment of Oil Spill Incident

(1) Decision of Response Tier

The Emergency Response Team (ERT) of the facility shall decide the applicable response tier of the oil spill according to the information of the situation of the event, i.e. spill volume, extent of oil drift, severity of environmental and social impacts, etc. and response capability of the facility.

Primary indicators for decision of the response tier are to be as follows.

<u>Tier</u>	<u>Spill volume</u>	<u>Assessment indicators</u>
Tier 1	Less than 50 tons	- Oil drift is within operational area - No expansion of environmental and social impacts

Tier 2	50~500 tons	- Capable to respond solely by ERT of the facility - Expanded oil drift into adjacent areas - Need support/ collaboration with other response teams
Tier 3	More than 500 tons	- No trans-boundary oil drift - Further expansion of oil drift in wider area - Need further support/ collaboration with other response teams - Trans-boundary oil drift

Even if the oil spill is less than 50 tons, Tier 2 shall be decided when it is evaluated difficult to respond solely by ERT of the facility. And even if the oil spill is less than 500 tons, Tier 3 shall be decided when trans-boundary of oil drift is expected depending on the sea current and weather conditions.

After the response tier is decided, but needed additional response resources depending on the change of situation of the event and progress of the response operations undertaken, ERT shall decide to escalate the tier immediately for effective response operation.

(2) Safety Assessment

The Planning Group of the ERT shall conduct safety assessment immediately after collecting information of the event. The safety assessment aims to identify any potential hazards involve in the incident and to avoid or mitigate the hazards associated with the intended response activities in accordance with the policy of health and safety of the operational personnel, which is the first priority of the response operations. The findings of such assessment shall be reflected to the discussion of the response strategy and planning for response operations to be conducted.

The items for safety assessment for the response personnel include:

- Location of the incident
- Fire/ explosion, injured persons
- Spill source and spill status: transient, continuous, stopped
- Oil drift: direction, expansion
- Type of oil and hazards: volatile gas, toxic gas (H₂S)
- Weather conditions: ambient temperature, wind direction and speed, visibility, weather forecast
- Sea conditions: water current, wave height, tide

8.5.2. Decision of Response Strategy

(1) Response Priority

The issues to be considered for oil spill response operation and priority order of them are assumed as follows.

- Safety of people involved in the response operations and the communities affected by the event
- Protection of marine environment and wildlife
- Minimization of regional socio-economic impacts
- Safe and steady operation of the facility

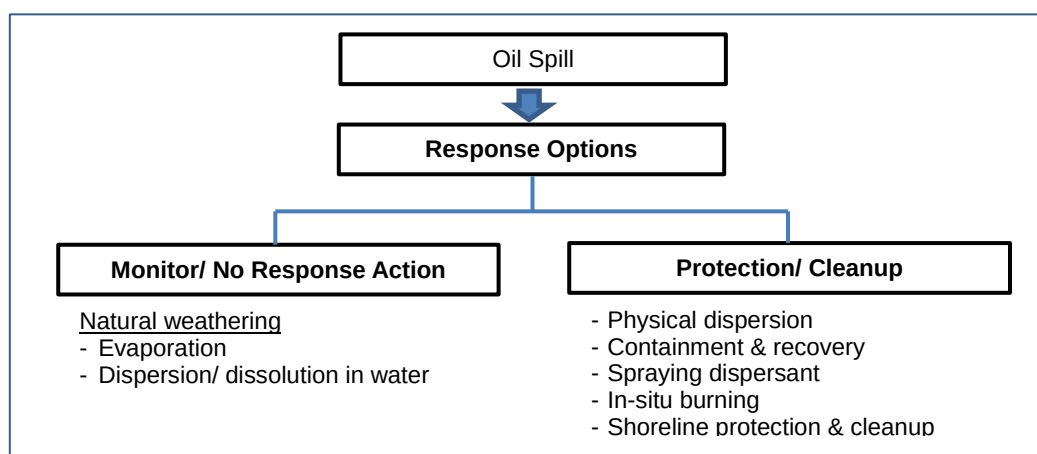
Priorities for oil spill response tactics and measures are selected based on the following criteria.

- The highest possible net environmental benefit
- The highest possible level of cleanup and lowest potential environmental and socio-economic impacts
- The most efficient use of response resources
- The minimum generation of wastes

(2) Response Options

Planning Section of the ERT shall discuss the applicable response strategy for the oil spill based on the information (oil spill status, type of spilled oil, location, weather and sea conditions, etc.) initially collected from the event site and the results of safety assessment.

The response options for oil spill in offshore operation are “No Response Action” and “Protection/ Cleanup”. (See Figure 8.5.2-1)



Source: Study team

Figure 8.5.2-1 Response Options

In “No Response Action”, the spilled oil is left for natural weathering and dispersion. On the other hand, applicable offshore protection/cleanup tactics and methods include:

- Physical dispersion of oil on water,
- Containment and recovery of the oil on water, and
- Spraying dispersant chemical
- In-situ burning
- Shoreline protection and cleanup

“In-situ Burning” shall not be employed to any oil types, because it is not accepted for application in the ROPME region by MEMAC.

Criteria for selection of applicable response tactics and measures depend on the properties of the spilled oil practically. Priorities of the applicable measures for various types of oil are indicated in the following table.

The first priority measures for Group I volatile and light oil, is “Monitor/ Natural Weathering”, whereas the first priority measures for Group II and III medium and heavy oil including crude oil, are “Containment and Recovery” and “Dispersant” application.

Table 8.5.2-1 Selection of Tactics and Measures

Type of Oil	Priority	Measure	Rationale
Group I Volatile & Light Oil Naphtha Gasoline Diesel Kerosene	1	Monitor/ Natural weathering	Oils evaporate/dissipate rapidly
	2	Shoreline protection	Shoreline environmental impacts
	3	Physical dispersion for diesel	For small spills near shore
	Do not	Physical dispersion for others	Not safe (harmful vapors)
		Use of dispersants	Potential environmental impacts
		Containment & recovery	Not safe (harmful vapors)
		In-situ burning	Not accepted by MEMAC
Group II Medium Oil Crude	1	Containment & recovery	Physical recovery of oil on water Little potential hazards for persons
	2	Use of dispersants	Rapid response and prevention of emulsification
	3	Monitor/ natural weathering	For small/ remote spills
	4	Shoreline protection	Potential environmental impacts
	Do not	Physical dispersion	Oils tend to emulsify easily.
		In-situ burning	Not accepted by MEMAC
Group III Heavy Oil Fuel Oil	1	Containment & recovery	Physical recovery of oil on water
	2	Use of dispersants	Select the applicable dispersants. Monitor closely the effects.
	3	Shoreline protection	Potential environmental impacts
	4	Monitor/ natural weathering	For small and remote spills
	Do not	Physical dispersion	Oils tend to emulsify easily.
		In-situ burning	Not accepted by MEMAC

Source: Study team

8.5.3. Protection/ Cleanup Methods

(1) Physical Dispersion

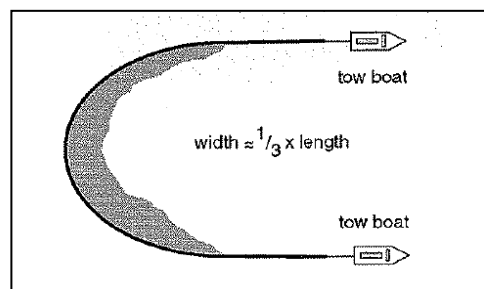
The thin oil films or sheens or highly volatile oil such as condensate can be physically deflected away from the spill source (ship or facility) by sweeping the surface with fire monitors onboard or fixed on the structure. Such oil can also be dispersed effectively by agitating the sea surface using propeller of ship.

(2) Containment and Recovery

The objective of containment is to concentrate the oil on water using “Mobile Containment Boom” to achieve a slick thickness that permits recovery. It shall be considered to ensure that oil can be contained in recoverable quantities for the expected duration of the operation. Booms are used in various configurations to contain and recover oil shown in Figure 8.5.3-1.

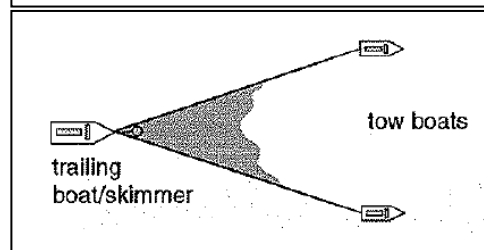
U-Booming

Two (2) boats can tow a boom in “U” configuration to collect oil. This is accomplished by drifting downstream, holding in a stationary position or moving upstream toward the spill source.



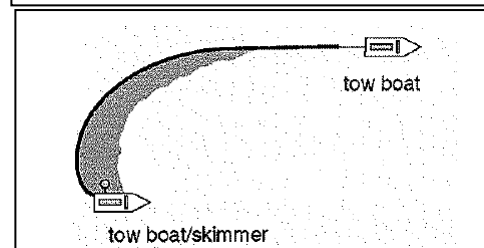
V-Booming

Booms are deployed in a “V” configuration using three (3) boats with a skimmer or two (2) boats and a trailing skimmer.



J-Booming

Booms are towed in a “J” configuration that diverts the oil to a skimmer to allow simultaneous containment and recovery.



Single Boat “Side Sweep”

Employs a boom attached to the side of a boat by means of a rigid arm. The boom forms “U” shaped pocket where the oil is concentrated for recovery by a skimmer.

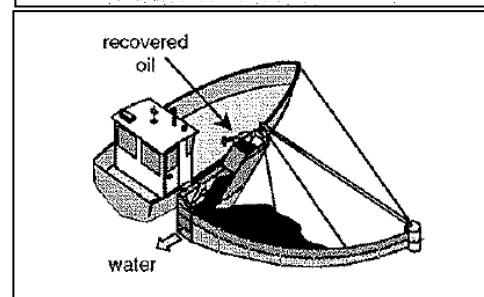


Figure 8.5.3-1 Booming Configurations

Aerial support is required for the effective location and targeting of oil. The aircraft to be used should have good downward visibility (over fuselage wing or helicopter) and with GPS and HF radio to enable direct communications with the boats.

For recovery of the oil on water contained by the boom, various types of skimmer can be used depending on the oil type and thickness of the slick as well as sea conditions. Typical skimmers for recovery of oils on water are shown in Figure 8.5.3-2 including portable weir, disc and brush type skimmers driven by electric or hydraulic power.

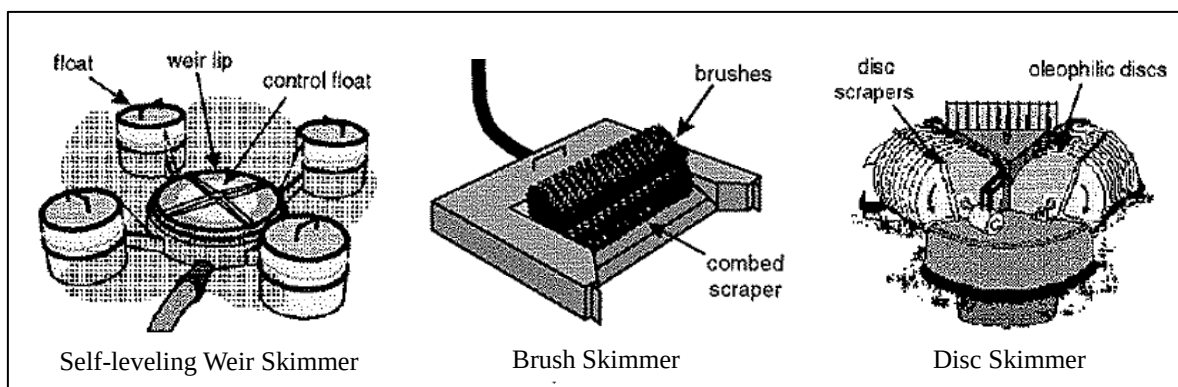


Figure 8.5.3-2 Oil Skimmers

(3) Dispersant

Dispersant chemicals are used to promote the formation of oil droplets in order to accelerate the natural dispersion and biodegradation of oil spilled on water.

Application decisions are based on estimating minimum effective dosages of oil in water to minimize possible impacts on estuaries, shore and sensitive habitats. Dispersants must be applied as early in the spill as possible because weathering significantly increases the viscosity of spilled oil. (Dispersants are effective on the oils with a viscosity of less than 2,000 cSt generally.)

Dispersants can be applied from boats with spray booms and/ or aircrafts with application equipment. (See Figure 8.5.3-3.) In extreme weather and sea conditions, it is unlikely that dispersants would be applied to a spill.

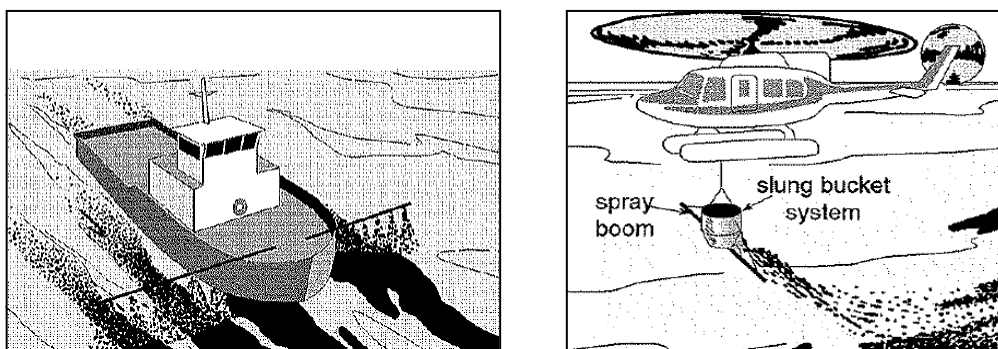


Figure 8.5.3-3 Dispersant Spraying

Specific dispersants are approved for use in the Persian Gulf by ROPME/ MEMAC, which are low toxic for marine environment. Permitted area to apply dispersants should be limited preliminarily in the specific OSRP to prevent possible impacts of the chemicals on the sensitive marine or shore environment.

(4) In-situ Burning

In-situ burning is the process of controlled burning of the contained oil at sea. (See Figure 8.5.3-4.) Burning may be considered when oil can be contained with booms, but recovery, transport to other locations is impossible.

Oil on water can be burned if the oil thickness is greater than 2 or 3 mm. Oil slicks must be contained and concentrated to achieve this thickness on open water using fire-resistant booms. Towing or drifting boats may be able to hold U-booming configurations with fire-resistant booms in position to capture oil when currents at the spill source are low enough to allow containment (less than 0.4 m/sec. or 0.7 knots).

Two types of ignition systems are available, i.e. hand-held igniter such as propane torches used from a boat and igniter for use from helicopters.

A plan for In-situ Burning to be applied to the possible site shall be developed preliminarily in the specific OSRP considering the following issues.

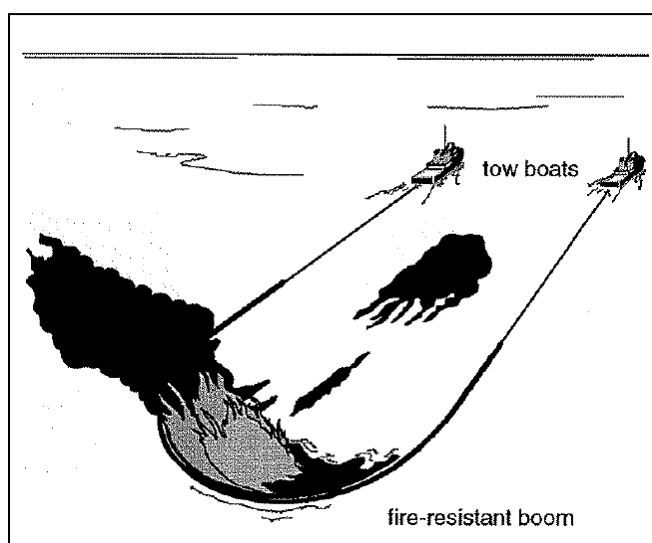


Figure 8.5.3-4 In-situ Burning

- Wind and sea conditions applicable for In-situ Burning
- Health and safety risks on the response personnel
- Prediction of plume trajectory
- Assessment of potential environmental impacts and the net environmental benefit
- Notification to ships in and adjacent water, communities in the region and other stakeholders

Application of In-situ burning in the response operation shall be subject to approval of the responsible authority in accordance with the procedure defined in the respective specific OSRP. Note that ROPME/ MEMAC prohibited this method basically in the ROPME sea area due to the probable secondary impacts on marine and atmospheric environment in the region.

(5) Shoreline Protection and Clean-up

1) Shoreline Protection

For protection of the sensitive areas along the shoreline from oil slicks, mobile floating booms are deployed on the water surface to intercept, control/ diversion and/ or recovery of oil.

The floating booms for this application generally can be grouped into four types shown in Figure 8.5.3-5.

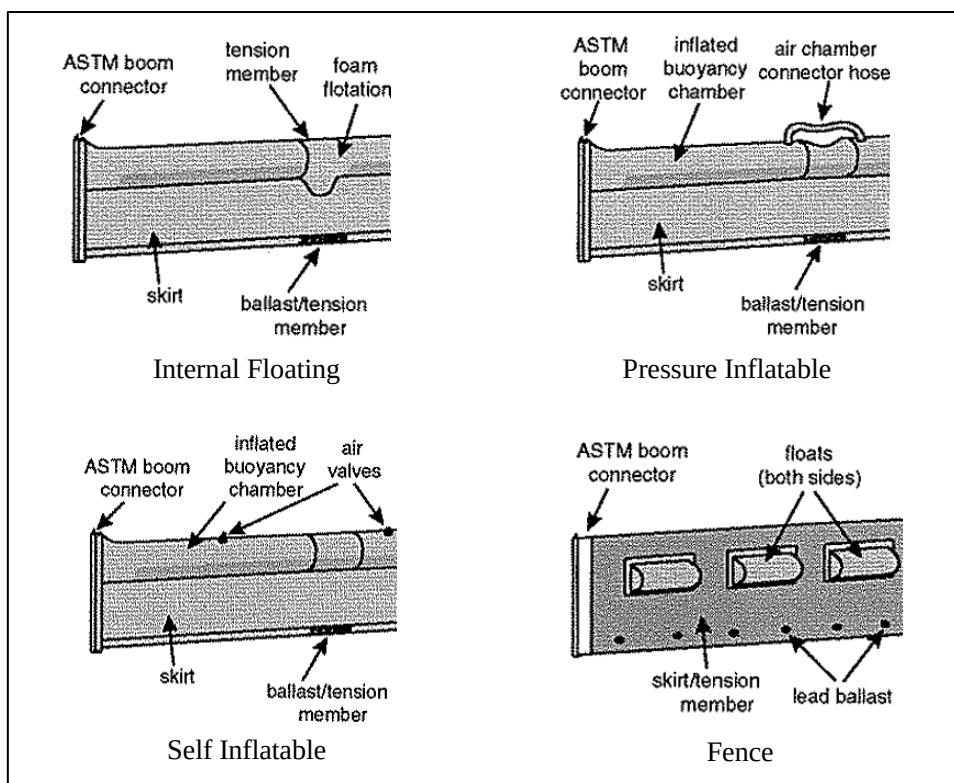


Figure 8.5.3-5 Floating Boom Types

In each type, the boom extends above (sail) and below (skirt) the water surface. Large-size floating booms are designed for open-water condition, whereas smaller-size is intended for use in sheltered or calm water.

In order to achieve rapid response for shoreline protection, basic deployment plan of the booms shall be discussed preliminarily in the specific OSRP in accordance with each scenario of the possible oil spill events expected in the sea area. An effective deployment of booms at the occurrence shall be decided appropriately by the EMT depending on the situation of the event, predicted trajectory of the slick and weather and sea conditions.

2) Shoreline Clean-up

Shoreline clean-up aims to accelerate the recovery of the oiled shoreline areas. The clean-up methods selected to meet the objective shall be compatible with the shoreline type (characteristics of the shore area) and with the oiling conditions, i.e. type and volume of oil. The applicable clean-up/ treatment methods are categorized into 5 as follows.

- Natural recovery
- Physical treatment
 - Washing
 - Removal
 - In-situ treatment
- Chemical/ biological remediation

In practice, two or more applicable methods are selected in combination to achieve the treatment objective effectively.

Natural Recovery

Shoreline that is affected by small amount of non-persistent oil can be naturally recovered in given appropriate circumstances. The objective of natural recovery is to allow a site to recovery without intervention or intrusion.

The natural recovery option may be applicable in the following conditions.

- The clean-up/ treatment of stranded oil may cause more damage of environment than leaving
- Physical treatment methods are not practical and cannot accelerate natural recovery
- Health and safety considerations could place operational personnel in danger from the oil or environmental conditions, i.e. adverse weather, difficult access, etc.

On the other hand, natural recovery may not be appropriate if important ecological or human resources are threatened. Net environmental benefit analysis is required for application of this option.

Washing

Washing techniques to remove oil from shore include flooding, low/ high pressure washing with cold/ hot water and steam washing practically.

Each washing technique requires a number of separate operational steps such as washing, collection/ containment or recovery of contaminated wash fluid and displaced oil for disposal. The following techniques are associated with washing.

- Floating booms for containment of the washing fluid and oil skimmers onto the adjacent water
- Sump lines or trenches for recovered washing fluid toward a collection area (See Figure 8.5.3-6.)

Washing operation should be planned to minimize or avoid possible impacts on the plant or animal communities in the area, if any at down slope into the lower intertidal zones. Such impact can be avoided by working at mid-tide or high-tide levels. (These communities are below the water level.)

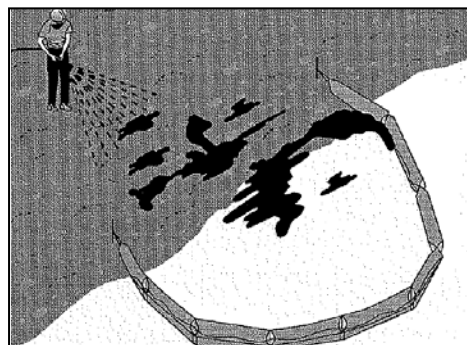


Figure 8.5.3-6 Washing

Removal

This technique is to remove/ eliminate the oil or oiled materials (i.e. oil, sediments, sand, debris, vegetation, etc.) from the shore areas for disposal.

This technique includes five basic methods as follows.

- Manual removal (See Figure 8.5.3-7.)
Remove oil or oiled materials with manual and hand tools
- Vacuum systems
Remove oil by suction from areas pooled or collected in sumps
- Mechanical removal (See Figure 8.5.3-8.)
Remove oil and oiled materials using mechanical equipment
- Vegetation cutting
Remove oiled stems to prevent remobilization of the oil or contact by animals and birds, or to accelerate the recovery of the plants
- Passive sorbents
Place sorbents (pads, rugs, blankets, rolls, sweeps or booms) in a fixed location to pick up oil by contact

The mechanical methods essentially use equipment designed for general civil works and general tools. On the other hand, special equipment for beach cleanup and most sorbents are manufactured specially for use on oil spills.

In selection of the appropriate methods, it is important to consider the size of the area, the type and amount of oil, access to the site and the shoreline type as well as evaluation of efficiency, costs, time period for operation and volume of the wastes to be disposed.

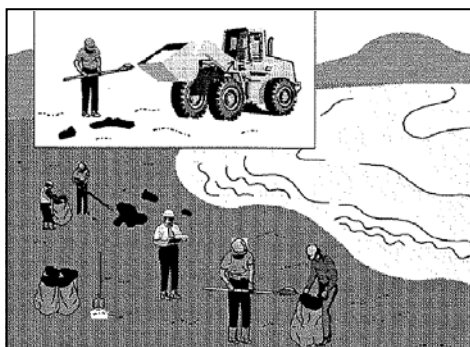


Figure 8.5.3-7 Manual Removal

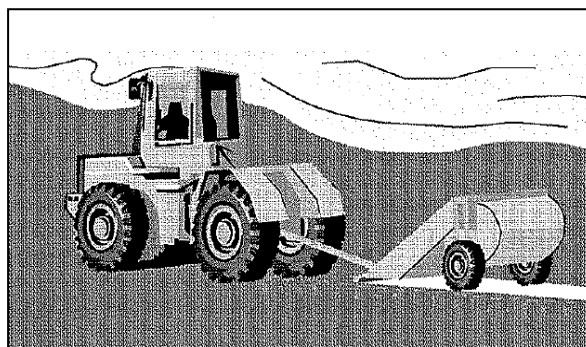


Figure 8.5.3-8 Mechanical Removal

In-situ Treatment

This technique aims to alter the character of the oil or change the location of the oil in the intertidal zone to promote or increase weathering and natural degradation.

- Basic methods of this technique are described as follows.
Expose or breakup surface and/or sub-surface oil to accelerate evaporation of oil and other degradation processes i.e. dilution of oil, etc.
- Relocation of oily sediment
Accelerate natural degradation by moving oil and oiled materials to areas with higher levels of physical (wave) energy
- Burning
Remove or reduce the amount of oil pooled and/ or oil on the oiled materials by burning on site

For the application of these methods, an assessment should be made of the anticipated change/ effect in oil weathering or natural removal rate that will be brought by the treatment. Burning will require a permit from the local relevant authorities, if carried out on a large scale.

Chemical/ Biological Remediation

The objective of this technique is to alter the oil to enhance collection or to accelerate natural degradation processes. This technique includes four basic methods as follows.

- Dispersants
Create fine oil droplets that are dispersed into water where they are naturally weathered and degraded
- Shoreline cleaners
Remove and recover oil using cleaning agents that lifts the oil from the sand and/ or debris
- Solidifier and Visco-elastic agents
Solidifier alter the oil from liquid to solid/gel to make recovery easier

Visco-elastic agents decrease the viscosity of oil to enhance recovery and collection

- Nutrient enrichment/ bioremediation

Accelerate natural biodegradation processes by the addition of nutrients (fertilizers)

Use of chemicals is subject to prior approval and/ or permission of the relevant authority in the stage of development of the specific OSRP for coastal/ shoreline area. Small-scale tests can assess the feasibility and practicality of these agents, if these methods are considered to be potentially appropriate.

Biodegradation is an effective method, but relatively is a slow process compared to other options. The rate of biodegradation varies depending on the temperature and nutrient enrichment of the locations.

(6) Wildlife Protection

Wildlife protection in the areas affected by oil spill event is part of the oil spill response activities. The primary strategy for protecting wildlife is to prevent or minimize potential exposure of species and habitat to spilled oil on water through;

- controlling the release and spread of spilled oil
- relocation of wildlife from locations that are in the expected destination or pathway of spilled oil

The spilled oil control for wildlife protection shall be included in the planning for response operations such as deployment of the response resources. Wildlife deterrent techniques can be used to relocate/ move wildlife to other safe areas, which include noise (air horns, alarm sounds, etc.), scare devices (balloons, scarecrows), herding using vehicles, boats, aircraft, and human presence.

In addition, rescue and rehabilitation of oiled wildlife may be required, if the oil slicks hit the habitat on the shoreline. Capture and care for oiled wildlife can be a hazardous activity and rescue efforts will be successful only if person and wildlife are not placed at unreasonable risks. Wildlife protection plan shall be developed dedicatedly as part of each specific OSRP taking into consideration to;

- Ensure the safety of the response personnel
- Coordinate with the competent and experience institutes/ organization or experts

8.5.4. Application of Remote Sensing

(1) Aerial observation

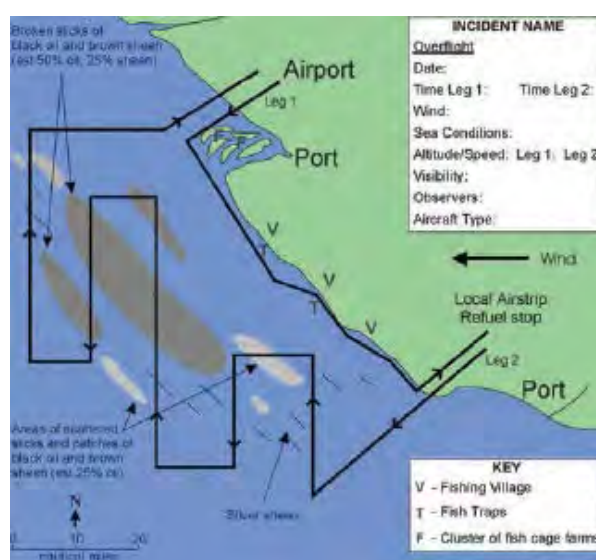
For detection of the spilled oil using remote sensing technology, the satellites and aircrafts mounted with a high-performance sensor such as SAR are utilized in general. For observation using such remote sensing device, it takes quite a long time to obtain the analysis results, so that, it is not applicable to observe in real time the spilled oil drifting on water from time to time.

On the other hand, for observation and tracking the oil at the spill site, it is generally understood that visual observation from the sky by aircraft is the best practical method.

It is required preliminarily to establish the procedure and method for observation and tracking the target oil slicks as well as common terms for observation for obtaining accurate information for the purpose.

(2) Method of observation

It is necessary to plan a systematic aerial survey for oil in a large sea area in the earliest stage. A ladder survey is the most practical and economical method (See Figure 8.5.4-1). For survey planning, due attention must be paid to visibility of the survey area and altitude, the estimated flight duration and fuel availability. Drifting oil has a tendency to be elongated and aligned in parallel to the wind direction in a shape of long and narrow “windrows” typically 30-50 meters apart. It is advisable to arrange a ladder survey across the direction of the prevailing wind to increase the chances of oil detection. The distance between the “rungs” of the ladder survey shall be determined by the visibility during the flight.



Source: ITOPF

Figure 8.5.4-1 Oil Drifts and Aerial Survey Route

(3) Result of observation

The location and features of the spilled oil on the sea surface are the survey items of aerial observation. The simplified table indicating the major survey items and the features of oil on water are applicable for the aerial survey report. Refer to Table 8.5.4-1.

Table 8.5.4-1 Major Survey Items and Features to be reported by Aerial Observation

Feature	Data	Comment		
Location and extent	Latitude and longitude (preferably by GPS) for location of slicks GPS readings for centre or edges of large slicks	It is important to retain a sense of scale so that what is observed on the water is not exaggerated when being recorded. It is worth establishing a mental picture of distance on the outward leg of a flight by observing and noting recognisable land features. When observing large areas affected by oil, the presence of any ships is useful in gauging the scale of slicks. Regular reference to GPS readings is useful to confirm estimates made visually.		
Colour	For oil slicks: Black, Brown, Orange For sheen: Silver, Iridescent (rainbow)	Colour offers an important indication of oil thickness. For oil slicks, a brown or orange colour indicates likely presence of water-in-oil emulsion. In terms of oil spill response, sheen may be disregarded as it represents a negligible quantity of oil, cannot be recovered or otherwise dealt with to any significant degree by existing response techniques, and is likely to dissipate readily and naturally. Depending on the circumstances, sheen may often be omitted from the final report prepared after the flight.		
Character	Windrow, Slick, Patch, Streak	Observers should avoid too many descriptive phrases and should apply their selected terms consistently throughout.		
Features	Leading Edge	If the thick oil characterising the leading edge of a slick can be identified, it should be denoted by a heavier line on maps and referenced in accompanying reports.		
Coverage	  25% 50% 75%	For response efforts to be focused on the most significant areas of oil pollution, it is important to have information on the relative and heaviest concentrations. To avoid distorted views it is necessary to look vertically down on the oil when assessing the distribution. It is difficult to make an accurate assessment of the % coverage and it is advisable not to try to be too precise with the estimation. The diagrams may be used as a reference guide. More experienced observers may be able to interpolate intermediate coverage.		
The adoption of common terms can also provide an indication of the amount of oil present in a given area. In combination, the estimate of % coverage together with selected terms, provides a consistent and flexible method of describing the amount of oil in an area to a degree of accuracy sufficient for response decisions to be made.				
Traces <10%	Scattered 25%	Patchy 60%	Broken 75%	Continuous >90%

Source: ITOFF

8.5.5. Application of Oil Spill Model

On the occasion of oil spill accident, prediction of the trajectory and change of properties of the spilled oil for planning of effective response operations is vital. The oil spill model is utilized to assist in obtaining the information necessary for the purpose, as a tool. The outcomes of oil trajectory modeling are provided with the information necessary for planning of oil boom deployment and estimation of the probable time duration for oil drift to the nearest shoreline. The model also estimates the weathering progress of spilled oil on water and such findings are helpful for decision of dispersant application at the site.

To predict the drift and fate of the spilled oil properly, it is required to collect the latest meteorological and oceanographic information as much as possible. The outputs of the oil spill modeling shall be updated adequately based on the latest information obtained.

(1) GNOME

GNOME developed by NOAA predicts simply the trajectory and weathering processes of the spilled oil. It shall be noted that GNOME addresses only evaporation in the weathering process of the oil because GNOME is aimed for prediction of the worst case situation of the event.

The modeling studies using GNOME in the project predicted the probable fates of the oil released on water based on the assumed event scenarios. Therefore, for application of the model on the occasion of a real incident, it is needed to predict precisely the probable trajectory and weathering of the oil based on the information of the real spill situation collected by the site observation as well as aerial survey.

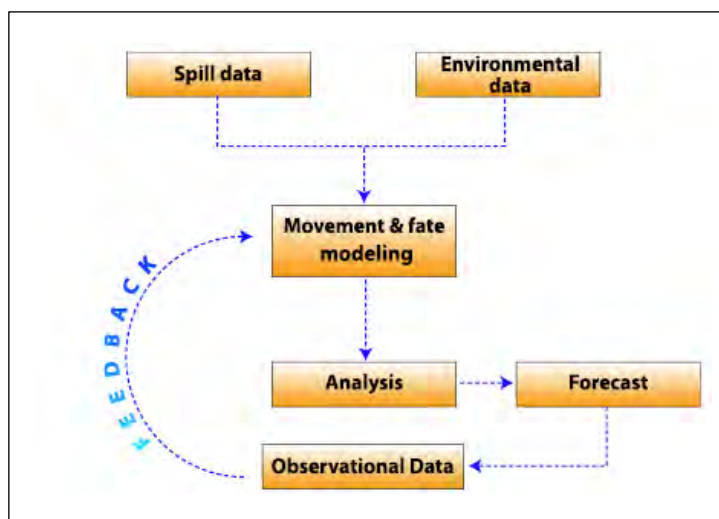
(2) ADIOS2

ADIOS2 developed by NOAA simulates the weathering processes of the spilled oil quickly and accurately. ADIOS2 estimates the changes of viscosity of oil due to weathering on water with time, which is the indicator of application of chemical dispersant for effective protective operation.

The chemical dispersant is typically applicable for low viscosity of oil (below 2,000 cSt). ADOS2 can estimate the time duration until the spilled oil viscosity exceeds the application limit from the occurrence.

For application of ADOS2 on the occasion of the incident, it is also needed to set up the modeling scenario for modeling based on the information collected by the site observation.

Typical work flow of oil spill modeling on the occasion of incident is summarized in Figure 8.5.5-1.



Source: Study team

Figure 8.5.5-1 Flow of Oil Spill Modeling on the Incident Occasion

8.6. Response Resources

Proper preparation and deployment of sufficient response resources is essential for formulation of emergency response system and implementation of effective protective strategy and methods for possible oil spill incident. The necessary response resources to be provided are described below.

8.6.1. Response Personnel

Oil spill emergency response team and response operational groups of the facility shall be comprised of the personnel in the routine operation and maintenance sections of the facility as well as the crews of related boats and contractors available in the area upon necessary. Therefore, it is essential to nominate the members in charge of operations and management, and assign their roles and responsibilities in advance for enabling rapid deployment of the resources and effective response operation.

The nominated emergency response team members of each operational group shall be registered in a directory with assignment, name, department, contact address/ telephone number. The directory shall be kept updated and/or immediately revised when any member is altered.

8.6.2. Response Equipment and Materials

Preparation of response equipment and materials for probable oil spill incident is important for proper and effective protective operations. The operation company is responsible to prepare the

necessary equipment and materials for Tier 1 oil spill, which are required for recovery and treatment of spilled oil on water, protection and cleanup of shoreline. Primary equipment and materials for such response operations are listed below.

- Oil booms
- Oil skimmers
- Temporary storage tank/ vessel for recovered oil
- Chemical dispersant spraying equipment
- Operational boats (for booming, oil recovery, dispersant spraying, monitoring, etc.)
- High pressure jet cleaner
- Vacuum pump
- Absorbents (mat, rope, mops)
- Chemical Dispersant

In addition to the above, power generators, lighting apparatus, personnel protection equipment (PPE), general tools, etc. measurement and monitoring instrument of oil and gas, facility for control of the incident and response operation, storage of the equipment and materials, vessels, vehicles and cranes for transportation are also required.

For Tier 2 oil spill, under the command of provincial PMO branch, further protective resources shall be mobilized from other facilities in adjacent region to be utilized for the operation. For Tier 3 oil spill, further more response resources shall be mobilized from other PMO branches and company as well as supports from MEMA and neighboring countries, depending on the situation of the event.

In the three pilot areas, the areas required for preparation of oil spill response equipment and materials are Khark Island and Assaluyeh. The major response equipment and materials to be prepared by the oil spill response teams of each responsible operating company in the pilot areas as well as the costs for procurement of the goods are estimated in Table 8.6.2-1 for reference.

Table 8.6.2-1 Response Equipment and Materials to be prepared

Response equipment and materials (set)	Khark Island			Assaluyeh
	Production Platforms (2 locations)	IOOC	IOTC	
Offshore protection				
- Heavy duty oil containment boom	2	1	1	
- Oil containment boom	2	2		1
- Multi-purpose oil skimmer	2	1	1	1
- Recovered oil storage tank (oil barge)	2	1	1	1
- Chemical dispersant spray system	2	1		1
Shoreline protection				
- Beach sealing boom		1	1	2
- Inflatable light boom		1	1	2
- Brush oil skimmer		2		1
Beach cleaning				
- Beach oil cleaner (brush type)		1	1	2
- High pressure cleaner		1	1	2
- Portable vacuum pump		1	1	2
- Oil storage tank		5		10
- Absorbents		1 lot	1 lot	1 lot
- Portable waste incinerator		2	1	4
- Miscellaneous materials		1 lot	1 lot	1 lot
Procurement cost (US\$1,000)	8,100	4,600	800	4,700
Total cost	18,200			

Source: Lamor Corporation Ab, Finland

Notes:

- IOTC in Khark Island has already deployed several items of response equipment. This table shows recommended additional equipment to be provided for effective response operation.
- Equipment provided by IOOC and IOTC are to be shared by both companies for response operation to oil spill in Khark sea areas.
- Response operation at offshore is to be made using existing operational services boats of each company.
- Facilities and vehicles necessary for storage, maintenance, move and transportation of response equipment are not included in this list.

8.6.3. Finances

It is stipulated that all the expenses required for recovery of environmental pollution and compensation for socio-economic damages associated with oil spill shall be responsible to the operational company or organization of the source facility of oil spill. Accordingly, assurance of

sufficient finances for such expense is one of the most important items for preparedness of possible oil spill in the operations. The finances for oil spill response shall be prepared as follows.

- Budget
 - Construction of management facility for response operation (office, storehouse, etc.)
 - Procurement of response equipment and materials
 - Organization of emergency response teams and personnel
 - Maintenance of response equipment
 - Training and exercise
 - Emergency response operations to probable small oil spill incidents
- Foundation
 - Emergency response operation including external support
 - Survey and recovery of environmental impacts
 - Compensation of environmental and socio-economic damages
- Insurance
 - Costs/ expenses spent for response operation
 - Compensation for socio-economic damage caused by oil spill
 - Damage of facility and loss of operation due to incident

Operational company and organization shall be responsible for finances required for response to Tier 1 oil spill. Meanwhile, in case of Tier 2 and Tier 3 oil spills, it is expected that the expenses to be spent for response operations, recovery of the impacts and compensation for damage caused by the event will be extremely high amount due to expanded affective areas and associated socio-economic damages. In such case, it is highly difficult for the operator of the source facility to bear the entire amount alone, so that, certain scheme involving the higher organization of the same sector (the mother company) and/ or responsible authority (Ministry of Petroleum) is essential for the purpose.

Accordingly, it is necessary to discuss the legal framework with regard to preparation of finances required for recovery and compensation for the environmental impacts and socio-economic damages due to possible large oil spill incident.

8.7. Oil Spill Response Plan (OSRP)

8.7.1. Composition of OSRP

Operation companies of oil and gas development facility are responsible for preparation of oil spill response plan dealing with possible oil spill incident associated with operational activities in the developing sea area and coastal area. Such facility OSRP shall be subject to Tier 1 oil spill at the facility and it is positioned as an important part of the National Oil Spill Contingency Plan (NOSCP) formulated by PMO.

The OSRP to be provided by the operator of each facility shall be developed properly in accordance with relevant guideline of the international organization (IPIECA) and the instructions given by PMO, which shall be comprised of the contents, but not limited to, as follows.

【Strategy】

1. Introduction
 - Objectives
 - Definitions
 - Coverage and extents
2. Risk assessment of possible oil spill
 - Source of oil spill, prediction of drift/ fate of oil
 - Environmentally sensitive areas
3. Basic response tactics
4. Emergency response organization, roles and responsibilities
5. Reporting, communications, commands
6. Response resources: personnel and equipment/ materials
7. Training and exercise

【Response Operations】

8. Initial response procedure
9. Response planning
10. Mobilization and deployment of response resources
11. Command of response operation
12. Change of response plan
13. Protective measures
 - Containment and recovery
 - Dispersant
 - Beach cleanup

- 14. Waste management
- 15. Safety provision
- 16. Termination of response operation

【Related information and data】

- 17. Marine charts, maps, facility layout
- 18. Weather and maritime data
- 19. Emergency notification directory
- 20. Lists of response equipment and materials
- 21. Data of oils
- 22. Material Safety Data Sheet (MSDS) for chemicals to be used for operation
- 23. Check lists, information and report formats
- 24. Others: procedures and manuals, other related information

8.7.2. Approval of the Authority

The OSRP developed by the facility operator, which form part of the NOSCP, shall be submitted to the provincial PMO branch for review in accordance with the specific procedure for authorization. The operator of the facility shall finalize the plan in accordance with the instruction given by PMO, if any. Then, the OSRP will be enacted upon approval of PMO.

8.7.3. Management of OSRP

The facility's OSRP is an essential emergency management plan for the HSE management system of the operating company, which shall be registered formally in the HSE management documents after approval of the top management through the specific procedure of the company.

The OSRP shall be updated immediately reflecting any change of organization/ members and alteration or addition of response equipment. In addition, the OSRP shall be reviewed regularly by the responsible section and management, and improved properly reflecting the findings of the periodical response exercise and drills as well as the lessons learnt through the response operations undertaken for the actual incident, if any.

8.8. Post Response Operations

8.8.1. Report

After completion of the response operation for the oil spill, all the response activities taken by the response team including response equipment used and procedures shall be assessed for verification of effectiveness of the operations undertaken and further improvement of the OSRP. Therefore, the emergency response team shall provide a response operation report describing the following issues.

- Oil spill source and cause of the incident
- Type of spilled oil and volume, and situation of the event
- Response activities taken by the emergency response team
- Result/ achievement of OSRP and evaluation
- Equipment/ materials and costs used for the response operations
- Extent of impacts
 - Environmental impacts of the oil spill
 - Comments and claims for environmental and socio-economic effects
 - Accuracy of oil spill modeling
- Issues to be improved

The report shall be submitted to emergency management center in headquarter of the operating company, mother company of the petroleum sector and provincial PMO branch.

8.8.2. Monitoring after Response Operations

After response operations, the facility's operation company or the affiliate of DOE of the region shall organize an environmental monitoring team comprised of members of related institute or specialist(s) in the field for monitoring of environmental conditions of the area. Purposes of the monitoring are identification of the area(s) affected by the event and evaluation of the recovery condition/ rate of the affected environmentally sensitive area such as habitats of wildlife.

Based on the outcomes of the monitoring, the monitoring team shall estimate an extent of the affected area and assess the possibility of remediation of the residual impact. And then, the team shall provide the monitoring report describing the monitoring result and plan for remediation of the residual impact to the relevant authority.

8.9. Training and Exercise

8.9.1. Capacity Building for Response Organization and Personnel

All personnel and organizations involved in the oil spill response shall be trained regularly through various exercises to ensure that their skills are enhanced and/or maintained sufficiently so that effective response and control can be provided during emergency operations.

Through OPRC convention, the International Maritime Organization (IMO), along with relevant international and regional organizations, oil and shipping industries, calls to develop a comprehensive training program in the field of oil pollution preparedness and response including the availability of expertise for the development and implementation of training programs. In this regard, it was decided to develop three model training courses as shown in Table 8.9.1-1.

Table 8.9.1-1 Summary of the IMO's OPRC Model Courses

Level	Description
Level 1	• Participants: First Responder (Operational Staff) • Objectives: First Responder on Oil Spill Response – and enable them to manage and lead a smaller group of responders • Course Duration: 3 - 5 days
Level 2	• Participants: Supervisors and On-Scene Commanders (OSC) • Objectives: Enhance capabilities of OSC to response management and planning function • Course Duration: 5 days
Level 3	• Participants: Senior Managers and Administrators • Objectives: Build management's confidence and awareness to effectively perform the role of an Incident Commander • Course Duration: 2 days

Source: Study team

8.9.2. Oil Spill Response Exercises and Drills

In addition to the above training, oil response exercises and drills at site or indoors are also effective for evaluation whether the respective emergency response groups and commander/supervisor in the OSRP functions effectively in emergency situation. The styles of exercise and drill include:

- Emergency notification and reporting drill
- Desk-top exercise
- Response equipment deployment exercise

- Emergency response control drill

The Oil Spill Response Plans have to be reviewed and tested periodically to assess their adequacy through the well-programmed exercises and drills. Planning and conducting the practical exercise program, reviewing the results and updating the OSRP shall be incorporated into the OSRP. Assessing the adequacy of a contingency plan consists as follows:

- Realistic assessment of the sources and the risks of spill
- Priorities for protection
- Strategy for protecting and cleaning
- Organization and the responsibilities
- Levels of equipment, materials and manpower
- Temporary storage sites and final disposal routes
- Alerting and initial evaluation procedures
- Effective communication between shore, sea and air
- Been tested and nothing significant found lacking
- Compatible with plans for adjacent areas and other activities

8.10. Prevention of Oil Spills

Oil Spill Response Plan (OSRP) is the secondary passive measure aiming to mitigate and recover environmental impact arising from possible oil spill from the facility/ equipment for offshore oil and gas development. On the other hand, prevention of the possible incident is the primary measure for protection of the potential environmental and social impact.

Possible oil spill risks associated with offshore oil and gas development and practical preventive measures to be made are described hereinafter.

8.10.1. Oil Spill Risks in Oil and Gas Development

Offshore oil and gas development project is implemented subsequently in phases of well drilling and construction of production facilities, and production/ operation. Probable risks of oil spill in the respective phases of the project are assumed as follows. (Refer to 5.4.1 (1) for details.)

<u>Project phase</u>	<u>Project Activity</u>	<u>Reasons of Oil Spilled events</u>
• Construction	• Well drilling	- Well blowout - Defective well equipment - Rig capsizing

	• Construction of production facilities	- Collision of construction vessels - Defective fuel storage/ supply system
• Production/ operation	• Operation of production facilities	- Defective production equipment and control devices - Defective subsea pipeline (e.g. corrosion) - Collision of support vessels - Natural disaster - In-correct facility operation
	• Operation of crude export facility	- Defective loading equipment - Collision of vessels - Natural disaster - In-correct operation

It is assumed that well blowout is one of the possible cause of largest oil spill in oil and gas development activities, which could affect not only surrounding area of the project site, but also the territorial waters of neighboring countries and the whole Persian Gulf depending on the scale of the incident including weather and sea conditions.

On the other hand, corrosion of aged subsea pipeline and equipment are considered to be the major causes of small oil spills related to oil and gas development in general.

8.10.2. Oil Spill Prevention Measures

Integrity of the facility of petroleum development and production and its operation is heavily related to the prevention of the incident accompanying oil spill. It is an outcome of proper design, construction, maintenance and operating practices. It is achieved when the facility is structurally and mechanically sound and performs the processes and produces the products for which they were designed. The sound operation of the facility is secured by dedicated implementation of appropriate management system and procedures including the management for potential risks in the operation. It is supported by the functional organization with competent and capable management and operational personnel.

(1) Facility Integrity

1) Design Standards

Based on the development and production plan, the production facility for oil and gas development is designed properly in compliance with the design standards specified by the oil sector or company and by seriously considering conditions of the site.

The design standards, based on the operation conditions, specify the required functions and strength of equipment and pipes of the facility, selection of materials to be used, control and monitoring system for equipment, corrosion protection measures and others for the facility.

Safety and durability (reliability) of the equipment could be largely affected by the selected design conditions and applicable design standards. Accordingly, for assurance of facility integrity, it is essential to define the proper design conditions and apply the correct design standards in design stage of the project.

The Ministry of Petroleum (MOP) of Iran established the Iranian Petroleum Standards (IPS) as national engineering standards of Iran in 1990's with reference to related international standards and guidelines which were practically applied to the petroleum industries in the world. The IPS is comprised of various categories such as engineering, design, construction, maintenance, inspection, safety, environment, etc. required for construction and operation of the petroleum related facilities.

The IPS is reviewed and updated frequently in accordance with the changes of requirements of worldwide petroleum sector.

For assurance of facility integrity in design stage, mother companies of the respective oil sector shall review and/ or discuss the applicable design standards for the sector in accordance with IPS and related international standards and practices for the sector.

2) Facility Safety Assessment

For safety assessment for the planned facility, a comprehensive study on hazardous identification and risk assessment for the designed facility including all the equipment, processes and control systems in each stage of design activities is required. For such study, HAZID (Hazard Identification Analysis) and HAZOP (Hazard and Operability Analysis) are practically applied in petroleum industry.

Where the potential hazard accompanying possible cause of significant oil spill are identified in the planned facility through above study in design stage, the findings shall be reflected to improve the facility plan and/or design to eliminate and/or reduce the risk to the acceptable level.

Primary risk assessment such as HAZID and HAZOP studies are conducted in the early design stage. And then, according to the progress of facility designing, detailed quantitative risk analysis (QRA) is practically conducted for the issues associated with significant hazard in the planned facility for verification of safety design and mitigation of the probable risks.

These safety assessment is an essential procedure to ensure safety and integrity of the planned

facility in planning and design stage of the project and such activities shall be conducted with participation of not only engineering/ design section (including design contractor), but also the sections of facility operation and maintenance as well as HSE of the company.

For prevention of potential hazards and mitigation of the risks for possible cause of oil spills, the mother company of respective oil sectors and affiliate operation companies shall specify an adequate standard and practicable procedure for implementation of proper risk management.

3) Facility Maintenance

Quality of the facility and equipment gradually declines due to exhaustion, corrosion and deterioration of the materials comprising the installations. The degradation is directly related to the reliability of the steady and safe operation. For example, the major cause of the small oil spill from subsea pipeline, which is one of the most serious issues in the offshore oil production, is considered to be caused by interior or external corrosion of the pipe.

Therefore, for prevention of such probable incident, proper inspection and maintenance of the facility are essential in order to ensure the quality of the existing facility and equipment involved in the operation.

Planning of facility maintenance shall consist of check and inspection of equipment, evaluation of operating condition and prediction of remnant life of the equipment, and schedule of effective repair. The planning also includes preventive maintenance aiming periodical inspection for important and critical equipment in the facility.

Effective facility maintenance plan and proper implementation of the plan are essential for prevention of unexpected incident of equipment which could cause oil spill.

(2) Management of Facility Operation

Safe and steady operation of the facility is achieved by proper implementation of the operational procedures specified in accordance with the purpose, characteristics of the facility and the condition of the site as well as the accompanying potential risks.

The concrete operation management system supported by documented operational procedures and manuals as well as safety procedure for emergency cases shall be in place at the respective facility for the purpose. The operational procedures shall be developed reflecting the outcomes of risk assessment for potential incident or major accident accompanying the facility operation. Proper implementation of such operation management is also essential for mitigation of the potential risks and prevention of probable incident which may cause oil spill.

(3) Personnel

Personnel stand above all facility/ equipment, operation and management. Human factors, such as when individuals interact with each other, with facility and equipment, with operations, and with the management system, share the large weight for assurance of operation integrity. The human factors and interaction will depend on the competences and capabilities of the personnel involved in the management and operations of the facility as well as nature of the individuals.

For enhancement of competence, capability and HSE awareness of the personnel involved in the operation, a comprehensive technical and management training and education plan shall be provided in the company and each operation unit at site. The plan shall consist of the specific sources subject to all levels of the organization.

(4) Control of Ships

Safety of tanker sailing in the regional sea area and entering and leaving the port/ terminal is supported by proper navigation control system of marine traffic control station in the region and the specific berthing and un-berthing procedure of the facility. In addition, the safe tanker operation is also secured by competency of the master and officers on board, conditions of the ship and its equipment as well as proper operation which complied with the requirements of international conventions and laws.

Port State Control (PSC) is the inspection of foreign ships in national ports to verify that the condition of the ship and its equipment comply with the requirements of the international regulations and that the ship is manned and operated in compliance with these rules. In this regard, the PMO has commenced a series of efforts to guarantee safety of navigation and protect the marine environment in the water under the jurisdiction of Iran. Under the agreement in the Indian Ocean Memorandum Agreement (IOMOU), which was signed among the countries facing the Indian Ocean, PMO undertakes to implement the PSC at all the ports and crude terminal in the territorial waters of Iran including Persian Gulf.

According to the international statistics of small oil spills (less than 7 tons) related to tanker operations, most part of such incidents occurs at time of loading operation at oil export terminals. In Iran, Iranian Oil Terminal Company (IOTC) is the responsible organization for response to oil spills at oil export terminal

Meanwhile, in case of tanker oil spill after loading of crude oil at export terminal, operating company of the tanker shall be legally responsible for such event.

However, where the incident or the large oil spill is caused by failure in operation or

incompliance of vessel design with applicable international standard, the oil company or terminal operator which loaded the crude oil to the improper vessel, together with the tanker operator, are to be pursued for social liability by the stakeholders in case of the incident.

Therefore, strict implementation of Port State Control (PSC) and compliance of the requirements by PMO and Oil Company/ terminal operator are required for prevention of such affair.

8.11. MOP's Roles

The NOSCP established by PMO defines the primary strategy of 3-tiered response and the organizations in charge of the respective tiers, wherein Tier 1 is the operator of the spill source facility, Tier 2 is the regional organization of PMO and Tier 3 is PMO with support of MEMAC. PMO has also prepared dedicatedly the emergency response scheme of Tier 2 for regional, and Tier 3 for national level and such schemes are practicable and functional. Meanwhile, preparation of Tier 1 for local level of response scheme and necessary preparedness is still in progress, which is the responsibility of the operator of the facility concerned.

According to such situation, MOP's roles for preparation of Tier 1 OSRPs which shall be established by respective operation companies of facility are proposed below.

8.11.1. Supervision of National Companies

Operations of oil and gas companies are directly supervised by the responsible national company of the oil sector. MOP is responsible for the integration and supervision of all the national companies. Accordingly, Tier 1 OSRP of operating company shall be prepared dedicatedly under the supervision and direction of the mother company. MOP' supervisory activities for subsidiary national companies should include;

- Clear commitment of policy and goal for oil spill response preparedness and direction to establish tangible specific OSRP to the facility
- Assessment of current situation of OSRP preparation
- Promotion of establishment of OSRPs
- Enhancement of oil spill prevention measures at each facility
- Technical and financial supports for oil spill prevention and response preparedness

8.11.2. Coordination with relevant Organizations

Preparation and operation of the facility/ local OSRP requires coordination with PMO, which is the

authority for offshore oil spill response, and the NOSCP working group comprising of relevant ministries and organizations.

The preparation of Tier 1 OSRPs for each pilot area is still in progress. However, it seems that the progress of preparation of the respective areas varies depending on the different specific situations of the area. In order to encourage the tasks, it is required to further discuss the following issues among the organizations concerned in the area.

- Consistent awareness of the importance of OSRP among the organizations concerned
- Potential oil spill risks on the facility and operation
- Assessment of probable environmental and social impacts caused by the potential oil spill
- Verification of primarily responsible organization for initial response to the oil spill
- Definition of emergency response scheme and strategy in the area
- Establishment of the practicable and effective OSRP with resources
- Integration of Tier 1 OSRP with NOSCP

8.11.3. Preparation of Legal Framework

National Oil Spill Contingency Plan (NOSCP) stipulates that the operating company is fully responsible for the preparation and implementation of the emergency response plan for any possible oil spill from oil and gas development facility.

Since oil spill, if occurred, may cause serious environmental pollution of adjacent sea areas and coasts and impact on local industries including fishery, the operating company is required to preliminarily ensure that finances necessary for clean-up and recovery of environmental impacts as well as compensation for the socio-economic damages are secured.

In the progress of privatization of oil industries, the earliest review and preparation of relevant laws concerning the liabilities of operators of source facility to potential oil spill and preparation of finances for response operations and compensation for probable damages are required accordingly.

8.12. Actions for strengthening Oil Spill Response Plan

The above sections of this chapter describe the procedure and methods for development and strengthening OSRP, and roles of MOP, the authority of petroleum industry in Iran, for the implementation of the master plan. In accordance with that, the actions to be taken by the respective responsible organizations are listed hereunder.

Table 8.12-1 Actions of the Master Plan for Strengthening OSRP

	Actions
Action 1	Confirmation of current situation of OSR preparedness of each Pilot Area
Action 2	Definition of policy and goal for strengthening oil spill response scheme
Action 3	Formulation of oil spill response structure in petroleum industry
	3-1 Emergency response organization
	3-2 Definition of roles and responsibilities of organizations concerned
	3-3 Coordination with PMO and other relevant organizations
Action 4	Basic planning of strengthening oil spill response scheme
Action 5	Oil spill risk analysis and environmental & social impact assessment
Action 6	Definition of oil spill response strategy
Action 7	Development/ strengthening OSRPs
	7-1 Development of facility/ site specific OSRPs
	7-2 Review and strengthening current OSRPs
Action 8	Procurement of response equipment
Action 9	Training and exercise
Action 10	Authorization of OSRP
Action 11	Prevention of oil spill incident
	11-1 Risk assessment of facility
	11-2 Review and improvement of facility maintenance plan
	11-3 Review and improvement of operation management plan
	11-4 Capacity strengthening operation and maintenance personnel
	11-5 Proper management of related vessels port state control and operations)
Action 12	Preparation of relevant laws and regulations
Action 13	Preparation of finances

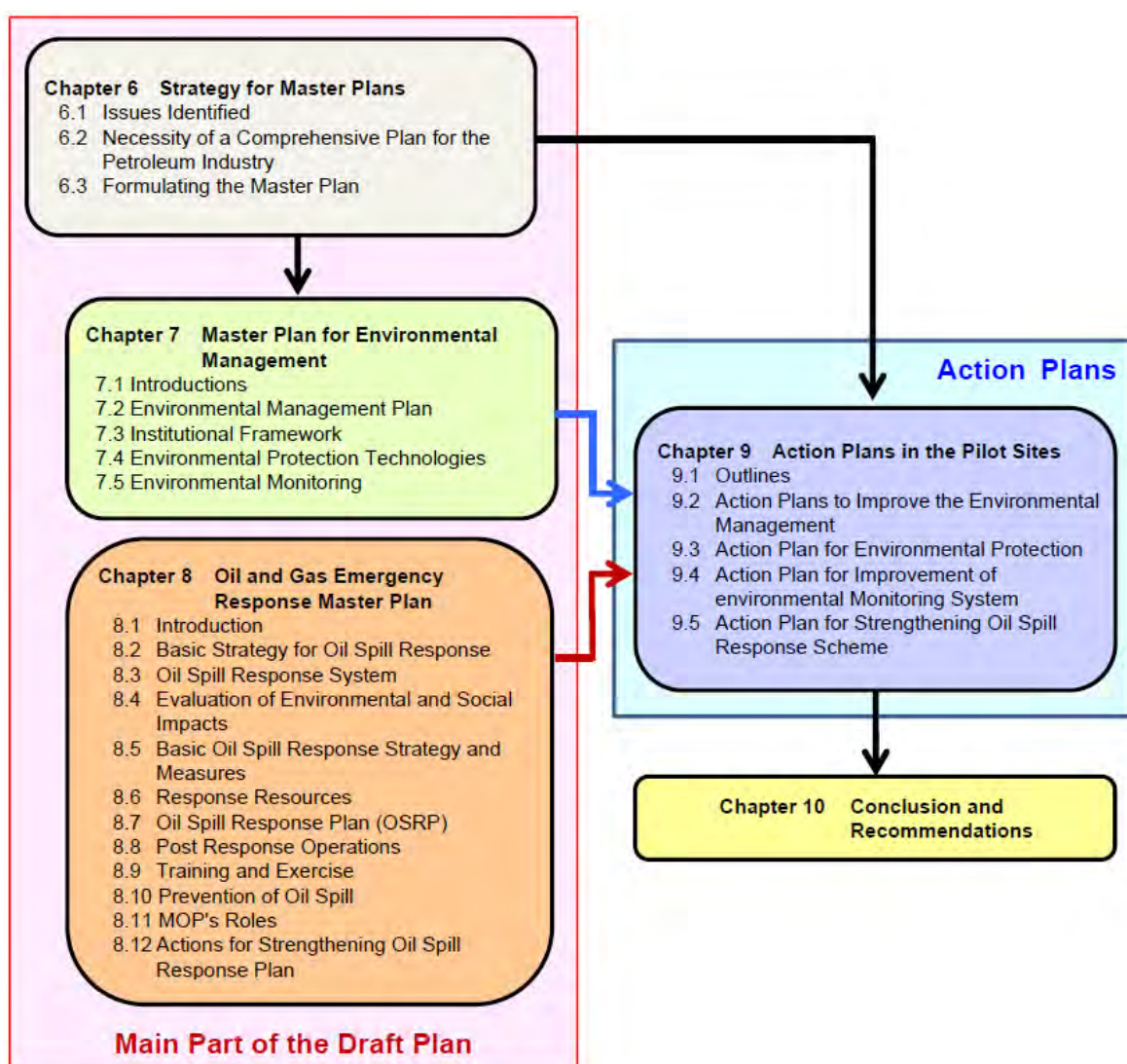
Source: Study team

9. Action Plan in Each Pilot Site

9.1. Outline

(1) Structure of Action Plan

As shown in Figure 9.1-1, the action plan for environmental management is formulated as a practicable plan to tackle with issues clarified in *Strategy of Master Plan* in Chapter 6, *Environmental Management Plan* (management system / responsive technologies and improvement plan for reducing pollution ion pilot sites) in Chapter 7, and *Emergency Oil Spill Response Plan* in Chapter 8 of this report. The plan compiles environmental management in each pilot site as described in the section 9.2 and the following parts.



Source: Study team

Figure 9.1-1 Relation between Master Plan and Action Plan

(2) Goal Management and Sharing of Responsibilities

In compiling the practicable action plan, short-, medium-, and long-term goals were set and the main responsible organizations for goal management are clarified so that their responsibilities and budgeting are identifiable.

9.2. Action Plans to Improve the Environmental Management

Actions to be taken in the Draft Master Plan are described in Subsection 7.3.1 and 7.3.3. To implement the Draft Master Plan, the MOP, national companies, zone management companies and operating companies shall take following actions. The implementation schedule of the Actions Plans are also shown in Table 9.2.

9.2.1. MOP

Strengthening capacity of the MOP, clarifying the roles of key players and developing necessary institutional framework are required to implement the Draft Master Plan. The HSE-MOP shall take following actions to initiate the realization of the Draft Master Plan.

- (1) Reorganizing the HSE management structure
- (2) Strengthening the capacity of Environmental Protection Section of the HSE-MOP
- (3) Redefining roles of key players on the HSE management
- (4) Developing the supervisory structure of the HSE-MOP
- (5) Delegating the authority of environmental management
- (6) Promoting HSE culture development
- (7) Formulating specific regulations for the environmental protection in the petroleum industry
- (8) Rationalizing the resource allocation
- (9) Improving the EIA Implementation Procedures

9.2.2. National Companies

The national companies are made responsible for control of environmental management in each sector of the petroleum industry in cooperation with the HSE-MOP, and shall take the following actions towards the realization of the Draft Master Plan.

- (1) Improving the environmental monitoring systems
- (2) Gathering necessary information and updating the IPS, based on the delegation of the of environmental management authority
- (3) Rationalizing the HSE implementation structure
- (4) Promoting the HSE culture development and evaluating the situation of subsidiaries
- (5) Promoting good practices sharing and implementing the small group work to coordinate and collaborate across the company
- (6) Identifying the legal framework to be followed by the petroleum industry
- (7) Introducing a measure to control the total emission in one industrial zone
- (8) Rationalizing the resource allocation
- (9) Planning the staff deployment and setting the target year, and developing education and training programs

9.2.3. Zone Management Companies

The zone management companies are made responsible for control of environmental management in the entire petroleum industry zones, and shall take the following actions towards the realization of the Draft Master Plan.

- (1) Operating the integrated environmental monitoring systems
- (2) Evaluating the environmental performance of companies operating in the zone
- (3) Rationalizing the HSE implementation structure
- (4) Promoting good practices sharing and implementing the small group work to coordinate and collaborate across the company
- (5) Preparing a flow chart of the environmental emissions and the environmental hazard map in the zones
- (6) Executing the total emission control systems as trial basis
- (7) Planning the staff deployment and setting the target year, and developing education and training programs

9.2.4. Operating Companies

The operating companies are made responsible for reduction of environmental pollution, and shall take the following actions towards the realization of the Draft Master Plan.

- (1) Participating in the integrated environmental monitoring systems
- (2) Rationalizing the HSE implementation structure
- (3) Promoting good practices sharing and implementing the small group work to coordinate

and collaborate across the company

- (4) Providing the information about process and sources generating the environmental pollutants to develop an environmental hazard map
- (5) Accumulating the environmental monitoring records to investigate the target values of the total emission control systems in a model area towards introduction of the total emission control in one industrial zone
- (6) Rationalizing the resource allocation
- (7) Planning the staff deployment and setting the target year, and developing education and training programs

9.3. Action Plan for Environmental Protection

9.3.1. MOP

MOP, the responsible authority for the achievement of the master plan for environmental protection in the pilot areas, shall promote the implementation of the master plan by respective concerned operation companies through supervision and various supports for the affiliate national corporations and zone management companies of each pilot area. For achieving the objectives successfully, MOP shall organize a sub-committee comprising of relevant national corporations, zone management companies and concerned operation companies as well as related organizations such as DOE and local government of each pilot area.

For implementation of the master plan, the activities to be undertaken by MOP are listed below.

- (1) Confirmation of current situation of environmental situations of each pilot area
- (2) Clear statement of policy and goal for environmental protection
- (3) Formulation of environmental protection structure in each pilot area
 - Environmental protection organization
 - Definition of roles and responsibilities of organizations concerned
 - Coordination with DOE and other relevant organizations
- (4) Authorization of the master plan and action plans
- (5) Promotion of environmental protection measures
- (6) Technical supports
- (7) Preparation of relevant laws and regulations
- (8) Preparation of finances

9.3.2. Mahshahr

(1) Air Pollution Prevention

Section 7.4.2 (6) described the actions to be taken in the master plan for air pollution prevention in Mahshahr area. For implementation of the master plan, the activities to be undertaken by MOP, relevant national companies, zone management company and operation companies are listed below and the action plan is shown in Table 9.3-1.

- 1) Understanding the situation of air quality/ pollution in the area
- 2) Identification of emission sources of the pollutants and inventories
- 3) Confirmation of the cause(s) of degraded air quality
- 4) Discussion of air quality protection policy (emission standards, total emission control, etc.)
- 5) Definition of targeted air quality for mitigation of environmental impact
- 6) Study of effective air pollution prevention methods
 - Reduction of emission gases and pollutants
 - Reduction of flare gases
 - Improvement of combustion efficiency of flare burners (smoke-less)
- 7) Planning of air pollution prevention
 - Improvement and/or installation of air pollution prevention equipment
- 8) Preparation of finances for the project
- 9) Project implementation (design, procurement and construction)

(2) Water Quality Conservation

Subsection (5) in 7.4.3 lists action items of Draft Master Plan for water quality conservation. In executing the plans, action items of a zone management company and operating companies in Mahshahr area for executing the plan are shown as follows. Their action plans are also listed in Table 9.3-2.

<Wastewater Management>

PSEZ and operating companies manage wastewater in Mahshahr area. On the other hand, NPC is responsible for supervising and supporting them in line with the MOP's policies and goals for wastewater management as well as reporting matters related to wastewater management in Mahshahr area to the MOP. The following items are the activities for wastewater management taken by a zone management company (PSEZ) and operating companies:

- 1) Compilation of the issues on wastewater management
- 2) Inventory survey of drainage systems

- 3) Examination of solutions to current and potential future issues in wastewater management
- 4) Discussion about wastewater management policy
- 5) Preparation of a wastewater management plan
- 6) Allocation of the budget
- 7) Upgrade of the wastewater treatment facilities

9.3.3. Khark Island

(1) Air Pollution Prevention

Section 7.4.2 (6) described the actions to be taken in the master plan for air pollution prevention in Khark Island. Since surplus associated gas of crude oil production is burnt out by flare stacks, recovery and effective reuse of the associated gas is a major challenge in this area.

For implementation of the master plan, the activities to be undertaken by MOP, relevant national companies, operation companies are listed below and the action plan is shown in Table 9.3-1.

- 1) Understanding the situation of air quality/ pollution in the area
- 2) Identification of emission sources of the pollutants and inventories
- 3) Confirmation of the cause(s) of degraded air quality
- 4) Discussion of air quality protection policy (emission standards, total emission control, etc.)
- 5) Definition of targeted air quality for mitigation of environmental impact
- 6) Study of effective air pollution prevention methods
 - Reduction of emission gases and pollutants
 - Improvement of combustion efficiency of flare burners (smoke-less)
 - Recovery of flare gases and efficient reuse
- 7) Planning of air pollution prevention (conceptual design, basic design)
 - Improvement and/or installation of air pollution prevention equipment
- 8) Preparation of finances for the project
- 9) Project implementation (design, procurement and construction)

(2) Water Quality Conservation

Subsection 7.4.3 (5) lists action items of Draft Master Plan for water quality conservation. In executing the plans, action items of the national companies and operating companies in Khark Island area for executing the plan are shown as follows. Their action plans are also listed in Table 9.3-2.

< Wastewater Management >

Operating companies manage wastewater in Khark Island area. On the other hand, NIOC and NPC are responsible for supervising and supporting them in line with the MOP's policies and goals for wastewater management as well as reporting matters related to wastewater management in Khark Island area to the MOP. The following items are the activities for wastewater management taken by operating companies:

- 1) Compilation of the issues on wastewater management
- 2) Inventory survey of drainage systems
- 3) Examination of solutions to current and potential future issues in wastewater management
- 4) Discussion about wastewater management policy for designed joint wastewater treatment with IOTC and IOOC
- 5) Preparation of a wastewater management plan
- 6) Allocation of the budget
- 7) Upgrade of the wastewater treatment facilities

< Underground Injection >

In executing the underground injection in Khark Island area, NIOC are responsible for supervising and supporting IOOC in line with the MOP's policies and goals for underground injection as well as reporting matters related to an underground injection project in Khark Island area to the MOP. The following items are the activities for the underground injection taken by NIOC and IOOC:

- 1) Compilation of the information about underground injection
- 2) Investigation of the injection sites (Survey of groundwater aquifer, and evaluating oil reservoirs)
- 3) Formulation of an underground injection plan
- 4) Allocation of the budget
- 5) Conceptual study, design of injection water treatment and injection facilities
- 6) Construction of injection water treatment and injection facilities
- 7) Implementation of the underground injection of produced water

(3) Oily Soil Cleanup and Remediation

Subsection 7.4.4. describes technologies for oily soil cleanup and remediation of the catchment basin sites and surrounding areas contaminated by oil in Khark Island. This section proposes activities for implementation of the master plan for remediation of the contaminated areas as follows.

- 1) Investigation of conditions of the oily contaminated areas
- 2) Discussion of uses of the areas after remediation
- 3) Decision of scope of work and project specifications

- 4) Selection of applicable technologies
- 5) Project planning
- 6) Feasibility study
- 7) Preparation of project finances
- 8) Project implementation
- 9) Evaluation of residual environmental effects

Meanwhile, the project is to be commenced after completion of improvement projects for the existing wastewater treatment systems of IOOC and IOTC.

The proposed practical action plan for this subject is shown in Table 9.3-3.

(4) Wastes management

Subsection 7.4.5 (4), from view point of environmental protection, discusses management practices for drill cuttings discharged from offshore oil exploration drilling operation which is particular to Khark area. Activities to be implemented in the master plan for improvement of the drilling wastes management are proposed below.

- 1) Inventory of wastes from each plant (types and volumes)
- 2) Assessment of components and values of the wastes (for recycle/reuse)
- 3) Assessment of physical and chemical properties
 - Shape and chemical compositions, hazard/ toxicity
- 4) Decision of ultimate treatment methods (recycle/reuse/disposal including drill cutting injection)
- 5) Assessment of HSE risks associated with treatment/ disposal
- 6) Discussion of treatment specification (e.g. target residual oil content)
- 7) Discussion of treatment conditions
 - Time limits, location/area, budget, extraction of valuables, etc.
- 8) Discussion of treatment method(s)
- 9) Technical and financial feasibility study
- 10) Decision of treatment method based on company's policy
- 11) Preparation of finance (budget)
- 12) Procurement/ installation of treatment equipment/ facility
- 13) Implementation and monitoring
- 14) Evaluation of performance

The proposed practical action plan for this subject is shown in Table 9.3-4.

9.3.4. Assaluyeh

(1) Air Pollution Prevention

Subsection 7.4.2 (6) described the actions to be taken in the master plan for air pollution prevention in Assaluyeh. Severe air pollution caused by massively emitted gases from large scale of gas refinery and petrochemical complexes is serious problem in this area. For implementation of the master plan for remediation of such environmental condition, the activities to be undertaken by MOP, relevant national companies, zone management companies and operation companies in this area are listed below and the action plan is shown in Table 9.3-1.

- 1) Understanding the situation of air quality/ pollution in the area
- 2) Identification of emission sources of the pollutants and inventories
- 3) Confirmation of the cause(s) of degraded air quality
- 4) Discussion of air quality protection policy (emission standards, total emission control, etc.)
- 5) Definition of targeted air quality for mitigation of environmental impact
- 6) Study of effective air pollution prevention methods
 - Reduction of emission gases and pollutants
 - Reduction of flare gases
 - Recovery of flare gases and efficient reuse
 - Improvement of efficiency of combustion equipment
 - Prevention of gas leaks from plant equipment
 - Treatment/ elimination of pollutants in gas exhausted
 - Installation of dust precipitators and NO_x removal units
 - Improvement of gas dispersion in the atmosphere
 - Review and optimization of flare stack systems
- 7) Planning of air pollution prevention (conceptual design, basic design)
 - Improvement of facility operation
 - Improvement and/or installation of air pollution prevention equipment
- 8) Preparation of finances for the project
- 9) Project implementation (design, procurement and construction)

(2) Water Quality Conservation

Subsection 7.4.3 (5) lists action items of Draft Master Plan for water quality conservation. In executing the plans, action items of zone management companies and operating companies in Assaluyeh area for executing the plan are shown as follows. Their action plans are also listed in Table 9.3-2.

< Wastewater Management >

PSEEZ, PNOSC and operating companies manage wastewater in Assaluyeh area. On the other hand, NIOC and NPC are responsible for supervising and supporting them in line with the MOP's policies and goals for wastewater management as well as reporting matters related to wastewater management in Assaluyeh area to the MOP. The following items are the activities for wastewater management taken by zone management companies (PSEEZ, PNOSC), and operating companies:

- 1) Compilation of the issues on wastewater management
- 2) Inventory survey of drainage systems
- 3) Examination of solutions to current and potential future issues in wastewater management
- 4) Discussion about wastewater management policy
- 5) Preparation of a wastewater management plan
- 6) Allocation of the budget
- 7) Upgrade of the wastewater treatment facilities

9.4. Action Plan for Improvement of the Environmental Monitoring System

Master plan regarding environmental monitoring and its action plans in each pilot area, Mahshahr, Khark Island and Assaluyeh, are introduced in Section 7.5. Activity items in each pilot area for executing the master plan are discussed below and its action plans are shown in Table 9.4.

9.4.1. Mahshahr

PSEZ is managing the PETZONE in Mahshahr area. And a shipping facility for oil products (Mahshahr terminal) is located about 8km east of the PETZONE owned by Abadan Oil Refinery (under control of the NIORDC). Therefore, the monitoring plan in this area is supposed to be carried out in collaboration with two (2) areas, the PETZONE and the Mahshahr terminal. The demarcation of the responsibility of each sector, such as the MOP, the national company in Mahshahr area, the zone manager and the operating companies, for implementation of the monitoring system is shown in Table 7.5.4-2.

(1) Establishment of Monitoring Structure

Monitoring structure shall be established within 2-3 years, as proposed in Subsection 7.5.3. And the monitoring result will be periodically evaluated by the evaluation committee to update the environmental improvement plan.

(2) Data Online with DOE

Based on the requirement of the 5-Year Plan, monitoring data from each company is supposed to be

on-lined with DOE. Although the details about the monitoring parameters are not clear at the moment, this data shall also be shared with the zone manager for effective environmental management and prompt action on emergency situation such as abnormal data found. Therefore, the budget for the integration of the system between DOE shall be secured.

(3) Automation and Integration of Periodical Air Monitoring

Online air monitoring by each company seems to be prioritized according to interview with MOP based on the requirement of the 5-Year Plan. Therefore, online air monitoring by PSEZ (the zone manager) targeting the environment of the zone shall be established on the midterm basis.

(4) Automation and Integration of Wastewater Monitoring

Following the automation and integration of the online air monitoring, wastewater monitoring by the zone manager at major locations shall be on-lined in the long-term basis to share information between related organizations.

(5) Study on Proper Distribution of the Monitoring Locations

Proper distribution of the monitoring locations shall be studied periodically based on the improvement of the environment for more effective environmental management.

9.4.2. Khark Island

In the Khark Island area, forming a zone manager, which manages the Khark Island area consisted of IOOC, IOTC and privatized KPC, under the supervision of NIOC is proposed on the premise of retention of the current structure. The demarcation of the responsibility of each sector, such as the MOP, the national companies in Khark Island area, the zone manager and the operating companies, for implementation of the monitoring system is shown in Table 7.5.4-6.

(1) Establishment of Monitoring Structure

Monitoring structure shall be established within 3-4 years, as proposed in Subsection 7.5.3. And the monitoring result will be periodically evaluated by the evaluation committee to update the environmental improvement plan.

(2) Integration of the Current Online Systems for Air Monitoring

The current online systems, which are working independently, shall be consolidated in short-term basis for integrated management. Since underground injection of accompanied water on oil production is planned, online monitoring of flare line is also recommended.

(3) Data Online with DOE

Based on the requirement of the 5-Year Plan, monitoring data from each company is supposed to be on-lined with DOE. Although the details about the monitoring parameters are not clear at the moment, this data shall also be shared with the zone manager for effective environmental management and prompt action on emergency situation such as abnormal data found. Therefore, the budget for the integration of the system between DOE shall be secured.

(4) Automation and Integration of Wastewater Monitoring

Wastewater monitoring shall be automated and integrated together with cleanup of the retention pond and improvement of wastewater treatment facilities in midterm basis.

(5) Data Sharing Between the Offshore Platforms and the Zone Manager

Following the integration of the wastewater monitoring, information from platforms shall be integrated and shared by online system in the long-term basis.

(6) Study on Proper Distribution of the Monitoring Locations

Proper distribution of the monitoring locations shall be studied periodically based on the improvement of the environment for more effective environmental management.

9.4.3. Assaluyeh

In the monitoring plan in Assaluyeh area, a structure, in which whole area is controlled by the PSEEZ and the PNOSC and the SPGC control each operational zone, is proposed on the premise of maintenance of the current monitoring structure as much as possible. The demarcation of the responsibility of each sector, such as the MOP, the national companies in Assaluyeh area, the zone manager and the operating companies, for implementation of the monitoring system is shown in Table 7.5.4-10.

(1) Establishment of Monitoring Structure

Monitoring structure shall be established within 2-3 years, as proposed in Section 7.5.3. And the monitoring result will be periodically evaluated by the evaluation committee to update the environmental improvement plan.

(2) Data Online with DOE

Based on the requirement of the 5-Year Plan, monitoring data from each company is supposed to be on-lined with DOE. Although the details about the monitoring parameters are not clear at the

moment, this data shall also be shared with the zone manager for effective environmental management and prompt action on emergency situation such as abnormal data found. Therefore, the budget for the integration of the system between DOE shall be secured.

(3) Automation and Integration of Periodical Air Monitoring

Online air monitoring by each company seems to be prioritized according to interview with DOE based on the requirement of the 5-Year Plan. Therefore, on-line air monitoring by PSEEZ (the zone manager) targeting the environment of the zone shall be established in the short-term basis, because the situation of air pollution is serious in Assaluyeh.

(4) Automation and Integration of Wastewater Monitoring

Following the automation and integration of the online air monitoring, wastewater monitoring by the zone manager at major locations shall be on-lined to share information between related organizations in midterm basis.

(5) Introduction of the Total Emission Control System

Since the increase of environmental impact is concerned in Assaluyeh area due to expansion of the industrial area, the introduction of the total emission control system shall be considered in long-term basis.

(6) Study on Proper Distribution of the Monitoring Locations

Proper distribution of the monitoring locations shall be studied periodically based on the improvement of the environment for more effective environmental management.

9.5. Action Plan for Strengthening Oil Spill Response Scheme

The master plan for strengthening of oil spill response scheme of petroleum industry in Iran is proposed in Chapter 8. Then, the activities which shall be implemented by Ministry of Petroleum (MOP), the relevant national corporations and concerned operation companies in the pilot areas for achievement of the objectives are described below. The practical action plan for implementation of the master plan is proposed in Table 9.5 for discussion.

9.5.1. Ministry of Petroleum (MOP)

MOP, the responsible authority for the achievement of the master plan for strengthening oil spill response scheme of petroleum industry, shall promote the implementation of the plan by respective concerned operation companies through supervision and various supports for the affiliate national

corporations. For achieving the objectives successfully, MOP shall organize a sub-committee comprising of relevant national corporations, concerned operation companies and key related organizations such as PMO and DOE for management of the plan.

- (1) Confirmation of current situation of OSR preparedness of each Pilot Area
- (2) Definition of policy and goal for strengthening oil spill response scheme
- (3) Formulation of oil spill response structure in petroleum industry
 - Emergency response organization
 - Definition of roles and responsibilities of organizations concerned
 - Coordination with PMO and other relevant organizations
- (4) Basic planning of strengthening oil spill response scheme
- (5) Promotion of oil spill preventive measures
- (6) Technical supports
- (7) Preparation of relevant laws and regulations
- (8) Preparation of finances

9.5.2. Mahshahr

A functional oil spill response scheme among oil operation companies and regional PMO is already in place in Mahshahr area, and the PMO regional branch has been entrusted by the companies concerned to take the necessary response operation on the occasion of oil spills. Therefore, TTPC, the operating company of product loading facility (port operation) in PETZONE, shall undertake an initial notification and report of the incident happening and situation of the event to PMO. The tasks of TTPC for the master plan are described below.

- (1) Review and improvement of current OSR response procedure
- (2) Training and exercise
- (3) Prevention of oil spill incident

9.5.3. Khark Island

IOOC and IOTC, operating companies of the facilities in Khark region are responsible for preparedness of possible oil spill incident at their facilities. IOOC has already developed a basic OSRP covering the whole operational areas in the Persian Gulf but the preparation of specific Tier 1 OSRPs to each oil production platform and other production facility are still outstanding. Meanwhile, IOTC has drafted a functional Tier 1 OSRP for crude export terminal and deployed the response equipment necessary for response operation.

Collaboration/ integration of the OSRPs of IOOC and IOTC shall be discussed for effective preparedness in case of emergency situation in the area.

Tasks of the respective companies for the master plan are shown below.

(1) IOOC

- 1) Oil spill risk analysis and environmental & social impact assessment
- 2) Definition of oil spill response strategy
- 3) Development of facility/ site specific OSRPs
 - Offshore oil production platforms (Aboozar, Foroozan)
 - Khark Island (Dorood 1 & 2)
- 4) Procurement of response equipment
- 5) Training and exercise
- 6) Prevention of oil spill incident
- 7) Preparation of finances
- 8) Authorization of OSRPs

(2) IOTC

- 1) Coordination/ integration with IOOC
- 2) Procurement of response equipment (additional)
- 3) Training and exercise
- 4) Prevention of oil spill incident
- 5) Preparation of finances

9.5.4. Assaluyeh

TTPC, operating company of loading facility for various petrochemical products of PSEEZ, is responsible for emergency response to accidental oil spill from the loading facility and related vessels in the sea area. TTPC has provided Tier 1 OSRP for their facility. On the other hand, SPGC, operator of SPM condensate loading system, has not prepared OSRP for their facility so far. For establishment of functional OSRP in Assaluyeh area, integration of OSRPs of both companies is practical and preferable for effective response operation.

The tasks of TTPC of the master plan are described below.

- (1) Oil spill risk analysis and environmental & social impact assessment
- (2) Discussion of integrated OSRP in Assaluyeh
- (3) Review and improvement of current OSRP
- (4) Procurement of response equipment (additional)

- (5) Training and exercise
- (6) Prevention of oil spill incident
- (7) Preparation of finances

It is noted that prevention of oil spill is the most prioritized subject similar to effective response operation, which consists of several issues in various categories of the petroleum development and operations in each pilot area. The purpose of this subject is achieved effectively through periodical campaigns of facility and operations integrity review and improvement at each site conducted by competent persons in charge of respective disciplines under strong leadership of top management of the organization concerned.

Table 9.2 Action Plans for Improvement of the Environmental Management

Strategies and Actions	Description in M/P	Responsible Body	Short-Term		Mid-Term		Long-Term		
			1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year
			1393	1394	1395	1396	1397	1398	1399
			2014	2015	2016	2017	2018	2019	2020
[Environmental Management]									
1. Reorganizing the HSE management structure									
1-1 Improving the organizational structure of the MOP	7.3.1	HSE-MOP							
1-2 Strengthening the capacity of Environmental Protection Section of the HSE-MOP	7.3.1	HSE-MOP							
1-3 Redefining roles of key players on the HSE management	7.3.1	HSE-MOP							
1-4 Developing the supervisory structure of the HSE-MOP	7.3.1								
1) Providing the existing committee with a supervisory function	7.3.1	HSE-MOP							
2) Improving the environmental monitoring systems	7.3.1 7.3.5								
- Institutionalizing the integrated environmental monitoring systems		HSE-MOP	<- see the section on the environmental monitoring						
- Adopting and disseminating the integrated environmental monitoring systems		National Companies	<- see the section on the environmental monitoring						
- Operating the integrated environmental monitoring systems		Zone Companies	<- see the section on the environmental monitoring						
- Participating in the integrated environmental monitoring systems		Operating Companies	<- see the section on the environmental monitoring						
1-5 Delegating the authority of environmental management									
1) Updating the Iranian Petroleum Standards (IPS)	7.3.1								
- Delegating the authority to update the IPS to the national companies		HSE-MOP							
- Gathering necessary information and updating the IPS		National Companies							
2) Evaluating the environmental performance of the operating companies	7.3.1								
- Delegating the authority to evaluate the environmental performance to the zone management companies		HSE-MOP							
- Evaluating the environmental performance of companies operating in the zone		Zone Companies							
1-6 Rationalizing the HSE implementation structure	7.3.1								
- Reviewing the responsibility of departments and taking initiative towards rationalization of the HSE implementation structure		National Companies							
- Reviewing the responsibility of departments and taking initiative towards rationalization of the HSE implementation structure		Zone Companies							
- Reviewing the responsibility of departments and taking initiative towards rationalization of the HSE implementation structure		Operating Companies							
2. Promoting HSE culture development									
2-1 Pointing a direction of the HSE culture development	7.3.1	HSE-MOP							
2-2 Encouraging the petroleum companies to evaluate the HSE culture development	7.3.1	HSE-MOP			<- Promoting the evaluation continuously				
		National Companies							
2-3 Promoting Coordination and Collaboration across the Company									
1) Defining the Integrated HSE Management Systems	7.3.1	HSE-MOP							
2) Encouraging the petroleum companies to share the good practices of the integrated HSE management systems	7.3.1								
- Gathering information of good practices		HSE-MOP	-> Continuing						
- Gathering information of good practices and sharing the information with the subsidiary companies operating in the zone		National Companies	-> Continuing						
- Gathering information of good practices and sharing the information with the companies operating in the zone		Zone Companies	-> Continuing						
- Gathering information of good practices and sharing the information across the company		Operating Companies	-> Continuing						
3) Promoting a small group work	7.3.1	HSE-MOP	<- Starting from HSE and gradually expanding to other departments						
		National Companies	<- Starting from HSE and gradually expanding to other departments						
		Zone Companies	<- Starting from HSE and gradually expanding to other departments						
		Operating Companies	<- Starting from HSE and gradually expanding to other departments						
3. Formulating specific regulations for the environmental protection									
3-1 Identifying the legal framework to be followed by the petroleum industry	7.3.1	HSE-MOP							
		National Companies							
3-2 Institutionalizing the "one zone one management principle"	7.3.1	HSE-MOP							
3-3 Introducing a Measure to Control the Total Emission in One Industrial Zone	7.3.1								
- Preparing a flow chart of the environmental emissions and the environmental hazard map in the zones		Zone Companies							
- Providing the information about process and sources generating the environmental pollutants		Operating Companies							
3-4 Introducing a measure to control the total emission in one industrial zone	7.3.1 7.3.3								
- Institutionalizing the total emission control systems		HSE-MOP							
- Preparing the trial of the total emission control systems in a model area (investigation of target values)		National Companies							
- Executing the total emission control systems as trial basis		Zone Companies							
- Accumulating the environmental monitoring records to investigate the target values of the total emission control systems in a model area		Operating Companies							
4. Rationalizing the resource allocation									
4-1 Identifying the operational level of plants from the environmental protection perspective	7.3.1	HSE-MOP							
4-2 Introducing advanced technology to reduce the environmental loads	7.3.1 7.4	HSE-MOP	<- See the section on environmental protection technology						
		National Companies	<- See the section on environmental protection technology						
		Operating Companies	<- See the section on environmental protection technology						
4-3 Evaluating the effect of resource allocation to the environmental protection	7.3.1								
5. Improving the EIA Implementation Procedures									
5-1 Developing specific EIA guidelines and check list for the petroleum industry	7.3.1 7.3.2	HSE-MOP	<- See the section on EIA						
		National Companies	<- See the section on EIA						
5-2 Developing specific SEA procedures for the petroleum industry	7.3.1 7.3.2	HSE-MOP	<- See the section on EIA						
		National Companies	<- See the section on EIA						
5-3 Developing specific CSR procedures for the petroleum industry	7.3.1 7.3.2	HSE-MOP	<- See the section on EIA						
		National Companies	<- See the section on EIA						
6. Promoting Capacity Development at All Levels									
6-1 Planning the staff deployment and setting the target years	7.3.1	HSE-MOP							
		National Companies							
		Zone Companies							
		Operating Companies							
6-2 Planning education and training programs	7.3.1	HSE-MOP							
		National Companies							
		Zone Companies							
		Operating Companies							

Table 9.3-1 Action Plans for Air Pollution Prevention

Strategies and Actions	Description in M/P	Responsible Body	Short-Term				Mid-Term		Long-Term							
			1st Year		2nd Year		3rd Year		4th Year		5th Year		6th Year		7th Year	
			1393		1394		1395		1396		1397		1398		1399	
			2014		2015		2016		2017		2018		2019		2020	
Air Pollution Prevention																
1. Mahshahr	7.4.2 (2)	NPC/PSEZ/Company														
(1) Understanding the situation of air quality/ pollution in the area		HSE/Eng/Ope														
(2) Identification of emission sources of the pollutants and inventories		HSE/Eng/Ope														
(3) Confirmation of the cause(s) of degraded air quality		HSE/Eng/Ope														
(4) Discussion of air quality protection policy (emission standards, total emission control, etc.)		HSE/Eng/Ope														
(5) Definition of targeted air quality for mitigation of environmental impact		HSE/Eng/Ope														
(6) Study of effective air pollution protection methods		HSE/Eng														
• Reduction of emission gases and pollutants																
- Reduction of flare gases																
- Improvement of combustion efficiency of flare burners (smoke-less)																
(7) Planning of air pollution protection		HSE/Eng														
• Improvement and/or installation of air pollution protection equipment																
(8) Preparation of finances for the project		HSE/Eng														
(9) Project implementation (design, procurement and construction)		HSE/Eng														
2. Khark Island	7.4.2 (2)	NIOC/IOOC														
(1) Understanding the situation of air quality/ pollution in the area		HSE/Eng/Ope														
(2) Identification of emission sources of the pollutants and inventories		HSE/Eng/Ope														
(3) Confirmation of the cause(s) of degraded air quality		HSE/Eng/Ope														
(4) Discussion of air quality protection policy (emission standards, total emission control, etc.)		HSE/Eng/Ope														
(5) Definition of targeted air quality for mitigation of environmental impact		HSE/Eng/Ope														
(6) Study of effective air pollution protection methods		HSE/Eng														
• Reduction of emission gases and pollutants																
- Improvement of combustion efficiency of flare burners (smoke-less)																
- Recovery of flare gases and efficient reuse																
(7) Planning of air pollution protection (conceptual design, basic design)		HSE/Eng														
• Improvement and/or installation of air pollution protection equipment																
(8) Preparation of finances for the project		HSE/Eng														
(9) Project implementation (design, procurement and construction)		HSE/Eng														
3. Assaluyeh	7.4.2 (2)	NPC/NIGC/PSEEZ /Company														
(1) Understanding the situation of air quality/ pollution in the area		HSE/Eng/Ope														
(2) Identification of emission sources of the pollutants and inventories		HSE/Eng/Ope														
(3) Confirmation of the cause(s) of degraded air quality		HSE/Eng/Ope														
(4) Discussion of air quality protection policy (emission standards, total emission control, etc.)		HSE/Eng/Ope														
(5) Definition of targeted air quality for mitigation of environmental impact		HSE/Eng/Ope														
(6) Study of effective air pollution protection methods		HSE/Eng														
• Reduction of emission gases and pollutants																
- Reduction of flare gases																
- Recovery of flare gases and efficient reuse																
- Improvement of efficiency of combustion equipment																
- Prevention of gas leaks from plant equipment B51																
• Treatment/ elimination of pollutants in gas exhausted																
- Installation of dust precipitators and NOx removal units																
• Improvement of gas dispersion in the atmosphere																
- Review and optimization of flare stack systems																
(7) Planning of air pollution protection (conceptual design, basic design)		HSE/Eng														
• Improvement of facility operation																
(8) Preparation of finances for the project		HSE/Eng														
(9) Project implementation (design, procurement and construction)		HSE/Eng														

Table 9.3-2 Action Plans for Water Quality Conservation

Strategies and Actions	Description in M/P	Responsible Body	Short-Term				Mid-Term		Long-Term				
			1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year				
			1393	1394	1395	1396	1397	1398	1399				
			2014	2015	2016	2017	2018	2019	2020				
Wastewater Management													
1. Mahshahr													
(1) Compilation of the issues on wastewater management		PSEZ (HSE), Operating companies (HSE, Ope*)											
(2) Inventory survey of drainage systems	7.4.3	Operating companies (HSE, Ope)											
(3) Examination of solutions to current and potential future issues in wastewater management	7.4.3	Operating companies (HSE, Ope)											
(4) Discussion about wastewater management policy		PSEZ (HSE), Operating companies (HSE)											
(5) Preparation of a wastewater management plan	7.4.3	PSEZ (HSE), Operating companies (HSE, Ope)											
(6) Allocation of the budget		Operating companies											
(7) Upgrade of the wastewater treatment facilities (New construction, Modification, Installation of optimum technologies)		Operating companies			S - Installation of pretreatment equipment (Fajr PC), etc. M - Installation of MBR system (Tondgouyan PC), etc. Large-scale - Switch from mercury method to ion-exchange membrane method (BPC) - Constraction of new wastewater treatment facility (BIPC, Razi PC), etc.								
2 Khark Island													
(1) Compilation of the issues on wastewater management		Operating companies (HSE, Ope)											
(2) Inventory survey of drainage systems	7.4.3	Operating companies (HSE, Ope)											
(3) Examination of solutions to current and potential future issues in wastewater management	7.4.3	Operating companies (HSE, Ope)											
(4) Discussion about wastewater management policy for designed joint wastewater treatment with IOTC and IOOC		IOTC (HSE), IOOC (HSE)											
(5) Preparation of a wastewater management plan	7.4.3	Operating companies (HSE, Ope)											
(6) Allocation of the budget		Operating companies											
(7) Upgrade of the wastewater treatment facilities (New construction, Modification, Installation of optimum technologies)		Operating companies			- Extension/ new construction of treatment facility for removing oil (IOOC, IOTC), etc.								
3. Assaluyeh													
(1) Compilation of the issues on wastewater management		PSEEZ (HSE), PNOSC (HSE), Operating companies (HSE, Ope)											
(2) Inventory survey of drainage systems	7.4.3	Operating companies (HSE, Ope)											
(3) Examination of solutions to current and potential future issues in wastewater management	7.4.3	Operating companies (HSE, Ope)											
(4) Discussion about wastewater management policy		PSEEZ (HSE), PNOSC (HSE), Operating companies (HSE)											
(5) Preparation of a wastewater management plan	7.4.3	PSEEZ (HSE), PNOSC (HSE), Operating companies (HSE, Ope)											
(6) Allocation of the budget		Operating companies											
(7) Upgrade of the wastewater treatment facilities (New construction, Modification, Installation of optimum technologies)		Operating companies			- Installation of pretreatment equipment (Mobin PC), etc. - Installation of biological treatment facility (SPGC), etc.								
Underground Injection													
1. Khark Island													
(1) Compilation of the information about underground injection	7.4.3	NIOC, IOOC											
(2) Investigation of the injection sites (Survey of groundwater aquifer, and evaluating oil reservoirs)	7.4.3	NIOC, IOOC											
(3) Formulation of an underground injection plan		NIOC											
(4) Allocation of the budget	7.4.3	NIOC											
(5) Conceptual study, design of injection water treatment and injection facilities	7.4.3												
(5-1) Conceptual study		NIOC											
(5-2) Basic Design		NIOC											
(5-3) Detail Design		NIOC											
(6) Construction of injection water treatment and injection facilities	7.4.3	NIOC											
(7) Implementation of the underground injection of produced water		IOOC											

* Operation section

Table 9.3-3 Action Plands for Oily Soil Cleanup and Remediation in Khark Island

Strategies and Actions	Description in M/P	Responsible Body		Short-Term		Mid-Term		Long-Term				
				1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year		
				1393	1394	1395	1396	1397	1398	1399		
				2014	2015	2016	2017	2018	2019	2020		
Oil Soil Cleanup and Remediation												
1. Khark Island		NIOC/IOOC/IOTC										
(1) Investigation of conditions of the oily contaminated areas	7.4.4 (2)	HSE/Eng										
(2) Discussion of uses of the areas after remediation	7.4.4 (3)	HSE/Eng										
(3) Decision of scope of work and project specifications	7.4.4 (2)(3)	HSE/Eng										
(4) Selection of applicable technologies	7.4.4 (1)	HSE/Eng										
(5) Project planning	7.4.4 (2)(3)	HSE/Eng										
(6) Feasibility study	7.4.4 (2)	HSE/Eng										
(7) Preparation of project finances		HSE/Eng										
(8) Project implementation		HSE/Eng										
(9) Evaluation of residual environmental effects		HSE/Eng										

Table 9.3-4 Action Plans for Waste Management (Drill Cuttings) in Khark Island

Strategies and Actions	Description in M/P	Responsible Body	Short-Term				Mid-Term		Long-Term			
			1st Year		2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year		
			1393		1394	1395	1396	1397	1398	1399		
			2014	2015	2016	2017	2018	2019	2020			
Wastes Management (Drill Cuttings)												
1. Khark Island	7.4.5 (4)	NIOC/IOOC/IOTC										
(1) Inventory of wastes from each plant (types and volumes)		HSE/Eng										
(2) Assessment of components and values of the wastes (for recycle/reuse)		HSE/Eng										
(3) Assessment of physical and chemical properties		HSE/Eng										
- Shape and chemical compositions, hazard/ toxicity												
(4) Decision of ultimate treatment methods (recycle/reuse/disposal/including drill cutting injection)		HSE/Eng										
(5) Assessment of HSE risks associated with treatment/ disposal		HSE/Eng										
- Assessment of marine environment (current status and future impacts)												
(6) Discussion of treatment specification (e.g. target residual oil content)		HSE/Eng										
(7) Discussion of treatment conditions		HSE/Eng										
- Time limits, location/area, budget, extraction of valuables, etc.												
(8) Discussion of treatment method(s)		HSE/Eng										
(9) Technical and financial feasibility study		HSE/Eng										
(10) Decision of treatment method based on company's policy		HSE/Eng										
(11) Preparation of finance (budget)		HSE/Eng										
(12) Procurement/ preparation of treatment equipment/ facility		HSE/Eng										
(13) Implementation and monitoring		HSE/Eng										
(14) Evaluation of performance		HSE/Eng										

Table 9.4 Action Plans for Improvement of the Environmental Monitoring System

Strategies and Actions	Description in M/P	Responsible Body	Short-Term			Mid-Term		Long-Term			
			1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year		
			1393	1394	1395	1396	1397	1398	1399		
			2014	2015	2016	2017	2018	2019	2020		
[Environmental Monitoring]											
1. Mahshahr											
1-1 Establishment of Monitoring Structure	7.5.3 7.5.4	Zone companies									
1-2 Data online with DOE	7.5.3 7.5.4	Zone companies									
1-3 Automation and integration of periodical air monitoring	7.5.3 7.5.4	Zone companies									
1-4 Automation and integration of wastewater monitoring	7.5.3 7.5.4	Zone companies									
1-5 Study on proper distribution of the monitoring locations	7.5.3 7.5.4	Zone companies									
2. Khark Island											
2-1 Establishment of Monitoring Structure	7.5.3 7.5.4	Zone companies									
2-2 Integration of the current online systems for air monitoring	7.5.3 7.5.4	Zone companies									
2-3 Data online with DOE	7.5.3 7.5.4	Zone companies									
2-4 Automation and integration of wastewater monitoring	7.5.3 7.5.4	Zone companies									
2-5 Data sharing between the offshore platforms and the zone manager	7.5.3 7.5.4	Zone companies									
2-6 Study on proper distribution of the monitoring locations	7.5.3 7.5.4	Zone companies									
3. Assaluyeh											
3-1 Establishment of Monitoring Structure	7.5.3 7.5.4	Zone companies									
3-2 Data online with DOE	7.5.3 7.5.4	Zone companies									
3-3 Automation and integration of periodical air monitoring	7.5.3 7.5.4	Zone companies									
3-4 Automation and integration of wastewater monitoring	7.5.3 7.5.4	Zone companies									
3-5 Introduction of the Total Emission Control System	7.5.3 7.5.4	Zone companies									
3-6 Study on proper distribution of the monitoring locations	7.5.3 7.5.4	Zone companies									

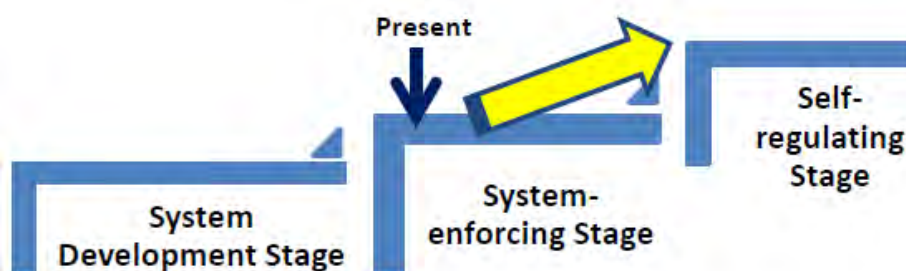
Table 9.5 Action Plans for Strengthening Oil Spill Response Scheme

Strategies and Actions	Description in M/P	Responsible Body	Short-Term				Mid-Term		Long-Term							
			1st Year		2nd Year		3rd Year		4th Year		5th Year		6th Year		7th Year	
			1393		1394		1395		1396		1397		1398		1399	
			2014		2015		2016		2017		2018		2019		2020	
Strengthening Oil Spill Response Scheme																
1. Ministry of Petroleum (MOP)		MOP														
(1) Confirmation of current situation of OSR preparedness of each Pilot Area	8.7.3	HSE														
(2) Definition of policy and goal for strengthening oil spill response scheme	8.3.1	HSE														
(3) Formulation of oil spill response structure in petroleum industry		HSE														
- Emergency response organization	8.3.2	HSE														
- Definition of roles and responsibilities of organizations concerned	8.11	HSE														
- Coordination with PMO and other relevant organizations	8.11.2	HSE														
(4) Basic planning of strengthening oil spill response scheme	8.3.1	HSE														
(5) Promotion of oil spill preventive measures	8.1															
(6) Technical supports	8.11.1															
(7) Preparation of relevant laws and regulations	8.11.3	HSE														
(8) Preparation of finances	8.6.3	HSE														
2. Mahshahr		NPC/SPEZ/TTPC														
(1) Review and improvement of current OSR response procedure		HSE														
(2) Training and exercise	8.9	TTPC/PMO														
(3) Prevention of oil spill incident	8.6.3	HSE														
3-1 Khark Island (oil fields)		NIOC/IOOC														
(1) Oil spill risk analysis and environmental & social impact assessment	8.5.1	HSE														
(2) Definition of oil spill response strategy	8.5.2	HSE														
(3) Development of facility/ site specific OSRPs		HSE														
- Offshore oil production platforms (Aboozar, Foroozan)	8.5, 8.7	HSE														
- Khark Island (Dorood 1 & 2)	8.5, 8.7	HSE														
(4) Procurement of response equipment	8.6.2	HSE														
(5) Training and exercise	8.9	IOOC/IOTC														
(6) Prevention of oil spill incident	8.10.2	Eng/Ope														
(7) Preparation of finances	8.6.3	HSE														
(8) Authorization of OSRPs	8.7.2	PMO														
3-2 Khark Island (crude export terminal)		NIOC/IOTC														
(1) Coordination/ Integration with IOOC	8.7.3	HSE														
(2) Procurement of response equipment (additional)	8.6.2	HSE														
(3) Training and exercise	8.9	IOTC/IOOC														
(4) Prevention of oil spill incident	8.10.2	Eng/Ope														
(5) Preparation of finances	8.6.3	HSE														
4. Assasluyeh		PSEEZ/TTPC														
(1) Oil spill risk analysis and environmental & social impact assessment		HSE														
(2) Review and improvement of current OSRP	8.7.3	HSE														
(4) Procurement of response equipment (additional)	8.6.2	HSE														
(5) Training and exercise	8.9	TTPC/PMO														
(6) Prevention of oil spill incident	8.10.2	Eng/Ope														
(7) Preparation of finances	8.6.3	HSE														

10. Conclusion and Recommendations

10.1. Value of the Master Plan

To put the Master Plan into practice, it is important to understand at which level the development of environmental management systems in Iran's petroleum industry is at the moment and to which level this Master Plan leads. Figure 10.1-1 shows the development steps of the environmental management systems in the petroleum industry. At the beginning stage, the period of system development, the environmental management policy of the petroleum industry is established. The institutional framework of the management systems is developed progressively to comply with the environmental standards based on the environmental laws and to monitor the environmental management. At the following stage, the period of system enforcing, full-scale operation of the management systems is carried on, such as operating the management systems in line with the environmental laws, strengthening the environmental monitoring and executing environmental improvement activities. At the ultimate stage, the period of self-regulation, the management systems based on environmental consciousness is formed spontaneously in collaboration with the petroleum industry and communities.



Source: Study team

Figure 10.1-1 Development Steps of the Environmental Management Systems

Period of System Development:	Formulating environmental management policy for the petroleum industry and developing the institutional framework of the management systems to comply with the environmental standards based on the environmental laws and to monitor the environmental management
Period of System-enforcing:	Operating the management systems in line with the environmental laws, strengthening the environmental monitoring and executing environmental improvement activities
Period of Self-regulation:	Formulating the management systems based on environmental consciousness in collaboration with the petroleum industry and communities

The HSE management systems in most of the Gulf and the African oil-producing countries can be classified into the system development stage or system-enforcing stage. As discussed in Section 3.5, only ADNOC in UAE has the HSE management systems that have reached to the self-regulating stage. The ADNOC's systems have been independently developed, modeling after the management systems of western major petroleum companies.

Current HSE management systems of the petroleum industry in Iran have been formulated since late 1990s under the initiative of the HSE-MOP. The establishment of management systems seems to be penetrated in the whole petroleum industry in around 2003. On the other hand, the policy on the introduction of foreign investment accelerated the offshore oil and gas field development from the middle of 1990s in Iran. This trend rapidly and strongly pressed forward with the oil and gas development plans. In special, gas refinery and petrochemical plants were continuously constructed in Assaluyeh, associated with the large gas field development (South Pars). As a result, the environmental problems worsen and this calls for urgent need to undertake the environmental improvement in the area. The environmental problems seem to be caused mainly by immaturity of development methodology to proceed the environmental management plan associated with the large scale industrial development and delay in institutional development by the DOE in response to such industrial development. Similarly, other pilot sites, Mahshahr and Khark Island, also face the same environmental problems. Most of the problems in the pilot sites are derived from not introducing the latest treatment technology based on the best practice method. The environmental management systems of the petroleum industry in Iran can be placed at the beginning of the system-enforcing stage at the moment from the viewpoint of maturity. That is why inconsistent policy for the operation, inadequate institutional design and deficiency in the management capacity still can be seen. Therefore, the Master Plan and Action Plans should be put into practice as a first step towards upgrading the stage of management systems in the country. The final step is to develop the self-regulating HSE management systems associated with a unique environmental culture.

10.2. Priority Action Plans

The Action Plans described in the Master Plan include thirty actions for the institutional framework of the HSE management systems and eighty actions for environmental pollution prevention in the pilot sites. Of which the actions that are indispensable for the environmental management development and calls for urgent implementation for regional environmental conservation are selected as priority action plans. The following area the priority ones:

- Developing and strengthening the MOP's management structure
- Institutionalizing the "One Zone One Management Principle" (Each pilot site)
- Implementing the flare gas reduction plan (Gas refinery plants in Assaluyeh)
- Implementing the air pollutant reduction plan (Gas refinery plants in Assaluyeh)
- Implementing the zero emission plan on treated produced water discharged from the crude

oil producing facilities (Khark Island area)

- Implementing the mercury zero emission plan with application of cleaner production technology (BIPC, Mahshahr)

(1) Developing and Strengthening the MOP's Management Structure

As mentioned above, current HSE management systems in Iran can be placed at the beginning of the system-enforcing stage. The systems have not been operated well. Therefore, this action is set as the top priority among the selected ones. This action aims to develop the supervisory structure and capacity of the HSE-MOP with strong leadership. This action also proposes that working groups under the special environmental committee be established and function as a driving force to implement the Master Plan. This arrangement is expected to ensure the execution of the Action Plans.

(2) Institutionalizing the “One Zone One Management Principle” (Each Pilot Site)

The zone management companies in the pilot sites are PSEZ for PETZONE in Mahshahr and PSEZ Organization in Assaluyeh. There is no zone management company in Khark Island, while IOOC, IOTC and KPC individually operate their facilities in the area. The issues on institutional framework are lack of authority of the zone management companies or lack of a zone management company itself, and not well-organized structure of the environmental monitoring. Therefore, the Master Plan states that the “One Zone One Management Principle” should be institutionalized promptly as an integrated environmental management structure in one petroleum industry zone. The improvement will help the smooth operation of the environmental management systems in the pilot sites. Centralizing the authority of the environmental management in the zone management companies will make the responsibility of environmental management clear. This action will also facilitate better management of the environmental monitoring records in the zone and implementation of plans on strengthening the monitoring facilities and preparing an environmental hazard map. As this action plan is of special importance for the improvement of the environmental management systems, a detailed implementation plan is described in Appendix 10.

(3) Implementing the Flare Gas Reduction Plan (Gas Refinery Plants in Assaluyeh)

The air pollution in Assaluyeh area can be considered as serious pollution level. One of the emission sources is the flare gas from the gas refinery plants. As stated in the strategy and basic policy of the Master Plan, the fundamental on applying technology for the environmental improvement is planning based on the best practice method. Zero flaring is the top priority matter of the flare gas treatment that the petroleum companies around the world deals with. This concept aims to reduce the emissions and promote efficient use of the gas resources. The Master Plan includes a plan to reduce the flare gas emitted from the gas refinery plants in Assaluyeh area based on this zero flaring concept. In this action plan, the first step is to reduce the excess gas by means of improving the operational skills of the operating companies. The following step is to recover or reuse the excess flare gas and realize the zero flaring concept. Prospective measures for the

efficient use are fuel supply to other plants, EOR (enhanced oil recovery) to the oil fields and raw material supply to the planned phases such as Phase 14. Therefore, it is necessary to examine what is appropriate to the efficient use of gas resources in Assaluyeh area and formulate a specific plan that covers reservoir engineering, production planning, operation management and design of safety facilities.

(4) Implementing the Air Pollutant Reduction Plan (Gas Refinery Plants in Assaluyeh)

As stated in the action plan abovementioned, “Implementing the Flare Gas Reduction Plan”, the emission from the plants causes the air pollution in Assaluyeh. The Master Plan includes the reduction of pollutants by introducing the total emission control system. This may, however, need much consideration and time. Therefore, the prime step to mitigate the current serious air pollution is to reduce the pollutants by means of installing the flue gas treatment facilities, before undertaking the steps to institutionalize the total emission control system. The action plan proposes installing the equipment with advanced technologies in the large-capacity boilers to remove the pollutants such as NO_x, SO_x and PM, based on the best practice measure.

(5) Implementing the Zero Emission Plan on Treated Produced Water Discharged from the Crude Oil Producing Facilities (Khark Island area)

The produced water treatment method adopted in the existing crude oil producing facilities is reduction of oil content to the environmental standard at the wastewater treatment plant and discharge to the sea. The treatment method is not appropriate from the viewpoint of long-term environmental conservation because this allows the solved organic substances in water and oil content below the environmental standard to flow into and accumulate in the Persian Gulf. The wastewater treatment method in the Gulf counties has been changed to the underground injection. The Master Plan includes the change of wastewater treatment to the underground injection. It is necessary to examine which option is suitable in Khark area, EOR to the oil fields or disposal to the underground aquifer, from the viewpoint of reservoir engineering, production planning, operation management and facility design, based on the zero emission concept.

(6) Implementing the Mercury Zero Emission Plan with Application of Cleaner Production Technology (BIPC, Mahshahr)

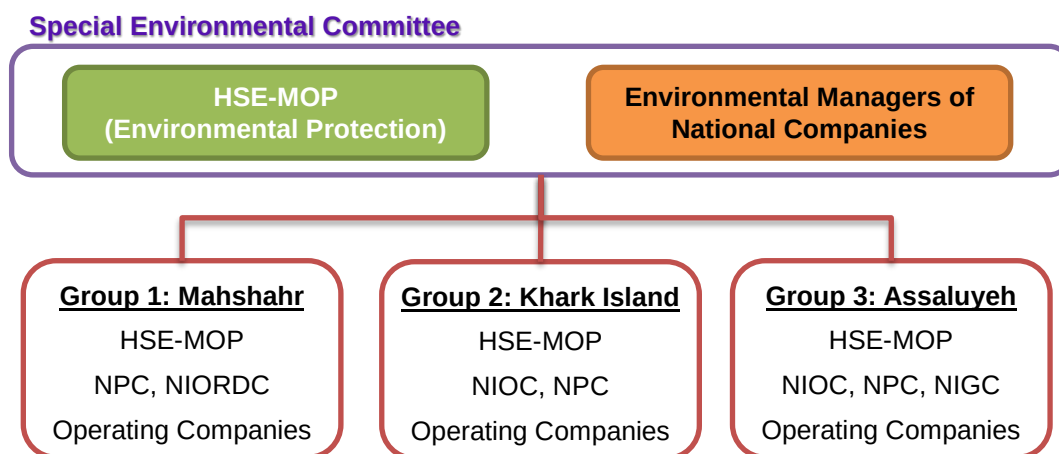
Applying the cleaner production technology to the petrochemical plants is one of the actions under the zero emission concept that is put forward in the Master Plan. This action promotes replacing the existing production process by the new one without mercury electrode and applies the cleaner production technologies to the petrochemical plants constructed before 1980s. The action in Mahshahr can be a model case for the application of cleaner production technology. Such action should be widely promoted as a priority matter.

10.3. Recommendations towards Execution of the Master Plan

The recommendations to promote the execution of the Master Plan are as follows:

(1) Establishing working groups

- The execution of the Master Plan requires approval from the Petroleum Minister, followed by budgetary steps, coordination with the relevant organizations and appointment of staff in the implementing bodies. These procedures need much time and energy. Therefore, it is recommended that the MOP and other organizations undertake the priority action plans for the short-term period and move forward with a phased approach. As a first step, the MOP will establish working groups under the environmental special committee (see Figure 10.3-1).
- The roles of the working groups are to prepare the detailed implementation plan of the Action Plans, liaise and coordinate with the relevant organizations, monitor the implementation and evaluate the performance. The result of monitoring and evaluation will be reported to the special environmental committee.
- The working groups will last during the execution period of the Master Plan. The staff exclusive to the execution of the Master Plan should be appointed/deployed. It is desirable to establish the working group for each pilot site: Group 1 for Mahshahr, Group 2 for Khark Island and Group 3 for Assaluyeh.



Source: Study team

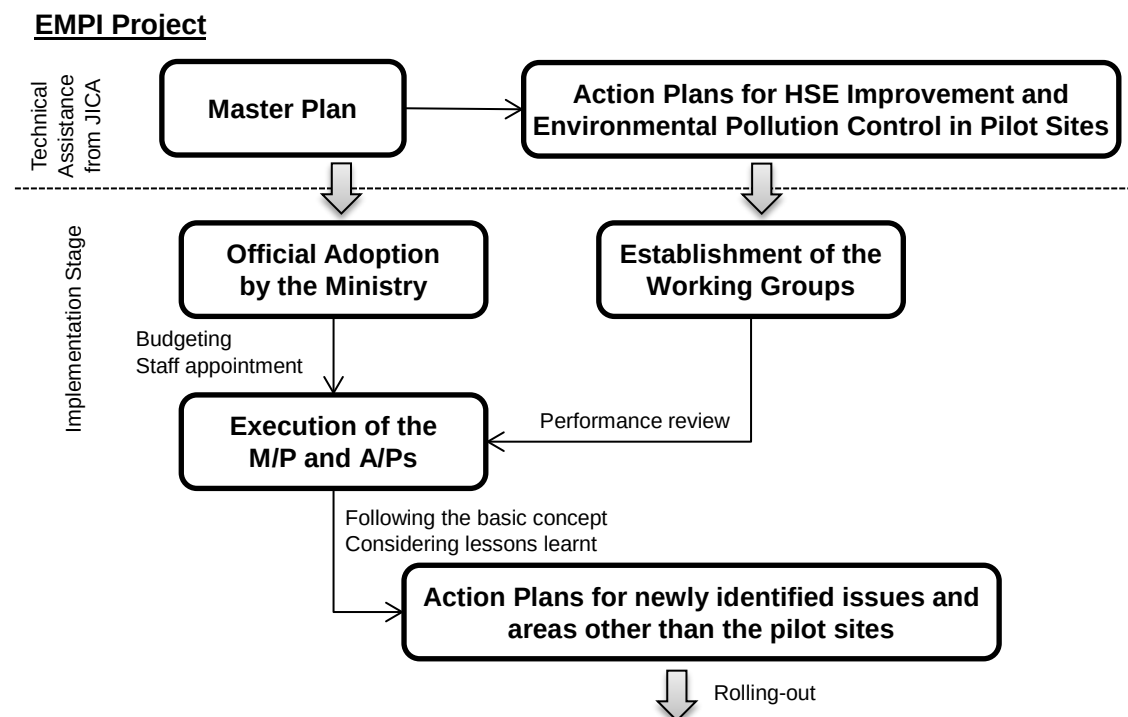
Figure 10.3-1 Working Group to Promote the Execution of the Master Plan

(2) Rolling Out the Master Plan and Action Plans to Other Areas

- As shown in Figure 10.3-2, it is recommended that the MOP formulates action plans for oil, gas and petrochemical plants in inland area and Oman Sea based on the best practice method stated in the Master Plan and rolls out the environmental improvement to areas

other than the pilot sites in the Project. Figure 10.3-2 shows an example of air pollution prevention applicable to the oil refinery plants (NIORDC).

- It is also recommended that action plans are prepared and rolled out to other areas, for example, the flare gas reduction and produced water management for the onshore oil and gas fields supervised by NIOC and wastewater management of petrochemical plants supervised by NPC.



Source: Study team

Figure 10.3-2 Implementation of the Master Plan and Rollin-out to Other Areas

Function of facilities		Pilot Area (Example)			Other applicable sites in Persian Gulf				
		Mahshahr	Khark	Assahveh	Crude Oil & Gas Production	Crude Oil Refining	Petrochemical Complex	Crude Oil Storage & Loading	Fuel Oil Storage & Loading Terminal
Main Company in charge		NPC/PSEZ	NIOC/IOOC	NIOC/PSEZ/SPGC	NIOC/IOOC	NIORDC	NPC	NIOC/IOOC	NIORDC
Air	Flare Gas Reduction	X	O	O	O	X	X	X	X
	Flaring Control	O	X	X	X	O	O	X	X
	Flue Gas Reduction & Control	O	O	X	X	O	O	X	X
	Air Quality Monitoring	O	O	O	O	O	O	X	X
Waste Water	Produced Water Control	X	O	O	O	X	X	X	X
	Waste water Treatment	O	X	O	X	O	O	X	X
	Waste water monitoring	O	O	O	O	O	O	X	X
Waste Materials	Oil Sludge Treatment	O	O	O	O	O	O	O	O
	Waste Treatment	O	O	O	O	O	O	O	O
	Waste Disposal	O	O	O	O	O	O	O	O
	Drilling Mud & Cuttings	X	O	X	O	X	X	X	X
Oil Spill Response	Crude oil Spill	X	O	X	O	O	X	O	O
	Fuel Oil spill	X	O	X	O	O	X	O	O
Protection Area	Ecosystem	O	O	O	O	O	O	O	O
	National conservation Area	O	O	O	O	O	O	O	O
Capacity Assessment	Organization	O	O	O	O	O	O	X	X
	HSE management	O	O	O	O	O	O	X	X
	Manpower Training	O	O	O	O	O	O	X	X

Source: Study team

Figure 10.3-2 Rolling Out of Action Plans to Other Areas

(3) Promoting the Best Practice Method

- The new petroleum minister announced the policy that the MOP would promote an oil production expansion with advanced technologies, development in South Pars and petrochemical product export. Therefore, it is recommended that the HSE-MOP and petroleum companies put forward the facility design with the advanced technologies based on the best practice method stated in Chapter 7 in accordance with the policy. The HSE-MOP is made responsible for improving the environmental management in the large scale petroleum plants and should initiate the promotion of the best practice method across the petroleum industry based on the output from a series of the workshop conducted in the Project

(4) Implementing Education and Training Programs

- Implementing the human resources development programs is an essential condition for the execution of the Master Plan. As shown in Table 7.3.1-5 in Section 7.3, the programs by staff level, e.g. top management, environmental managers and environmental experts, should be prepared and carried out as appropriate. Therefore, the HSE-MOP and petroleum companies are required to take budgetary steps for the education and training programs in accordance with the Action Plans
- It is desirable that the programs include not only providing the domestic training courses but also increasing the opportunity to learn overseas advanced technologies and management systems for the environmental improvement.
- There are government organizations and the petroleum industry in the developed countries

that bring in trainees from overseas. The HSE-MOP should gather information about such training courses and examine how to utilize the training opportunities. The following are the organizations in Japan that provide such training courses:

- ✧ JICA: General methodology for the environmental management, measures against the climate change and offshore incident prevention
- ✧ JOGMEC: HSE management systems and environmental protection technologies for oil and gas development sector
- ✧ JCCP: HSE management systems and environmental protection technologies for oil refining and petrochemical sector

(5) Promoting Continuous Environmental Management

- As discussed in Section 10.1, the ultimate stage of environmental management in the petroleum industry is to formulate the management systems based on environmental consciousness in collaboration with the petroleum industry and communities. To realize that, the HSE-MOP is made responsible for promoting the environmental culture development by means of strong leadership and appropriate policies. Therefore, it is recommended that the HSE-MOP should initiate formulation of action plans to address any issue that will be identified in the future, considering the steady implementation of Recommendation (1) Establishing working groups and (4) Implementing education and training programs, progressive development and sustainability of the environmental management systems.

Finally, the study team would like to express the gratitude to the HSE-MOP, four national companies (NIOC, NIGC, NPC and NIORDC), zone management organizations in the pilot sites (PSEEZ and PSEZ), operating companies in the pilot sites (BIPC, Razi PC, Tondguyan PC, Fajr PC, IOOC, IOTC, POGC, SPGC and Mobin PC), RIPI and other government agencies (DOE and PMO). Cooperation and participation of those organizations significantly contributed to preparation of the Master Plan and Action Plans. The study team believes that continuous collaboration among those organizations will serve as a foundation for the execution of the Master Plan and Action Plans.