3.6 SMCP/TMC

Total volume of waste water in SMCP/TMC is shown in Table VII-26.

Table VII-26 Quality of Waste Water (SMCP/TMC)

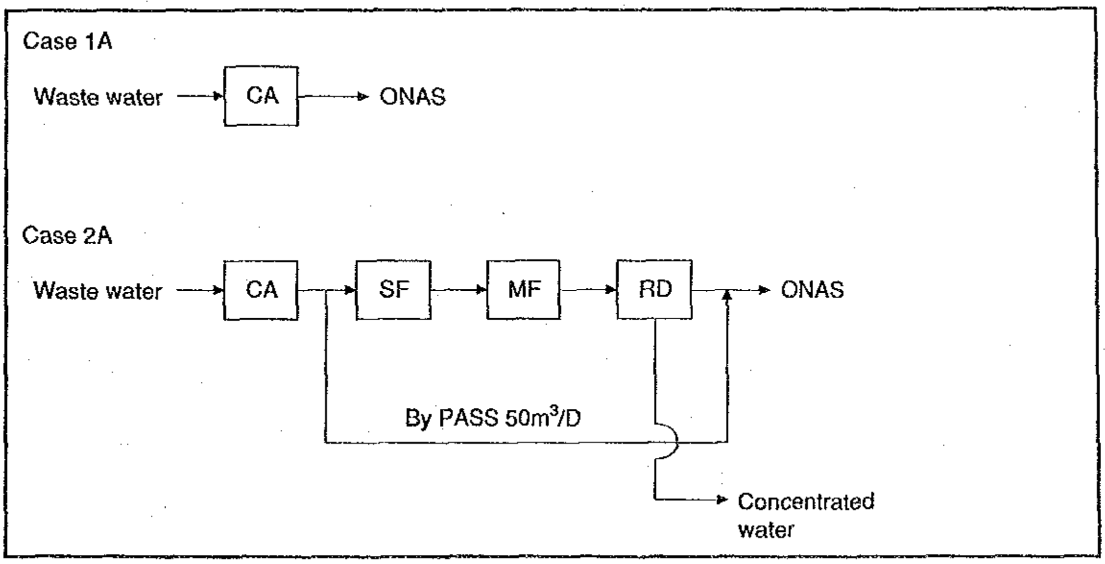
	FLOW m^3/D	COD mg/*l*	N-HEX mg/*l*	T-N(Kj) mg/*l*	NH_3-N mg/*l*	T-Cr mg/*l*	Cl mg/*l*	SO_4 mg/*l*
SMCP+TMC	300	4372	251	555	386	318	2400	3480

Elements picked up as water quality problems are COD and T-Cr for the case 1A and N-HEX, Cl and SO_4 are added for the case 2A. As Cr^{+6} is very small in quantity, T-Cr can be deemed as Cr^{+3}.

T-Cr is removed by the coagulation method. COD and N-HEX are also removed by coagulation method and organism treatment is not provided as the discharge standards are 2,000 mg/*l* for COD and 50 mg/*l* for N-HEX.

Block flow is shown in Table VII-27.

Table VII-27 Block Flow Sheet (SMCP/TMC)



Specifications of the reverse osmosis film concentrated water of the case 2A are as shown below:

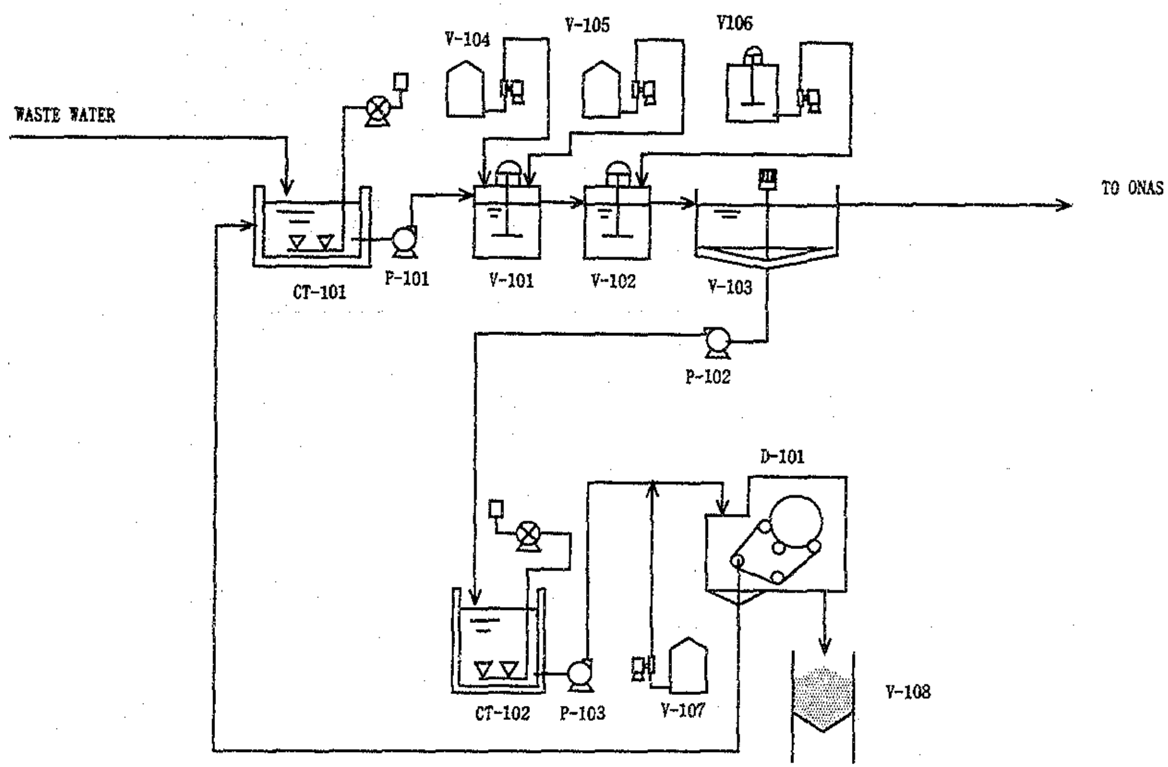
Water volume: 63 m^3/D

Cl condensation: 10,000 mg/*l*

SO4 condensatin: 14,000 mg/*l*

Detailed flow sheet and layout are shown in Fig. VII-23, 24, 25 and 26 and the list of equipment in Table VII-28 and 29.

Fig. VII-23 Flow Sheet of Waste Water Treatment Facilities (SMCP 1A)



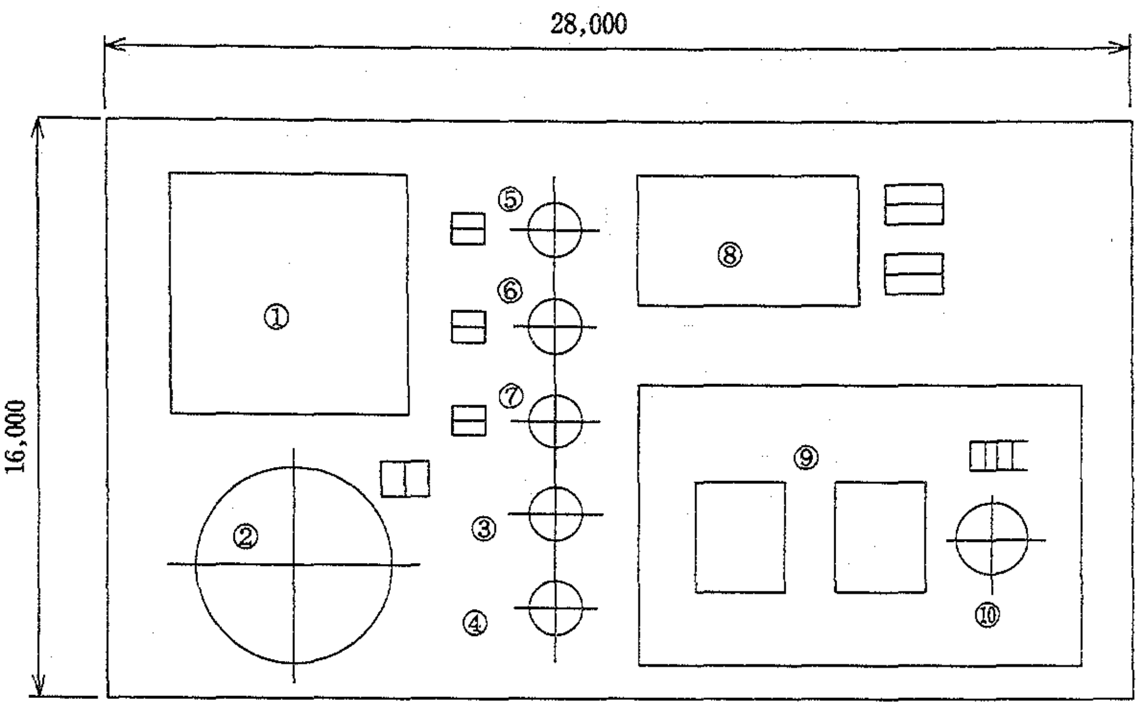
P-101 WASTE WATER PUMP
P-102 SLUDGE DRAWING PUMP
P-103 SLUDGE FEED PUMP

V-101 MIXING HEAD TANK
V-102 COAGULATION TANK
V-103 SEDIMENTATION TANK
V-104 ALUM TANK
V-105 NaOH TANK
V-106 POLYMER TANK
V-107 POLYMER TANK
V-108 CAKE HOPPER

D-101 BELT PRESS

CT-101 WASTE RECEPTION TANK
CT-102 SLUDGE HOLDING TANK

Fig. VII-24 Plot Plan of Waste Water Treatment Facilities (SMCP 1A)

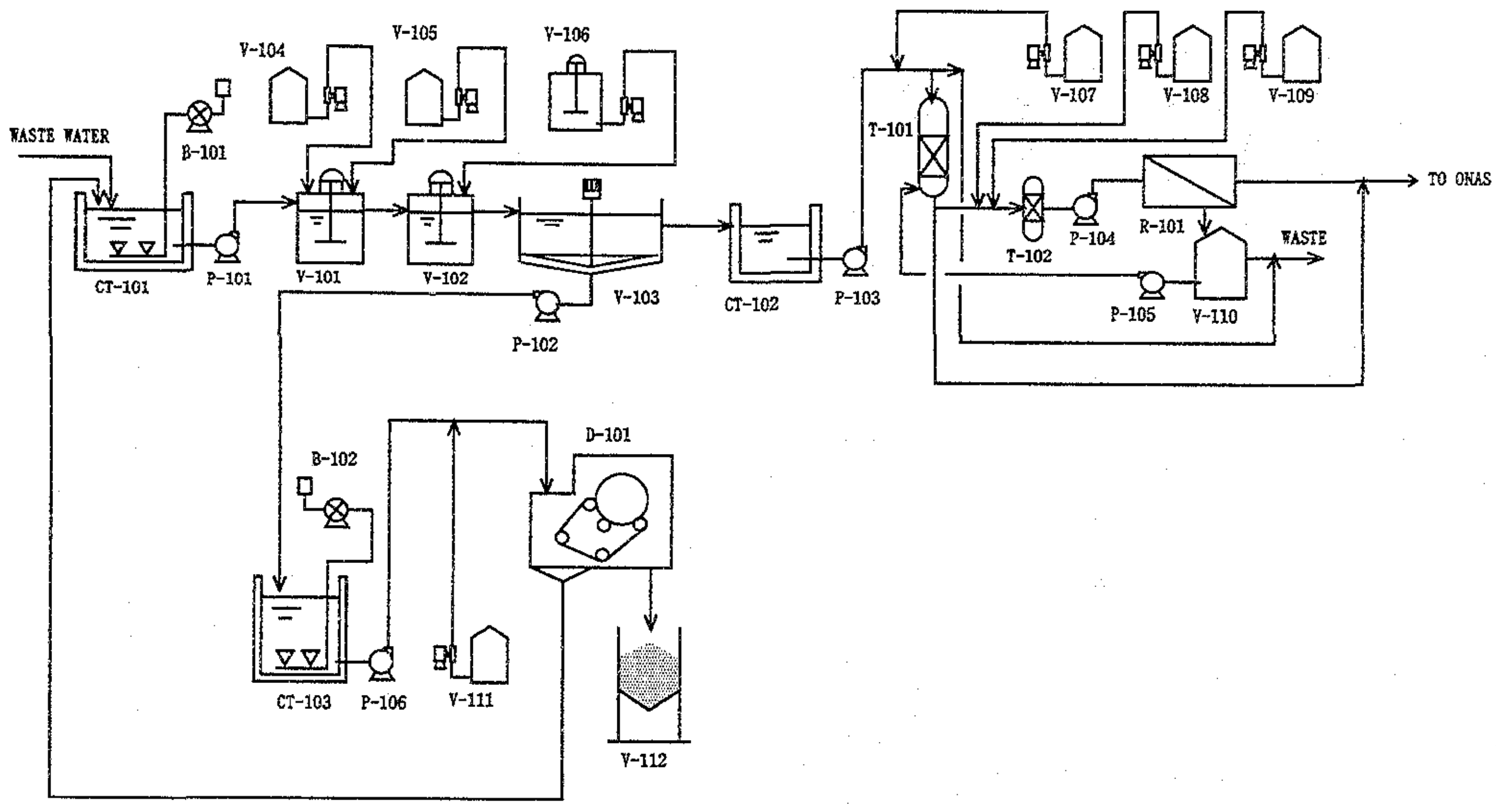


① WASTE WATER TANK
② SEDIMENTATION TANK
③ MIXING HEAD TANK
④ COAGULATION TANK
⑤ ALUM TANK
⑥ NaOH TANK
⑦ POLYMER TANK
⑧ SLUDGE HOLDING TANK
⑨ BELT PRESS
⑩ POLYMER TANK

Table VII-28 Main Equipment List (SMCP 1A)

No.	Equip. No.	Name of Equipment	No. of REQ'D	Remarks		
1	COAGULATION TREATMENT PLANT					
	CT-101	WASTE WATER TANK	1	300 m³	RC	
	V-101	MIXING HEAD TANK	1	2.0 m³	CS	AGITATER 0.75 kW
	V-102	COAGULATION TANK	1	2.0 m³	CS	AGITATER 0.75 kW
	V-103	SEDIMENTATION TANK	1	15 m²	RC	RAKE 0.1 kW
	V-104	ALUM TANK	1	1 m³		PUMP 0.1 kW
	V-105	NaOH TANK	1	1 m³		PUMP 0.1 kW
	V-106	POLYMER TANK	1	1 m³		PUMP 0.1 kW
	P-101	WASTE WATER PUMP	1+1	0.75 kW		
	P-102	SLUDGE DRAWING PUMP	1+1	0.75 kW		
2	SLUDGE DEWATERING PLANT					
	CT-102	SLUDGE HOLDING TANK	1	16 m³	RC	BLOWER 0.2 kW
	D-101	BELT PRESS	2	1 m	WIDTH	3.7 kW
	V-108	CAKE HOPPER	1	4 m³	CS	
	V-107	POLYMER TANK	1	1 m³	PUMP 0.1 KW	AGITATER 0.2 kW
	P-103	SLUDGE PUMP	1+1	0.2 kW		

Fig. VII-25 Flow Sheet of Waste Water Treatment Facilities (SMCP 2A)



P-101 WASTE WATER PUMP
P-102 SLUDGE DROWING PUMP
P-103 FILTER FEED PUMP
P-104 BOOSTER PUMP
P-105 BACK WASH PUMP
P-106 SLUDGE FEED PUMP

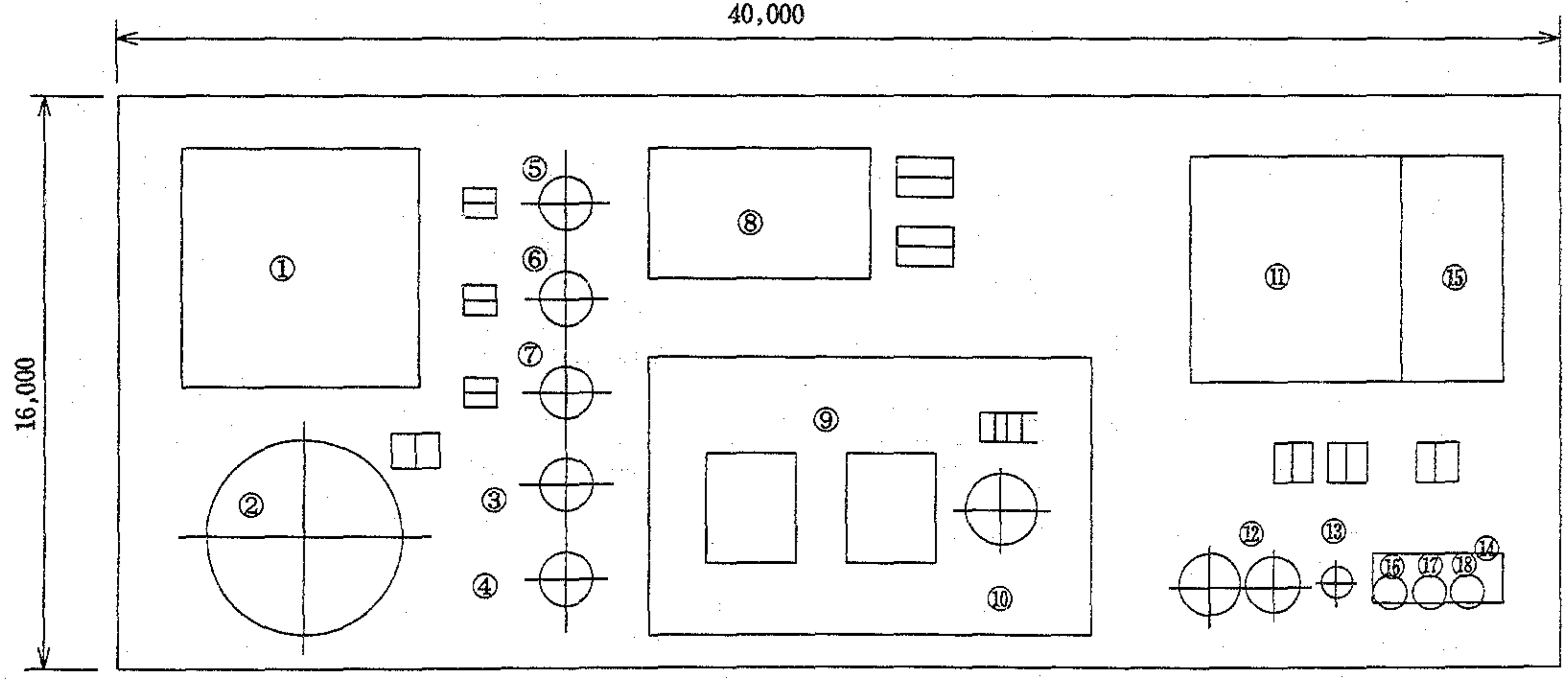
V-101 MIXING HEAD TANK
V-102 COAGULATION TANK
V-103 SEDIMENTATION TANK
V-104 ALUM TANK
V-105 NaOH TANK
V-106 POLYMER TANK
V-107 NaClO TANK
V-108 INHIVITER TANK
V-109 HCl TANK
V-110 BRINE TANK
V-111 POLYMER TANK
V-112 CAKE HOPPER

CT-101 WASTE WATER TANK
CT-102 RECEPTION TANK
CT-103 SLUDGE HOLDING TANK

T-101 SAND FILTER
T-102 CARTRIGE FILTER

R-101 RO FILTER
D-101 BELT PRESS

Fig. VII-26 Plot Plan of Waste Water Treatment Facilities (SMCP 2A)



① WASTE WATER TANK
② SEDIMENTATION TANK
③ MIXING HEAD TANK
④ COAGULATION TANK
⑤ ALUM TANK
⑥ NaOH TANK
⑦ POLYMER TANK
⑧ SLUDGE HOLDING TANK
⑨ BELT PRESS
⑩ POLYMER TANK

⑪ RECEPTION TANK
⑫ SAND FILTER
⑬ CARTRIGE FILTER
⑭ RO FILTER
⑮ BRINE TANK
⑯ NaOCl TANK
⑰ INHIVITER TANK
⑱ HCl TANK

Table VII-29 Main Equipment List (SMCP 2A)

No.	Equip. No.	Name of Equipment	No. of REQ'D	Remarks		
1	COAGULATION TREATMENT PLANT					
	CT-101	WASTE WATER TANK	1	300 m^3	RC	
	V-101	MIXING HEAD TANK	1	2.0 m^3	CS	AGITATER 0.75 kW
	V-102	COAGULATION TANK	1	2.0 m^3	CS	AGITATER 0.75 kW
	V-103	SEDIMENTATION TANK	1	15 m^2	RC	RAKE 0.1 kW
	V-104	ALUM TANK	1	1 m^3		PUMP 0.1 kW
	V-105	NaOH TANK	1	1 m^3		PUMP 0.1 kW
	V-106	POLYMER TANK	1	1 m^3		PUMP 0.1 kW
	P-101	WASTE WATER PUMP	1+1	0.75 kW		
	P-102	SLUDGE DRAWING PUMP	1+1	0.75 kW		
2	RO PLANT					
	CT-102	RECEPTION TANK	1	50 m^3	RC	
	T-101	SAND FILTER	1	1600ϕ		
	T-102	CARTRIGE FILTER	1 set	CARTRIGE TYPE		
	R-101	RO FILTER	1set	SDIRAL TYPE 200ϕ x 18 ELEMENTS		
	V-110	BRINE TANK	1	40 m^3	RC	
	V-107	NaClO TANK	1	1 m^3		PUMP 0.1 kW
	V-108	INHIVITER TANK	1	1 m^3		PUMP 0.1 kW
	V-109	HCl TANK	1	1 m^3		PUMP 0.1 kW
	P-103	FILTER FEED PUMP	1+1	0.75 kW		
	P-104	BOOSTER PUMP	1+1	11 kW		
	P-105	BACK WASH PUMP	1	1.1 kW		
3	SLUDE DEWATERING PLANT					
	CT-103	SLUDGE HOLDING TANK	1	16 m^3	RC	
	D-101	BELT PRESS	2	1 m	WIDTH	3.7 kW
	V-112	CAKE HOPPER	1	4 m^3	CS	
	V-111	POLYMER TANK	1	1 m^3	PUMP 0.1 kW	AGITATER 0.2 kW
	P-106	SLUDGE PUMP	1+1	0.2 kW		

3.7 STS

(1) Waste water treatment

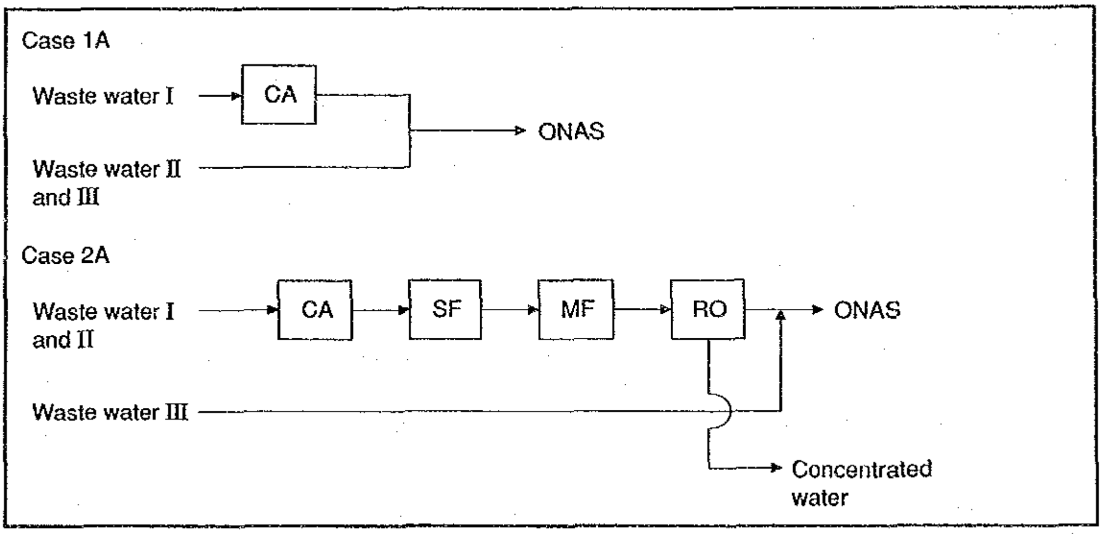
Assumptions of the plan are as shown in Table VII-30.

Table VII-30 Quality of Waste Water (STS)

STREAM NO.	SAMP NO.	FLOW m^3/D	COD mg/l	Cl mg/l	SO_4 mg/l	EC ms/cm
I	STP-13, 14, 15, 19	4.6	26276	1133	5476	19
II	STS-21	7	282	4800	5800	34.5
III	Other than the above	33.4	504	363	595	

The waste water of I is small in volume and COD concentration is very high. In the waste water of II, salt concentration is high. As shown in the block flow in Table VII-31, waste water of I, II and III are combined and treated.

Table VII-31 Block Flow Sheet (STS)



Specifications of concentrated water of reverse osmosis film in the case 2A are as follows.

Volume of water: 2.9 m^3/D

Cl concentration: 13,000 mg/*l*

SO_4 concentration: 22,000 mg/*l*

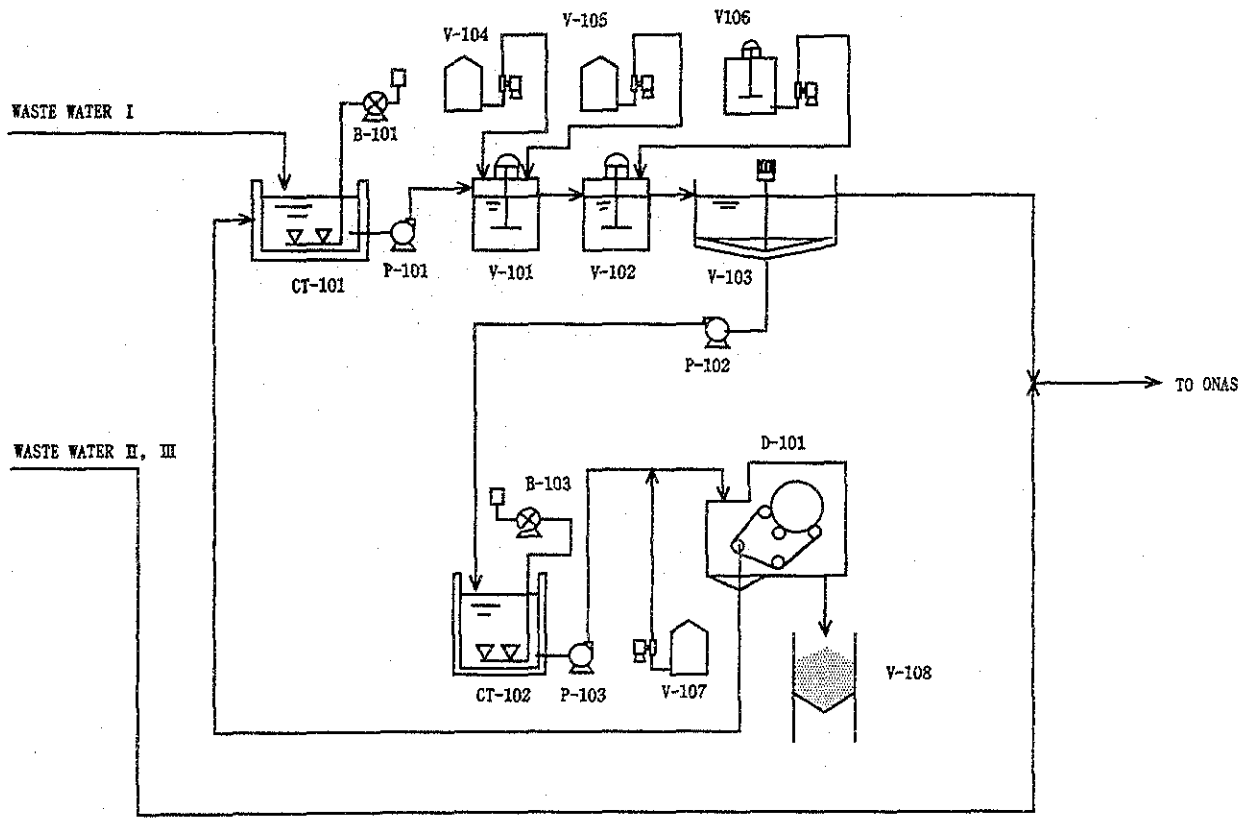
Detailed flow sheet and layout are shown in Fig. VII-27, 28, 29, and 30. List of equipment specifications is shown in Table VII-32 and 33.

(2) Exhaust gas treatment

Multi-cyclone was planned for the exhaust gas from the boilder and heating medium heater. Capacity of facilities and number of cyclones are as shown below. Major dimensions are in Table Table VII-13.

- STS-51 1,500 Nm^3/H 2×2
- STS-52 600 Nm^3/H 2×1

Fig. VII-27 Flow Sheet of Waste Water Treatment Facilities (STS 1A)



P-101 WASTE WATER PUMP
P-102 SLUDGE DRAWING PUMP
P-103 SLUDGE FEED PUMP

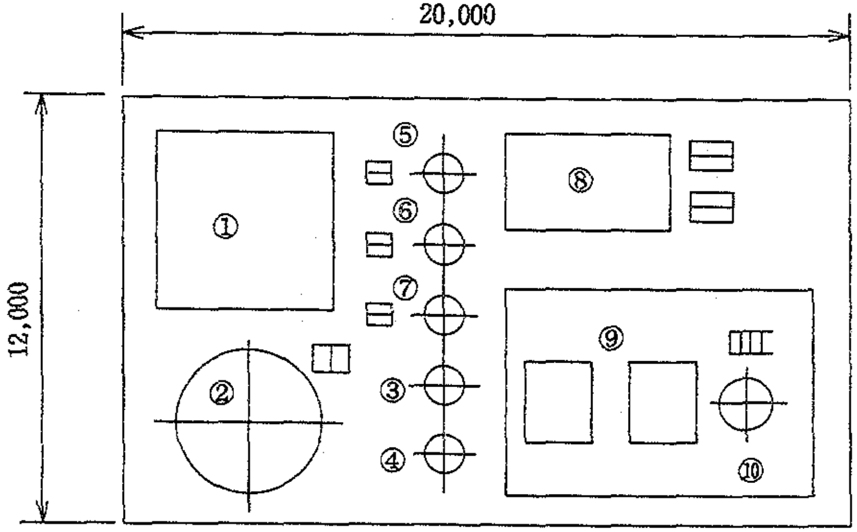
V-101 MIXING HEAD TANK
V-102 COAGULATION TANK
V-103 SEDIMENTATION TANK
V-104 ALUM TANK
V-105 NaOH TANK
V-106 POLYMER TANK
V-107 POLYMER TANK
V-108 CAKE HOPPER

D-101 BELT PRESS

B-101 MIXING BLOWER
B-102 AERATION BLOWER

CT-101 WASTE WATER TANK
CT-102 SLUDGE HOLDING TANK

Fig. VII-28 Plot Plan of Waste Water Treatment Facilities (STS 1A)

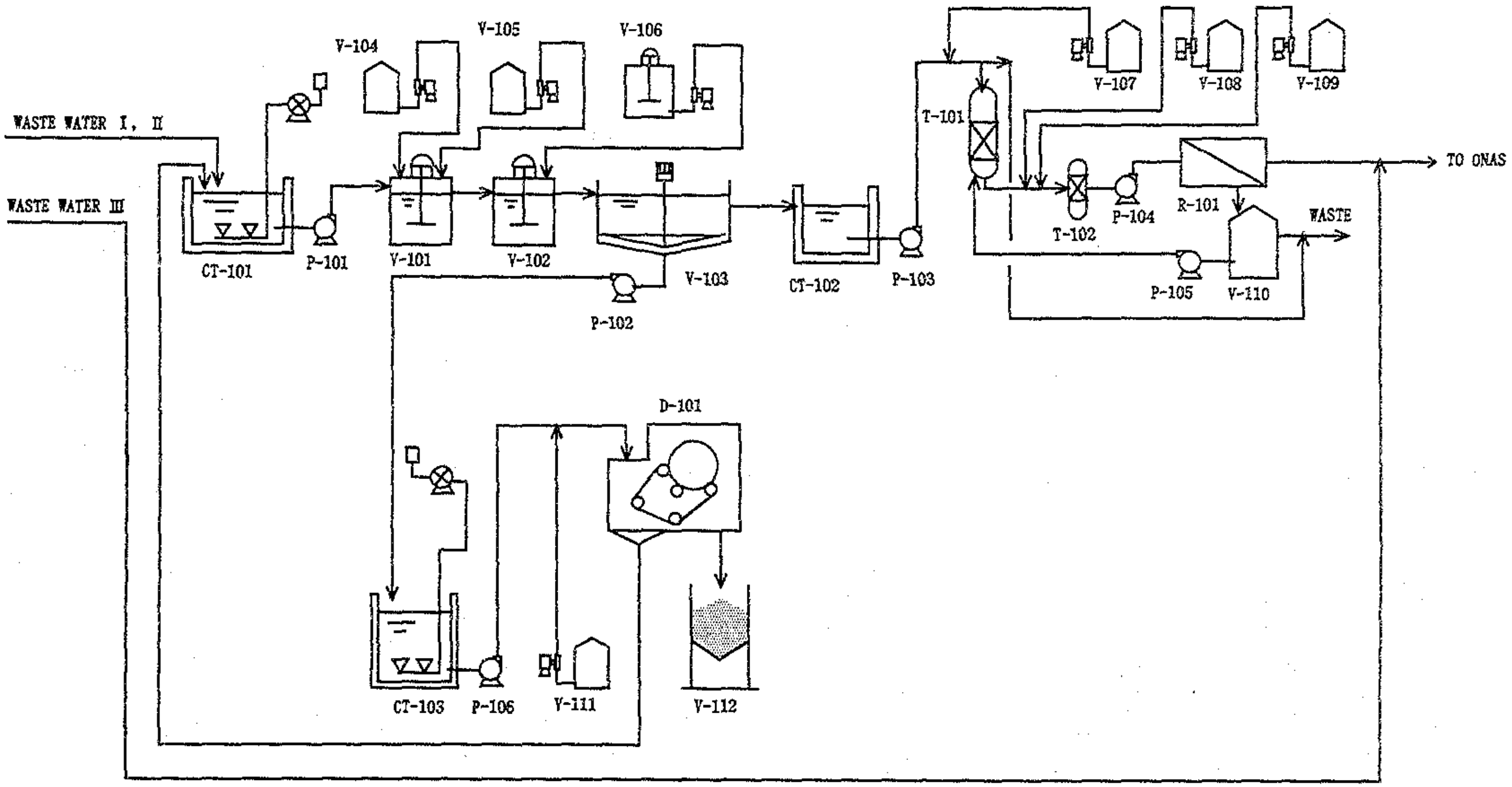


① WASTE WATER TANK
② SEDIMENTATION TANK
③ MIXING HEAD TANK
④ COAGULATION TANK
⑤ ALUM TANK
⑥ NaOH TANK
⑦ POLYMER TANK
⑧ SLUDGE HOLDING TANK
⑨ BELT PRESS
⑩ POLYMER TANK

Table VII-32 Main Equipment List (STS 1A)

No.	Equip. No.	Name of Equipment	No. of REQ'D	Remarks		
1	COAGULATION TREATMENT PLANT					
	CT-101	WASTE WATER TANK	1	3 m³	RC	
	V-101	MIXING HEAD TANK	1	0.03 m³	CS	AGITATER 0.1 kW
	V-102	COAGULATION TANK	1	0.03 m³	CS	AGITATER 0.1 kW
	V-103	SEDIMENTATION TANK	1	0.2 m²	RC	RAKE 0.1 kW
	V-104	ALUM TANK	1	1 m³		PUMP 0.1 kW
	V-105	NaOH TANK	1	1 m³		PUMP 0.1 kW
	V-106	POLYMER TANK	1	1 m³		PUMP 0.1 kW
	P-101	WASTE WATER PUMP	1+1	0.2 kW		
	P-102	SLUDGE DRAWING PUMP	1+1	0.2 kW		
2	SLUDGE DEWATERING PLANT					
	CT-102	SLUDGE HOLDING TANK	1	0.5 m³	RC	
	D-101	BELT PRESS	1	0.5 m	WIDTH	2.2 kW
	V-108	CAKE HOPPER	1	0.5 m³	CS	
	V-107	POLYMER TANK	1	1 m³	PUMP 0.1 KW	AGITATER 0.2 kW
	P-103	SLUDGE PUMP	1+1	0.2 kW		

Fig. VII-29 Flow Sheet of Waste Water Treatment Facilities (STS 2A)



P-101 WASTE WATER PUMP
P-102 SLUDGE DRAWING PUMP
P-103 FILTER FEED PUMP
P-104 BOOSTER PUMP
P-105 BACK WASH PUMP
P-106 SLUDGE FEED PUMP

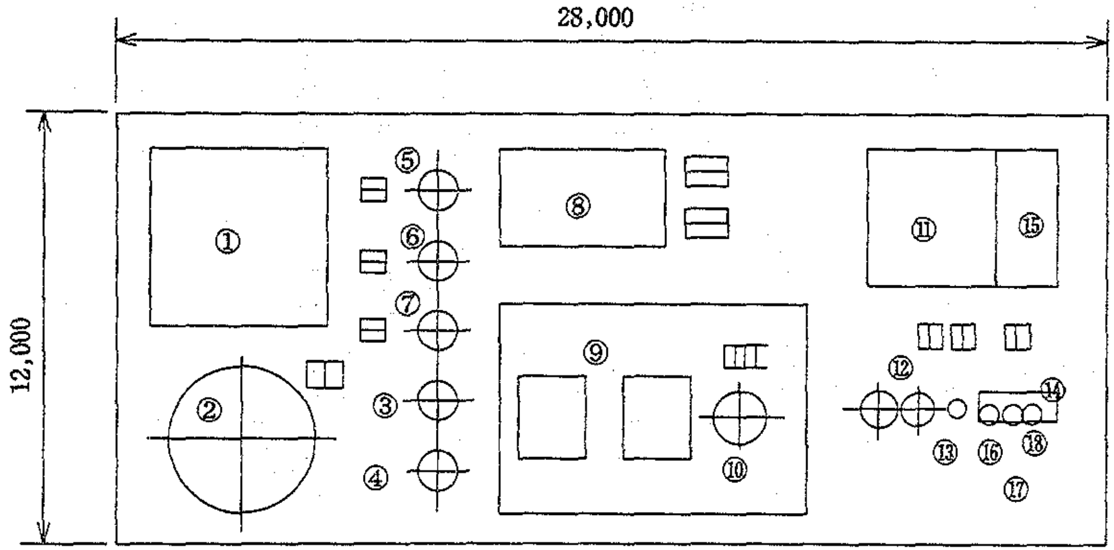
V-101 MIXING HEAD TANK
V-102 COAGULATION TANK
V-103 SEDIMENTATION TANK
V-104 ALUM TANK
V-105 NaClO TANK
V-106 POLYMER TANK
V-107 NaOCl TANK
V-108 INHIVITER TANK
V-109 HCl TANK
V-110 BRINE TANK
V-111 POLYMER TANK
V-112 CAKE HOPPER

CT-101 WASTE WATER TANK
CT-102 RECEPTION TANK
CT-103 SLUDGE HOLDING TANK

T-101 SAND FILTER
T-102 CARTRIGE FILTER

R-101 RO LILTER
D-101 BELT PRESS

Fig. VII-30 Plot Plan of Waste Water Treatment Facilities (STS 2A)



① WASTE WATER TANK
② SEDIMENTATION TANK
③ MIXING HEAD TANK
④ COAGULATION TANK
⑤ ALUM TANK
⑥ NaOH TANK
⑦ POLYMER TANK
⑧ SLUDGE HOLDING TANK
⑨ BELT PRESS
⑩ POLYMER TANK
⑪ RECEPTION TANK
⑫ SAND FILTER
⑬ CARTRIGE FILTER
⑭ RO FILTER
⑮ BRINE TANK
⑯ NaOCl TANK
⑰ INHIVITER TANK
⑱ HCl TANK

Table VII-33 Main Equipment List (STS 2A)

No.	Equip. No.	Name of Equipment	No. of REQ'D	Remarks
1	COAGULATION TREATMENT PLANT			
	CT-101	WASTE WATER TANK	1	8 m^3 RC
	V-101	MIXING HEAD TANK	1	0.1 m^3 CS AGITATER 0.1 kW
	V-102	COAGULATION TANK	1	0.1 m^3 CS AGITATER 0.1 kW
	V-103	SEDIMENTATION TANK	1	0.5 m^2 RC RAKE 0.1 kW
	V-104	ALUM TANK	1	1 m^3 PUMP 0.1 kW
	V-105	NaOH TANK	1	1 m^3 PUMP 0.1 kW
	V-106	POLYMER TANK	1	1 m^3 PUMP 0.1 kW
	P-101	WASTE WATER PUMP	1+1	0.2 kW
	P-102	SLUDGE DRAWING PUMP	1+1	0.2 kW
2	RO PLANT			
	CT-102	RECEPTION TANK	1	5 m^3 RC
	T-101	SAND FILTER	1	360ϕ
	T-102	CARTRIGE FILTER	1 set	CARTRIGE TYPE
	R-101	RO FILTER	1set	SDIRAL TYPE 100ϕ x 4 ELEMENTS
	V-110	BRINE TANK	1	2 m^3 RC
	V-107	NaClO TANK	1	1 m^3 PUMP 0.1 kW
	V-108	INHIVITER TANK	1	1 m^3 PUMP 0.1 kW
	V-109	HCl TANK	1	1 m^3 PUMP 0.1 kW
	P-103	FILTER FEED PUMP	1+1	0.1 kW
	P-104	BOOSTER PUMP	1+1	0.75 kW
	P-105	BACK WASH PUMP	1	0.2 kW
3	SLUDE DEWATERING PLANT			
	CT-108	SLUDGE HOLDING TANK	1	0.5 m^3 RC
	D-101	BELT PRESS	2	0.5 m WIDTH 2.2 kW
	V-112	CAKE HOPPER	1	0.5 m^3 CS
	V-111	POLYMER TANK	1	1 m^3 PUMP 0.1 kW AGITATER 0.2 kW
	P-106	SLUDGE PUMP	1+1	0.2 kW

3.8 ONAS

As water flowing into ONAS increases, intensifying the ONAS sewage treatment is planned. As described in Volume V, increase of the existing facility including new flow in is as shown in Table VII-34.

Table VII-34 Water Flowing into ONAS

		FLOW m^3/D	COD mg/*l*	BOD mg/*l*	SS mg/*l*	Cl mg/*l*	SO_4 mg/*l*
New flow	TOTAL	1694	1844	736	730	3272	1935
Existing flow	1991.6-1992.6 AVE.	19554	878	439	334	1026	429 Conversion by EC
Total flow		21248	955	463	366	1205	549

SO_4 in the waste water discharged to the sea is restricted to 1,000 mg/*l* and water quality is studied with respect to COD, BDD and SS.

Existing facilities are for lagoon type microorganism treatment. It is modified to the one of activated sludge type and NaClO is added to the treated water to prevent pathogenic bacteris.

Air is blown in for the activated sludge method and the sluge is returned. List of equipment is shown in Table VII-35.

Table VII-35 Main Equipment List (ONAS 2B • 3B)

Equip. No.	Name of Equipment	No. of REQ'D	Remarks	
B-101	AERATION BLOWER	2+1	30 m^3/min.	37 kW
A-101	AIR DIFFUSER	1 set		
P-101	RETURN SLUDGE PUMP	2+1	2 m^3/min.	3.7 KW
T-101	NaClO TANK	1	10 m^3	PUMP 0.2 kW

4. Implementation Plan

Based on the facility plan and result of the field study as described in Volume VII, an implementation plan was worked out covering an organization and schedule for implementing the waste water and exhaust gas treatment project.

4.1 Implementing Organization

Particular factories in Sfax City were selected for this study and a countermeasure against the environmental pollution was worked out. It is a matter of course that a countermeasure covering the whole city is needed. The selected factories are scattered all over the city and their operating conditions, time of construction, construction expense and economic situation are different. It is required to promote the plan to accomplish the common object of preventing the environmental pollution and improving the environment.

For this purpose, it is proposed to establish a committee as follows for the implementation of the plan.

(1) Establishment of Sfax industrial pollution prevention committee

Though the organizational details of the municipality of Sfax are unknown, the committee will be composed of the following members.

Chairman: Governor of Sfax city or equivalent person

Members of a committee:

General manager of environment department of Sfax city or equivalent person

Staff of MOE

President of LARSEN (Mr. K. MEDHIOUB)

Factory manager of each factory or equivalent person

Fishing industry related responsible person

Finance related responsible person

Representative of residents in Sfax city

(2) Duration of committee and contents of implementation

1) Duration of committee

From start of study on the implementation plan until evaluation of result of the trial operation.

Actually from September 1993 to December 1996.

If the organization covers the whole Sfax City including factories other than those selected this time, however, the term should be extended.

2) Contents of implementation

① Study on current situation of environmental pollution in Sfax city

Study the actual situation of industrial pollution in Sfax City and carry out environmental assessment.

② Preparation of written implementation plan

Evaluate the contents of this report, determine the most suitable cases and prepare written implementation plan (including details of facilities, total processes, and financing plan)

③ Promotion of governmental subsidies and accommodation of funds

Promote negotiations for taxes and subsidies, and secure funds accommodated

④ Promotion of implementation plan and schedule control check the implementation plan of each factory and control its progress

⑤ Technical guidance to each factory

Give advice on the implementation plan of each factory and give technical guidance including analysis

(3) Implementation plan of each factory

In addition to the plan of the above committee, each factory makes and carries out an implementation plan based on the basic plan of the committee.

4.2 Personnel Plan

A personnel plan was made for each factory and case about the operation of facilities.

Assumptions for the personnel plan and the outline are as follows.

(1) Operating personnel of the existing sulfuric acid plant which will be changed to a DCDA method, and the scrubbers of the phosphoric acid and TSP plants which will be also reconstructed will be continuously the operators of the plants reconstructed and therefore new operators were not provided in this plan.

(2) Water quality analysis personnel is necessary for the waste water treatment operation and newly provided.

(3) Current operating personnel of the factories are to take care of the exhaust fume treatment cyclone also and personnel for this purpose was not provided.

(4) Operating personnel of existing facilities are to take care of ONAS also and any personnel for this purpose was not provided.

Outline of the personnel plan is shown in Table VII-36.

Table VII-36 Personnel List

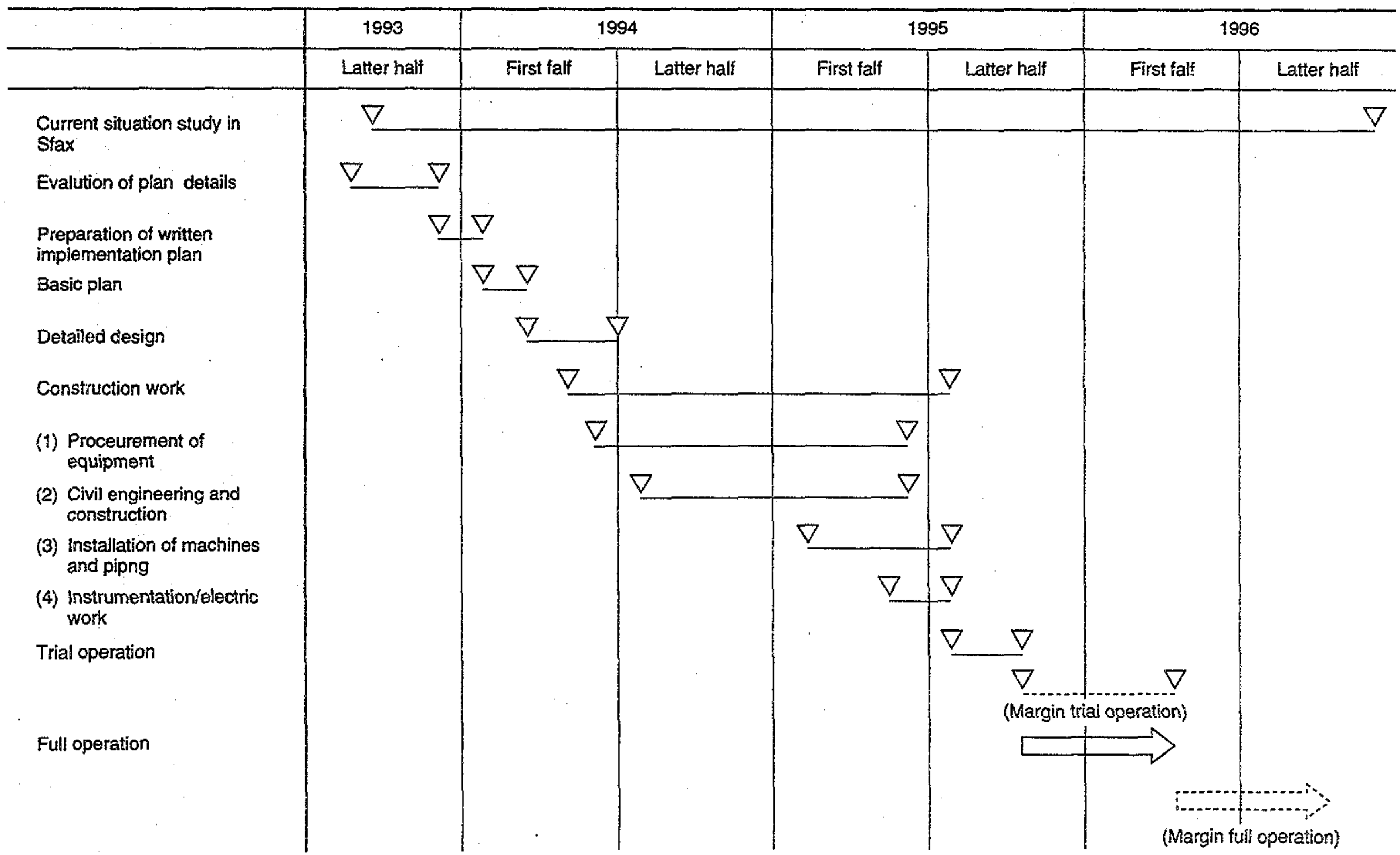
Facility	Name of factory	Case	No. of personnel				
			Engineer	Analysis engineer	Section leader	Operating personnel	Total
Waste water facility	SIAPE	1B		1	1	6	8
		2B		1	1	6	8
	UPOTS	1A	1	1	1	6	9
		2A	1	1	1	6	9
		3A	1	1	1	6	9
	SIOS-ZITEX	1A		1	1	1	3
		2A		1	1	3	5
		3A		1	1	3	5
		3B		1	1	3	5
		4A		1	1	5	7
	SATHOP	1A		1	1	1	3
		2A		1	1	3	5
		3A		1	1	3	5
		3B		1	1	3	5
		4A		1	1	5	7
	SMCP	1A		1	1	1	3
		2A		1	1	3	5
		3A		1	1	3	5
		3B		1	1	3	5
	STS	1A		0.5	0	0.5	1
		2A		0.5	0	0.5	1
		3A		0.5	0	0.5	1
	ONAS	3B		0	0	0	0
Exhaust fume facility	SIAPE			0	0	0	0
	SIOS-ZITEX			0	0	0	0
	SATHOP			0	0	0	0
	STS			0	0	0	0

4.3 Implementation Schedule

Implementation schedule for this plan is as follows, which is shown in Table VII-37.

(1)	Sfax current situation study:	Oct. '93 - Dec. '96
(2)	Evaluation of plan details:	Sept. '93 - Nov. '93
(3)	Preparation of written implementation plan:	Nov. '93 - Jan. '94
(4)	Basic plan:	Feb. '94 - Mar. '94
(5)	Detailed design:	Apr. '94 - June '94
(6)	Construction work:	May '94 - July '95
(7)	Trial operation:	Aug. '95 - Sept. '95
	(Margin:	Oct. '95 - Mar. '96)
(8)	Full operation:	Oct. '95 -
	(Margin:	April '96 -)

Table VII-37 Schedule for Industrial Pollution Prevention Plan in Sfax



VOLUME VIII

TRIAL CALCULATION OF FINANCIAL AND ECONOMIC PROFIT AND LOSS

VOLUME VIII TRIAL CALCULATION OF FINANCIAL AND ECONOMIC PROFIT AND LOSS

As the last of the present study, we made a trial calculation of financial and economic effect of profit and loss on enterprises.

When a construction plan of new production facilities is studied, financial and economic analysis for judging the profitability of investment is usually implemented.

But, there is no established analytical method for the environmental countermeasure which is a theme of the present study.

Moreover, the countermeasures and facilities following each standard set in Volume V are quite different each other is contents.

The effect of financial and economic profit and loss on each enterprise was calculated by these standards as a internal rate of return (IRR) by setting some preconditions.

In the trial calculation of this volume, continuation of each enterprise and observance of the minimum environmental standard were set as preconditions.

The result of trial calculation should not be used for seeking after the possibility of investment.

Therefore, in trial calculation, we only indicate the effect of financial profit and loss on each enterprise, the necessity of managerial efforts and the importance of governmental subsidiary measures as indices.

1. Total Capital Requirement and Capital Plan

1.1 Total Capital Requirement

The total capital requirement is divided into the cost of constructing the facilities and equipment, and cost for pre-operation stage (cost of personnel training, test operation, and office work plus interest during the construction period). It refers to the fund invested before the operation start.

Table VIII-1 summarizes the calculation results of the total capital requirement. The contents of each expenditure is as shown below.

Table VIII-1 Total Capital Requirement

(Unit:1000 TD)

		Case	Training Expense	Test Operation Expense	Office work cost, etc.	Interest During Constr.	Pre-operating Expense	Con-struction cost	Capital Require-ment
Waste Water Treatment Facilities	SIAPE	1B	3.6	49.8	18.0	206.4	277.7	3.449.4	3.727.1
		2B&3B	3.6	50.9	31.2	366.0	451.7	6.101.2	6,552.9
	UPOTS	1A	13.4	18.4	44.3	692.9	769.0	8,456.0	9,225.0
		2A	13.4	23.9	51.2	806.9	895.4	9.847.6	10,743.0
		3A	13.4	25.2	52.9	834.8	926.3	10,183.2	11,109.5
	STOS-ZITEX	1A	1.6	0.5	2.1	21.0	25.1	354.0	379.1
		2A	2.4	0.9	9.6	108.6	121.4	1.817.7	1,939.1
		3A	2.4	1.1	10.7	122.4	136.6	2.043.0	2,179.6
		3B	2.4	1.1	10.0	113.4	126.8	1,899.0	2.025.8
		4A	3.2	1.5	9.6	108.0	122.3	1,803.0	1,925.3
	SATHOP	1A	2.4	0.6	2.4	22.8	28.1	382.3	410.4
		2A	2.4	1.1	9.8	111.0	124.3	1,856.0	1,980.3
		3A	2.4	1.2	11.0	126.6	141.2	2,114.1	2,255.3
		3B	2.4	1.2	10.7	123.0	137.3	2,054.7	2,192.0
		4A	3.2	0.9	10.0	111.6	125.6	1,868.8	1,994.4
	SMCP	1A	1.6	0.4	4.3	48.0	54.2	800.2	854.4
		2A	2.4	0.7	8.8	100.2	112.1	1,670.2	1.782.3
		3A	2.4	0.7	9.4	106.8	119.3	1,781.6	1,900.9
		3B	2.4	1.0	10.3	118.2	131.9	1,971.3	2,103.2
	STS	1A	0.5	0.1	0.9	9.6	11.1	167.1	178.2
		2A	0.5	0.1	1.6	18.0	20.2	303.4	323.6
		3A	0.5	0.1	2.2	24.6	27.4	416.9	444.3
	ONAS		2.4	3.4	5.2	56.4	67.4	941.0	1,008.4
Exhaust Gas Treatment Facilities	SIAPE		2.4	10.6	77.9	1315.0	1405.8	15,479.9	16,885.7
	SIOS-ZITEX		2.4	0.3	1.4	15.3	19.4	188.5	207.9
	SATHOP		2.4	0.3	1.5	17.9	22.1	210.8	232.9
	STS		2.4	0.0	0.7	4.3	7.4	52.5	59.9

(1) Facility construction costs

The case of study for three cases of the tentative standard proposed by Japan, the tentative standard proposed by Tunisia and INNORPI which are selected as the pollution regulation values in this study, cases by discharge destination and case of process improvement are shown in Table VIII-2.

Table VIII-2 Study Cases

Classification	Case	Basic standard	Discharge destination
Waste water treatment facilities	CASE1A/B	Tentative standard proposed by Japan	A:ONAS, B:SEA
	CASE2A/B	Tentative standard proposed by Tunisia	A:ONAS, B:SEA
	CASE3A	INNORPI	ONAS
	CASE3B	INNORPI	SEA
	CASE4A	Tentative standard proposed by Japan	Process improvement considered
Exhaust gas treatment facilities			

Construction cost of facilities was calculated by taking the results of conceptual design into account. First, the construction cost in Japan as of April 1993 was added up, then the result was converted into Tunisian values by the following method:

① From the field survey result, cost of machines and equipment was estimated by 70% as import from neighboring advanced countries and 30% as domestically procured within Tunisia. Price index was set to 90% of the Japanese commodity price for the import products by assuming that they are imported from France, and 70% for the domestic products of Tunisia, and an average conversion rate to 85%.

In establishing the cost index, considering Article 7 of Law No. 88-91 which exempts the import tax and sales tax, these taxes have been excluded from the calculation.

② From the field survey result, it was determined that the whole field construction work can be executed by the domestic construction companies of Tunisia, so that the cost was estimated at 75% of the level in Japan.

③ The construction cost based on Japanese Yen was converted into Tunisian Dinars (TD) based on the exchange rate information from the Bank of Tokyo as of April 1993 as follows:

1 TD = 0.8085 SDR, 1 SDR = 1.37500 US$, US$1 = ¥112, therefore,
1 TD = ¥125.

As the reference term of the work was set to eighteen months from the start of basic design till the time of completion and test run, considering the range and difficulty of the construction, and the term of the work for margin was set to 24 months.

Table VIII-3 summarizes the construction cost classified by factory and by case.

Table VIII-3 Construction Cost

(Unit : 1000 TD)

Facilities	Factory	Case	Machine & Equip.	Incidental Equip.	Sub Total	Field Work	Total
Waste Water Treatment Facilities	SAIPE	1B	1735.4	304.6	2040.0	1409.4	3449.4
		2B&3B	4005.2	455.6	4460.8	1640.4	6101.2
	UPOTS	1A	4148.0	408.0	4556.0	3900.0	8456.0
		2A	5134.0	489.6	5623.6	4224.0	9847.6
		3A	5385.6	489.6	5875.2	4308.0	10183.2
	SIOS-ZITEX	1A	129.2	54.4	183.6	170.4	354.0
		2A	1046.2	159.8	1206.0	611.7	1817.7
		3A	1176.4	180.2	1356.6	686.4	2043.0
		3B	1094.8	159.8	1254.6	644.4	1899.0
		4A	513.4	53.0	566.4	1236.6	1803.0
	SATHOP	1A	135.3	64.6	199.9	182.3	382.2
		2A	1023.4	176.8	1200.2	655.8	1856.0
		3A	1175.0	204.0	1379.0	735.4	2114.4
		3B	1102.3	231.2	1333.5	721.3	2054.8
		4A	542.6	64.6	607.2	1261.6	1868.8
	SMCP	1A	349.9	142.8	492.7	307.5	800.2
		2A	1012.9	193.8	1206.7	463.5	1670.2
		3A	1123.7	193.8	1317.5	464.1	1781.6
		3B	1165.5	219.3	1384.8	586.5	1971.3
	STS	1A	52.5	26.4	78.9	88.2	167.1
		2A	155.0	37.4	192.4	111.0	303.4
		3A	230.5	44.2	274.7	142.2	416.9
	ONAS		112.2	414.8	527.0	414.0	941.0
Exhaust Gas Treatment Facilities	SIAPE		11198.4		11198.4	4281.5	15479.9
	SIOS-ZITEX		149.9		149.9	38.6	188.5
	SATHOP		167.3		167.3	43.5	210.7
	STS		40.8		40.8	11.7	52.5

(2) Cost of personnel training

The antipollution facilities under the present study does not require any expert techniques for the operation or management. However, it was decided to give a concentrated training session to the personnel for two months (or three months for the facilities for MARGIN) before starting the test run, on the assumption of a full-scale operation of the facilities.

To cover the above session, the training cost has been appropriated (utility expense, chemicals expense, labor expense, and factory overhead).

(3) Cost of test run supervision and technical support

Cost of supervision for starting the test run and technical support during the construction work is assumed to be included in the construction cost, and is therefore not to be added as an independent item.

(4) Initial refill cost of chemicals

Cost of the initial refill of chemicals, filters, and catalysts is assumed to be included in the construction cost or test run cost, and is therefore not to be added as independent item.

(5) Test run cost

As the test run period, six months are assumed to be required for the margin treatment to stabilize the treatment facilities, and two months for the exhaust-gas treatment and other waste water treatment. The labor expense, chemicals expense, electricity expense, etc. are assumed to be about 60% of the operation cost after starting the operation.

(6) Factory overhead and others

As the factory overhead for the construction period, about 0.5% of the construction cost has been added as a requisite during the period from the beginning of construction till the personal training start time. Also 10% of the personnel training cost and test run cost has been appropriated as the direct and indirect expenditure for the management staff, based on the personnel composition ratio.

1.2 Capital Plan

The capital plan and interest for the construction period have been prepared from the roughly estimated construction cost decribed in Section 1.1 above, by providing the following conditions:

(1) Division of construction period

The two years period from one year after the construction start (1.5 to 2 years prior to the operation start) till the second year from the construction start have been divided by four quarters, and the quarters are indicated as 1Y (1st year)/1Q (1st quarter) to 2Y (2nd year)/4Q (4th quarter).

(2) Criteria for Payment

① For Machines and equipment: Payment shall be made by three installments: — first installment on placing an order, second installment in the intermediate period, then the final installment on delivery acceptance. This is based on the consideration that a long period of time is required for the import or manufacture, and without any particular binding practice of contract.

The criteria by construction period is set as follows:

24 months' construction period: 1Y/1Q:30%, 1Y/3Q: 25%, 2Y/2Q: 25%, 2Y/4Q: 20%

18 months' construction period: 1Y/1Q: 30%, 1Y/3Q: 20%, 1Y/4Q: 20%, 2Y/2Q: 30%

② For construction work: Mainly the personnel expenses (wages). According to the field survey, it is known that the payment term for individual accounts can be established upon each ordering. Therefore, the following payment terms have been determined:

24 months' construction period: 1Y/3Q: 10%, 1Y/4Q: 20%, 2Y/1Q: 20%, 2Y/2Q: 20%, 2Y/3Q: 20%, 2Y/4Q: 10%

18 months' construction period: 1Y/2Q: 20%, 1Y/3Q: 20%, 1Y/4Q: 20%, 2Y/1Q: 20%, 2Y/2Q: 20%

Table VIII-4 summarizes the payment schedule of the construction cost by factory and by case which are the fund raising bases.

(3) Fund raising

For the fund raising, analysis has been made on the financial status of each enterprise based on the field survey results (financial situation and general management situation of each enterprise, etc.) and on the financial reports such as the financial statement of each enterprise. Consequently, taking account of the local fund raising examples, and considering the fact that the present investment is intended for antipollution facilities, the following conditions have been provided:

① Self-financing: The analysis of financial statements has led to a conclusion that a self-financing is difficult. Furthermore, in view of the non-profit making nature of the planned investment, capital increase is also difficult. In consequence, self-financing is assumed to be zero.

② Public subsidy: When the present investment is approved by the Tunisian Government as a project of antipollution facility, it can be subject to the public subsidy for environmental protection (Article 7 of Law No.88-91). Therefore, a special loan from the central bank (interest on borrowing: 8% per annum) is assumed.

③ Loan: Out of the total capital required, except the interest for the construction period, long term loans payable from the central bank are assumed for the amount of payment schedule based on the above criteria. To cover the money equivalent to the interest for the construction period, short-term loans from commercial bank are considered.

(4) Interest for the construction period

The interest for the construction period is assumed as being generated during the construction period for the balance of borrowed money. It has been calculated by setting the interest and repayment conditions as follows:

① Interest rate: 8% per annum for long-term and short-term borrowing

② Repayment condition: Repayment shall be made after the start of the operation, taking account of the corresponding depreciation.

Table VIII-4 Payment Schedule for Construction Cost

		Case	Construction Cost			1Y/1Q	1Y/2Q	1Y/3Q	1Y/4Q	2Y/1Q	2Y/2Q	2Y/3Q	2Y/4Q	Total
			Machine & Equipment	Field Work	Total									
Waste Water Treatment Facilities	SIAPE	1B	2040.0	1409.4	3449.4	612.0	281.9	689.9	689.9	281.9	893.9	0.0	0.0	3449.4
		2B&3B	4460.8	1640.4	6101.2	1338.2	328.1	1220.2	1220.2	328.1	1666.3	0.0	0.0	6101.2
	UPOTS	1A	4556.0	3900.0	8456.0	1366.8	0.0	1529.0	780.0	780.0	1919.0	780.0	1301.2	8456.0
		2A	5623.6	4224.0	9847.6	1687.1	0.0	1828.3	844.8	844.8	2250.7	844.8	1547.1	9847.6
		3A	5875.2	4308.0	10183.2	1762.6	0.0	1899.6	861.6	861.6	2330.4	861.6	1605.8	10183.2
	STOS-ZITEX	1A	183.6	170.4	354.0	55.1	34.1	70.8	70.8	34.1	89.2	0.0	0.0	354.0
		2A	1206.0	611.7	1817.7	361.8	122.3	363.5	363.5	122.3	484.1	0.0	0.0	1817.7
		3A	1356.6	686.4	2043.0	407.0	137.3	408.6	408.6	137.3	544.3	0.0	0.0	2043.0
		3B	1254.6	644.4	1899.0	376.4	128.9	379.8	379.8	128.9	505.3	0.0	0.0	1899.0
		4A	566.4	1236.6	1803.0	169.9	247.3	360.6	360.6	247.3	417.2	0.0	0.0	1803.0
	SATHOP	1A	199.9	182.4	382.3	60.0	36.5	76.5	76.5	36.5	96.5	0.0	0.0	382.3
		2A	1200.2	655.8	1856.0	360.1	131.2	371.2	371.2	131.2	491.2	0.0	0.0	1856.0
		3A	1379.1	735.0	2114.1	413.7	147.0	422.8	422.8	147.0	560.7	0.0	0.0	2114.1
		3B	1333.5	721.2	2054.7	400.1	144.2	410.9	410.9	144.2	544.3	0.0	0.0	2054.7
		4A	607.2	1261.6	1868.8	182.2	252.3	373.8	373.8	252.3	434.5	0.0	0.0	1868.8
	SMCP	1A	492.7	307.5	800.2	147.8	61.5	160.0	160.0	61.5	209.3	0.0	0.0	800.2
		2A	1206.7	463.5	1670.2	362.0	92.7	334.0	334.0	92.7	454.7	0.0	0.0	1670.2
		3A	1317.5	464.1	1781.6	395.3	92.8	356.3	356.3	92.8	488.1	0.0	0.0	1781.6
		3B	1384.8	586.5	1971.3	415.4	117.3	394.3	394.3	117.3	532.7	0.0	0.0	1971.3
	STS	1A	78.9	88.2	167.1	23.7	17.6	33.4	33.4	17.6	41.3	0.0	0.0	167.1
		2A	192.4	111.0	303.4	57.7	22.2	60.7	60.7	22.2	79.9	0.0	0.0	303.4
		3A	274.7	142.2	416.9	82.4	28.4	83.4	83.4	28.4	110.9	0.0	0.0	416.9
	ONAS		527.0	414.0	941.0	158.1	82.8	188.2	188.2	82.8	240.9	0.0	0.0	941.0
Exhaust Gas Treatment Facilities	SIAPE		11198.4	4281.5	15479.9	3359.5	856.3	3096.0	3096.0	856.3	4215.8	0.0	0.0	15479.9
	SIOS-ZITEX		149.9	38.6	188.5	45.0	7.7	37.7	37.7	7.7	52.7	0.0	0.0	188.5
	SATHOP		167.3	43.5	210.8	50.2	8.7	42.2	42.2	8.7	58.9	0.0	0.0	210.8
	STS		40.8	11.7	52.5	12.2	2.3	10.5	10.5	2.3	14.6	0.0	0.0	52.5

2. Calculation of Operation Cost

(1) Preconditions of calculation

The operating conditions of each facility and preconditions for calculating the operation cost are as detailed below.

1) Number of work days

① Waste water treatment facilities: Continued operation per annum (365 days) 8760 hours

② Exhaust gas treatment facilities: 300 days/year — 7200 hours

③ Glycerol recovery facilities: 330 days/year (SIOS-ZITEX/SATHOP)

2) Operation cost

The operation cost consists of variable cost and fixed cost. The variable cost includes the chemicals expense and utility expense. The fixed cost includes labor expense, maintenance expense, depreciation expense, catalyst depreciation, and factory overhead.

Cost of the land is considered as a buried cost, and is not included in the calculation, because the facilities are constructed within the factory site without additional expenditure. Property taxes and insurance premium are regarded as not necessary because the object is an environmental facilities.

(2) Calculation of operation cost

1) Chemicals expense:

The cost per day was calculated by estimating the consumption per day for each factory and each case. The unit purchase price was based on the result of field survey. For unknown items, the price based on Japan was converted into Tunisian based price.

$Ca(OH)_2$	(70%)	0.2 TD/kg	Alum	(8%)	0.16 TD/kg
Polymer		8	$CO(NH_2)_2$	(70%)	0.88
HCl	(35%)	0.24	NaOH	(24%)	0.108
NaClO	(12%)	0.32	NaH_2PO_4		3.12
H_3PO_4	(89%)	2.52			

The variable cost related to the process improvement (glycerol recovery) was calculated individually by separate estimation.

2) Utility expense:

First, the daily consumption at each factory and case was estimated to obtain the expense per day.

The unit purchase price was based on the result of field survey.

Electricity (medium pressure: 10, 15, 30 kV)	0.056 TD/kwh
Electircity (low pressure: 220, 380 V)	0.076 TD/kwh
Electricity (high pressure: 90,150,225 kV)	0.036 TD/kwh
Fuel oil (large consumption)	106 TD/*kl*

City water: rental/maintenance fee of water supply pipeline:

1.287 to 124.047 TD/Q (15 to 150 mm)

Water cost: 0.573 TD/m^3

Sewage treatment: Subscription fee 4,030 TD/quarter

Basic treatment fee 0.230 TD/m^3

Clean: 0.175

Dirty: 0.270

3) Labor expense

Number of required personnel was calculated for each factory and each case by job type. Unit price of the wage was based on the followings:

General manager:	650 TD/month-person
Production manager:	550 TD/month-person
Engineer:	450 TD/month-person
Skilled worker:	300 TD/month-person
Team head:	280 TD/month-person
Operator:	200 TD/month-person

4) Maintenance expense:

The following rates have been appropriated based on the record of existing facilities in Japan and considering the field survey result:

Consumption of ordinary repair parts and cost of consumables:

1.5% of the acquisition price of equipment

Repair fee after failure occurrence:

1.5% of the acquisition price of equipment

Total: 3% of the acquisition price of equipment

5) Depreciation expense:

The rates below have been adopted based on the field survey result. According to Article 7 of Law No.88-91, an antipollution equipment is subject to an additional depreciation by 15% per annum when the plan is approved by the Government. However, since this is a tax-exempted subsidy, such additional depreciation is treated as a reserve, and identified from the ordinary depreciation.

Ordinary depreciation: Ratio 10% by straight line method

These depreciation expenses are treated as an operation cost.

Special depreciation: Ratio 15% by straight line method

These depreciation expenses are not treated as operation cost by accounting them to be special depreciation reserves.

By the taxation system, an unlimited extension of depreciation is approved in case of a profit shortage. In ordinary case, however, the depreciation expenses shall be included in the expenditure for the fiscal year, including the special depreciation.

Table VIII-5 lists the calculation results of the depreciation and the special depreciation by factory and by case.

6) Catalyst depreciation:

The life of catalyst input in the exhaust gas treatment facilities is five years. Hence, the calculation has been based on five years' equal amount depreciation. Cost of the replacement work and waste catalyst treatment is included in the catalyst purchase cost.

7) Factory overhead cost:

The following ratio has been established based on the record of existing equipment in Japan and the field survey results:

10% of fixed operation cost.

The overhead shall include the direct management cost related to the analysis, operation, and maintenance work.

Table VIII-6 summarizes the calculation results of operation cost by factory and by case.

Table VIII-5 Depreciation Expenses

(Unit: 1000 TD)

		Case	Equipment Acquisition Price Const. Cost	Pre-ope. Expense	Total	Residual Value	Number of Depreci. Years	Dep. Meth. Straight Line M.	Depreci. Ratio %	Depreci. Expense	Special Depreci. & tax exemption: Special Depreci. 15%	Tax Exmp. Effect 35%
Waste Water Treatment Facilities	SIAPE	1B	3449.4	277.7	3727.1	0	10		10	372.7	559.1	195.7
		2B&3B	6101.2	451.7	6552.9	0	10		10	655.3	982.9	344.0
	UPOTS	1A	8456.0	769.0	9225.0	0	10		10	922.5	1383.7	484.3
		2A	9847.6	895.4	10743.0	0	10		10	1074.3	1611.5	564.0
		3A	10183.2	926.3	11109.5	0	10		10	1110.9	1666.4	583.2
	SIOS-ZITEX	1A	354.0	25.1	379.1	0	10		10	37.9	56.9	19.9
		2A	1817.7	121.4	1939.1	0	10		10	193.9	290.9	101.8
		3A	2043.0	136.6	2179.6	0	10		10	218.0	326.9	114.4
		3B	1899.0	126.8	2025.8	0	10		10	202.6	303.9	106.4
		4A	1803.0	122.3	1925.3	0	10		10	192.5	288.8	101.1
	SATHOP	1A	382.3	28.1	410.4	0	10		10	41.0	61.6	21.5
		2A	1856.0	124.3	1980.3	0	10		10	198.0	297.0	104.0
		3A	2114.1	141.2	2255.3	0	10		10	225.5	338.3	118.4
		3B	2054.7	137.3	2192.0	0	10		10	219.2	328.8	115.1
		4A	1868.8	125.6	1994.4	0	10		10	199.4	299.2	104.7
	SMCP	1A	800.2	54.2	854.4	0	10		10	85.4	128.2	44.9
		2A	1670.2	112.1	1782.3	0	10		10	178.2	267.3	93.6
		3A	1781.6	119.3	1900.9	0	10		10	190.1	285.1	99.8
		3B	1971.3	131.9	2103.2	0	10		10	210.3	315.5	110.4
	STS	1A	167.1	11.1	178.2	0	10		10	17.8	26.7	9.4
		2A	303.4	20.2	323.6	0	10		10	32.4	48.5	17.0
		3A	416.9	27.4	444.3	0	10		10	44.4	66.6	23.3
	ONAS		941.0	67.4	1008.4	0	10		10	100.8	151.3	52.9
Exhaust Gas Treatment Facilities	SIAPE		15479.9	1405.8	16885.7	0	10		10	1640.7	2461.1	861.4
	SIOS-ZITEX		188.5	19.4	207.9	0	10		10	20.8	31.2	10.9
	SATHOP		210.8	22.1	232.9	0	10		10	23.3	34.9	12.2
	STS		52.5	7.4	59.9	0	10		10	6.0	9.0	3.1

Table VIII-6 Operation Cost

(Unit:1000 TD/Year)

		Case	Utility Expense	Chemical Expense	Labor Expense	Mainte. Expense	Depreci. Expense	Factory Overhead	Catalyst Depreci.	Total
Waste Water Treatment Facilities	SIAPE	1B	66.2	2898.1	21.4	111.8	372.7	50.6		3520.8
		2B&3B	98.1	2933.6	21.4	196.6	655.3	87.3		3992.3
	UPOTS	1A	68.7	23.1	26.8	276.7	922.5	122.6		1440.4
		2A	74.6	54.0	26.8	322.3	1074.3	142.3		1694.2
		3A	76.5	60.8	26.8	333.3	1110.9	147.1		1755.4
	SIOS-ZITEX	1A	5.4	11.0	9.4	11.4	37.9	5.9		80.9
		2A	9.3	28.1	14.2	58.2	193.9	26.6		330.3
		3A	22.6	29.2	14.2	65.4	218.0	29.8		379.1
		3B	21.1	29.4	14.2	60.8	202.6	27.8		355.8
		4A	55.1	11.7	19.0	57.8	192.5	26.9		363.0
	SATHOP	1A	4.9	13.3	9.4	12.3	41.0	6.8		87.6
		2A	20.1	32.1	14.2	59.4	198.0	27.2		351.0
		3A	21.1	33.8	14.2	67.7	225.5	30.7		393.0
		3B	21.1	34.2	14.2	65.8	219.2	29.9		384.3
		4A	13.2	18.4	19.0	59.8	199.4	27.8		337.7
	SMCP	1A	3.4	7.3	9.4	25.6	85.4	12.0		143.2
		2A	10.3	14.7	14.2	53.5	178.2	24.6		295.4
		3A	10.3	16.1	14.2	57.0	190.1	26.1		313.8
		3B	16.2	25.8	14.2	63.1	210.3	28.8		358.4
	STS	1A	1.5	0.1	3.0	5.3	17.8	2.6		30.4
		2A	2.0	0.7	3.0	9.7	32.4	4.5		52.2
		3A	2.5	1.5	3.0	13.3	44.4	6.1		70.8
	DNAS		40.2	165.5	0.0	30.3	100.8	13.1		349.9
Exhaust Gas Treatment Facilities	SIAPE		282.2	0.0	0.0	506.6	1640.7	214.7	95.7	2644.3
	SIOS-ZITEX		8.5	0.0	0.0	6.2	20.8	2.7		38.2
	SATHOP		9.3	0.0	0.0	7.0	23.3	3.0		42.6
	STS		1.2	0.0	0.0	1.8	6.0	0.8		9.8

3. Financial Analysis

The present project study on countermeasures for waste water and exhaust gas can be called a kind of social infrastructural adjustment. For the investment on such non-productive facilities, it is difficult to determine or measure the economic benefits in numerical data. While it hardly conform to the evaluation by financial or economic analysis, we have decided to perform the study by using the concept of the opportunity cost or shadow price.

Based on the studies described above, we intended to analyze the influence over the financial profit by the present financial status and managerial achievement of each enterprise. For the analysis, we have generated such documents as a statement of profit and loss, and a cash flow statement.

(1) Present state analysis of each enterprise

A simple analysis has been made on the present state of each enterprise within the range of information provided by the field survey, such as the financial statements. The analysis is based on the fact that the planned investment will work a substantial influence over the management of the enterprises, and the capability of each enterprise to bear the cost is an important factor for selecting the case.

Further, for the calculation of economic benefits which will be described later, each enterprise's capability to bear the additional depreciation expenses is the precondition. From this, we have estimated a long-term capability and the room for qualitative improvement of each enterprise. For a convenience sake, we have estimated the possible changes of profits and losses of each enterprise, taking account of the favorable change of the managing environment and their policy of saving the fixed expenditures. Thus, a simulation of the possibility has been tried for the enterprises to decide the investment on the non-profit-making projects against the industrial pollution. Such simulation was made to foresee in what situation those enterprises can reach such decision under the existing public subsidy system.

The following summarizes the results of analysis:

① The numerical data shows that the enterprises are based on a managerial fundamentals and environment that hardly ensure a stable production continued for a long time-span. That is, operating ratio of the production equipment fluctuates with external factors (such as the demand-supply balance, and condition of raw-material supply). Continuation of hard-to-control conditions, such as the growing trend and sudden increase/decrease of the products and raw materials in stock, fluctuation of the production unit figure (estimate) and production profit ratio, etc.

② The enterprises require a qualitative improvement of the financial state, and have no retained profit for reinvestment.

Capital structure: The owned capital ratio is relatively high.

Quality of assets: The assets are concentrated on the products and raw materials in stock, with limited current assets (cash, deposits, securities, etc.). (That means a high ratio of current assets themselves.)

(a) For reinvestment on the production facilities, the funds will fully depend on the external source.

(b) Evaluation of the owned capital can also be reduced according to the inventory state of the products and raw material (existence of bad stock).

③ The present financial analysis has brought about a conclusion that, to encourage the investment on non-productive equipment, support of the public subsidies is an indispensable condition for the fund and operating cost.

④ For the SIAPE, it was impossible to try a full simulation because of an extremely low gross production profit ratio. The company is in need of a drastic reform of the management before studying the investment on the present plan.

⑤ Other enterprises appear to have a room to improve the profit to enable the planned investment.

Table VIII-7 summarizes the analysis results on the possibility of environmental countermeasures based on the major financial index and assumption of favorable turn of business and managerial efforts.

As an evaluation of this investment, we proceed our study on condition that there will be some efforts for improvement or subsidies as SIAPE is a nationalized enterprise.

The managerial information from the field survey has been obtained by the cooperation of the enterprises, by restricting the objective solely to using the information for the present analysis. Therefore, this data must be disclosed to the public by going through a close inspection and approval by those companies.

Table VIII-7 Analysis of Present State of Enterprices (from information for 1991)

(Unit: 1000 TD, %)

	Financial Accounting							Financial Analysis Index						
	Total Assets	Owned Capital	Borrowed Capital	Sales Amount	Estimate Raw Material Cost	Gross Product. Profit	Net Profit	Average Operat. Ratio	Owned Capital Ratio	Current Liability Ratio	Quick Ratio	Pro. Ratio of Variab Exped.	Labor Ex. /Total Expense	Stock/ Sales Amount
S I A P E	86,000	64,403	21,597	49,669	41,960	1,280	-13,674	83.4%	74.9%	31.7%	2.7%	3.0%	13.4%	45.0%
														5.4 M
SIOS-ZITEX	2,798	1,676	1,122	2,676	1,703	973	279	79.0%	59.9%	53.6%	24.8%	36.4%	30.6%	19.7%
														2.4 M
S A T H O P	734	477	257	1,346	718	211	22	95.6%	65.0%	53.3%	8.1%	15.7%	28.2%	15.0%
														1.8 M
S M C P	-2,185	768	1,417	1,901	1,598	303	60	83.8%	35.2%	40.3%	0.4%	15.9%	7.3%	10.3%
														1.2 M
S T S	447	336	111	1,195	921	258	-51	50.0%	75.2%	96.2%	42.6%	21.6%	18.4%	33.7%
														4.4 M

(Analysis Financial Profits/Losses)

SIMULATION-1 Correction of Operating Ratio of Production Facilities
(1)Corrected to Full Operating Ratio(Slide by 30% of Sales Amount, Production Gross profit, and Labor Cost, Other Item are Fixed)

SIMULATION-2 Selling Price Correction (1) 10%UP , (2) 15%UP , (3) 20%UP Salles Efforts, etc.

SIMULATION-3 Correction of Profit Ratio to Variable Expenses (1) 5%UP , (2) 10%UP , (3) 15%UP
Increase in Profit Ratio in Basic Production Unit, and Efforts for a Low-price Procurement of Raw Material

SIMULATION-4 Reduction / Correction of Fixed Expenses (1) 10%UP , (2) 20%UP , (3) 30%UP
Labor Efficiency Improvement, Reduction of Indirect Division(Reduction of Labor Cost), Thorough Control of Expenditure Budget

SIMULATION-5 Enforcement of Items SIMULATION 2-4 above

SIMULATION-6 Enforcement of Item SIMULATION 1-4 above

(Unit:1000 TD)

	SIMULATION-1			SIMULATION-2			SIMULATION-3			SIMULATION-4			SIMULATION-5			SIMULATION-6		
	Sales Amount	Product. Profit	Net Profit	Sales Amount	Product. Profit	Net Profit	Sales Amount	Product. Profit	Net Profit	Sales Amount	Product. Profit	Net Profit	Sales Amount	Product. Profit	Net Profit	Sales Amount	Product. Profit	Net Profit
S I A P E (1)	59,555	12,926	-2,464	54,636	6,247	-8,707	49,669	3,974	-10,980	49,669	3,974	-11,536	54,636	8,940	-3,875	65,511	9,810	-3,441
(2)				57,119	8,730	-6,224	49,669	6,457	-8,497	49,669	6,457	-9,397	57,119	13,907	3,230	68,488	15,385	4,272
(3)				59,603	11,214	-3,740	49,669	8,940	-6,014	49,669	8,940	-7,259	59,603	18,874	10,335	71,466	21,010	12.034
SIOS-ZITEX (1)	3,715	1,350	367	2,944	1,241	547	2,676	1,108	414	2,676	1,108	348	2,944	1,375	751	4,087	1,849	935
(2)				3,077	1,374	680	2,676	1,242	548	2,676	1,242	418	3,077	1,509	954	4,272	2,064	1,219
(3)				3,211	1,508	814	2,676	1,375	681	2,676	1,375	487	3,211	1,643	1,157	4,458	2,284	1,509
SATHOP (1)	1,550	243	48	1,481	346	157	1,346	279	90	1,346	279	83	1,481	413	285	1,705	460	325
(2)				1,548	413	224	1,346	346	157	1,346	346	143	1,548	481	413	1,783	541	467
(3)				1,615	480	291	1,346	413	224	1,346	413	204	1,615	548	541	1,860	623	610
S M C P (1)	2,180	470	203	2,091	493	250	1,901	397	154	1,901	397	84	2,091	587	369	2,398	652	409
(2)				2,186	588	345	1,901	492	249	1,901	492	109	2,186	682	488	2,507	766	547
(3)				2,281	683	440	1,901	587	344	1,901	587	133	2,281	778	607	2,616	881	687
S T S (1)	2,390	516	287	1,315	378	69	1,195	318	9	1,195	318	-19	1,315	437	161	2,629	787	431
(2)				1,374	437	128	1,195	378	69	1,195	378	14	1,374	497	253	2,749	931	607
(3)				1,434	497	188	1,195	437	128	1,195	437	47	1,434	557	345	2,868	1,082	790

(2) Major preconditions

The major preconditions to perform the financial analysis of the present study are summarized below.

1) Period:

The objective period has been set to fifteen years considering the economical durability of the facilities.

2) Price criteria:

To determine the construction cost, operation cost, and the economic benefits used for the financial analysis, the prices were fixed on the level in the year 1993, and the possible price escalation was not included. This was because the calculation was intended to compare the running cost and financial profits and losses, and it was preferable to exclude the uncertain price increase.

The basic design and operation of the present plan are supposed to start several years later. Actually, however, price increase by 10 to 30% must naturally be expected, thus increasing the total amount of the required capital from the above calculated level. Also there will be a large fluctuation in management records of the enterprises. This will obviously require a review of calculation for the actual stage of implementation. Nevertheless, the relative position of the determined influence is considered to remain almost the same over the financial profits and losses.

3) Tax system and rates:

In Tunisia, corporate income tax, personal income tax and value added tax are some of the main tax items. Corporate income tax consists of a standard minimum tax based on the sales amount as a standard and a proportionate tax based on the net income as the standard. The tax rates vary with the type of business. Some documents refers to 38% as the average rate, but we have set 35% as the proportionate tax for the present study based on the field survey results (by hearing).

(3) Economic benefits

1) Effect of evasion of output decrease by operation suspension

By implementing the present project, the subject entrepreneur shall fulfill the responsibility stipulated in Article 8 of Law No.88-91, to ensure an evasion of the penalty and order for suspension of operation by the application of penal clause in Article 11.

Considering the survey result, and the positive attitude of the environmental administration by the Tunisian Government, the obvious trend is toward a reinforced regulation for further prevention of industrial pollution. Also on the precondition to ensure a permanent existence of enterprises, and considering the examples of regulations and countermeasures in various countries, it can be judged as a whole that implementation of the present project will generate a greater effect than expected in the evasion of losses by the entrepreneurs.

For the present study, it is assumed that 15 to 90 days can be avoided from the suspension of operations when compared with a case of maintaining the present state, according to the precondition in Section (2) above, where 15 years are supposed to be the objective period.

Therefore, the gross production profit corresponding to the suspension period of operation is calculated as the opportunity cost for the operation suspension. Incidentally, some part of the operating ratio and sales amount has been modified to assume the calculation to be made on a healthy state of management, according to the survey result of each business enterprise.

Table VIII-8 shows the calculation results.

2) Reduction of cost for excessive part of waste water quality standard

Presently, the penalty regulations are currently applied on a flexible basis rather than the regulations by Article 8 and Article 11 of Law No.88-91 for 1988. For the future, however, the application of these regulations is likely to become more and more severe. The present countermeasures will eliminate such fear, so that the penalty money can be treated as an avoidable cost to be added as a part of the economic benefits.

The avoidable penalty amount is calculated to 50,000 TD per business enterprise, considering the present situation.

3) Reduction of sewage treatment cost

The sewage treatment fee is to be levied as penalty if, accord- ing to the sewage treatment regulations, an inhibition or refusal of drainage to the sewage lines is proved (in the amount same as the clean sewage fee).

From this, for the direct discharge to the sea out of the subject waste water treatment system, the discharge cost at ONAS is added as an economic benefit because it can be an avoidable cost.

Table VIII-9 summarizes the calculation results.

Table VIII-8 Amount of Avoidable Output Decrease (per month)

	Sales Scale						Profit Racio of Variable Cost (%)			Loss from Output Decrease (per Month)		
	Sales for '89	Sales for '90	Sales for '91	Sales for '92	Correction of Sales	Correct. Sales	Base	Correction	Profit Ratio	Decrease in Pro.	Dec. in Fix. Cost	Net Loss
SIAPE	79,134	53,656	49,669		Base for 1989	79,134	'90 13.6	Correction of 20 % Increase in Selling Price	33.6	2,216	122	2,094
SIOS-ZITEX			2,676		79%=>90% Load, Sellig Price 10 % Increase	3,353	'91 36.4	Correction of 10 % Increase in Selling Price	46.4	130	13	117
SATHOP			1,346	1,555	Selling Price 15 % Increase	1,788	'92 20.9	Correction of 15 % Increase in Selling Price	35.9	53	5	48
SMCP			1,901		Selling Price 20 % Increase	2,281	'91 15.9	Correction of 20 % Increase in Selling Price	35.9	68	2	66
STS		1,133	1,195		50%=>90% Load, Sellig Price 10 % Increase	2,366	'91 21.6	Correction of 10 % Increase in Selling Price	31.6	62	4	58

Table VIII-9 Avoidable Cost of Sewage Treatment Fee

(Unit: TD)

		Quantity of Waste Water		Subscription Fee		Treatment Fee		Reduction of Sewage Treatment Fee
		M3/D	M3/Y	for a Quarter	for a Year	Unit Price of Treat.	for a Year	
SIAPE	CASE 1B	1,488	543,120	4,030	16,120	0.175	95,046	111,166
	CASE 2B	1,284	468,660	4,030	16,120	0.175	82,016	98,136
SIOS-ZITEX	CASE 4	206	75,190	4,030	16,120	0.175	13,158	29,278
SATHOP	CASE 4	156	56,940	4,030	16,120	0.175	9,965	26,085
SMCP	CASE 4	225	82,125	4,030	16,120	0.175	14,372	30,492

4) Output profit from by-products

Out of the objects of the present study, by-products are to be used for an effective utilization of resources and added as an economic benefit.

① Methane gas collected at the UPOTS margin facility:

By-product of 80,000,000 kcal/day — to be used as an alternative energy of fuel oil.

===> 8 T/D * 365 D/Y * 106 TD/Y = approx. 310,000 TD/Y

② Glycerol collected by the improved process of SIOS-ZITEX/SATHOP (for Case 4 only):

Collection of 0.32 T/day — This generates a profit of approx. 178,000 TD at the stage of variable cost, so that it is added as an economic benefit by case study.

===> Selling price: 2.16 TD/kg

Sales amount: 2.16 TD/kg * 320 kg/D * 330 D/Y = approx. 228,000 D/Y

Profit of variable cost: Sales 228,000 TD/Y – variable cost 50,000 TD/Y = approx. 178,000 TD/Y

③ Raw material cost reduction by exhaust gas countermeasures at SIAPE

Out of the raw materials, sulfur is reduced — to increase the profit of variable cost.

===> Profit of variable cost: 5.3 T/D * 300 D/Y * 148.4 TD/T (165 US$/T) = approx. 236,000 TD/Y

5) Tax exemption effect by execution of special depreciation

For the calculation of profit and loss account, a tax exemption effect is generated equivalent to the depreciation increase by the execution of a special additional depreciation. To add such effect as an economic benefit, the profit must reach a level to cover the special depreciation amount.

The antipollution cost is to be borne once by those who caused the pollution, but it must eventually be absorbed through the efforts of the enterprise, while a part thereof shall naturally be shifted to the beneficiaries in a form of price increase or subsidy from the national treasury.

That is, in the financial analysis, such subsidual step is appropriated as an economic benefit as effective method, not merely by name.

Table VIII-5 lists the results of calculating the special additional depreciation amounts.

(4) Cost

For the operation cost, the same description will apply as in Chapter 2 regarding the expense of chemicals, utilities, labor, maintenance, depreciation and, depreciation of catalysts, and factory overhead. Therefore, the description is omitted here to avoid duplication.

Regarding the interest, the facility construction fund was calculated as subject to preferential treatment, and the shortage of operation capital related to the operation cost was based on an expectation of some fund raising method allowing a short-term borrowing from the commercial banks.

The interest on borrowing was calculated at 8% per annum for the balance of loan payable for both long-term and short-term borrowings.

(5) Financial analysis method To analyze the profitability of investment, the financial internal rate of return (F.IRR) has been adopted.

The F.IRR is a method to obtain the profit ratio of capital investment on the collected amount of the fund after taking account of the depreciation expenses, catalyst depreciation, and interest. The F.IRR represents the essential profitability of the project, excluding the influence by the financing conditions (repayment period, interest, etc.) of the debts and the change of owned capital ratio.

Table VIII-10 and -11 list the study results of the financial analysis by case and by factory.

(6) Analysis of sensitivity

Sensitivity was analyzed on the influence over the financial profit and loss when the following main factors are changed:

① Change of construction cost

② Change of economic benefits

③ Change of variable cost

Table VIII-10 (1) Financial Internal Rate of Return by Case

	SIAPE			SIOS-ZITEX						SMCP			
	CASE 1B	CASE 2&3B	E. Gas T.	CASE 1A	CASE 2A	CASE 3A	CASE 3B	CASE 4A	E. Gas T.	CASE 1A	CASE 2A	CASE 3A	CASE 3B
(1)Construction Cost (Total Investment)	3.727	6,553	17,364	379	1,939	2,180	2,026	1,925	208	854	1,782	1,901	2,103
(2)Economic Benefits													
1)Evasion of Loss from Output Red.(2M)	4,188	4,188	4,188	234	234	234	234	234	234	132	132	132	132
2)Evaluayion of By-product			236					228	0				
3)Evasion of Penalty Payment	50	50		50	50	50	50	50		50	50	50	50
4)Evasion of Sewage Treatment Fee	111	98					29						30
5)Effect of Corporate Tax Exemption	196	344	861	20	102	114	106	101	11	45	94	100	110
Total	4,545	4,680	5,285	304	386	398	419	613	245	227	276	282	322
(3) Cost													
1)Utility Expense	66	98	282	5	9	23	21	55	8	3	10	10	16
2)Cemical Expense	2,898	2,934	0	11	28	29	29	12	0	7	15	16	26
3)Labor Expense	21	21	0	9	14	14	14	19	0	9	14	14	14
4)Maintenance Exp.	112	197	507	11	58	65	61	58	6	26	53	57	63
5)Depreciation Rxp.	373	655	1,641	38	194	218	203	193	21	85	178	190	210
6)Catalyst Depre.	0	0	96	0	0	0	0	0	0	0	0	0	0
7)Plant Overhead	51	87	215	6	27	30	28	27	3	12	25	26	29
8)Interrest	124	219	579	13	65	73	68	64	7	28	59	63	70
Total	3,645	4,211	3,320	93	395	452	423	427	45	172	355	377	428
(4)Profit & loss	900	469	1,965	211	-9	-54	-4	186	200	56	-78	-95	-106
(5)Collection Amount per Annum													
1)Output Red.(60 D)	1,397	1,343	4,281	262	250	237	266	443	228	170	159	159	174
F.IRR	44.04%	17.81%	24.41%	104.94%	4.71%	0.43%	5.19%	21.70%	241.40%	16.82%	-4.68%	-6.49%	-6.61%
2)Output Red.(30 D)	-697	-751	2,187	145	133	120	149	326	111	103	93	93	108
F.IRR	X	X	4.51%	45.44%	-12.55%	-24.75%	-10.14%	12.04%	71.55%	3.12%	X	X	X
3)Output Red.(15 D)	-1,744	-1,798	1,140	87	75	62	91	268	53	70	60	59	75
F.IRR	X	X	-12.79%	21.62%	X	X	X	6.67%	25.18%	-6.91%	X	X	X
4)Output Red.(45 D)	350	296	3,234	204	192	179	207	384	169	137	126	126	141
F.IRR	-3.37%	X	15.07%	72.33%	-2.03%	-6.96%	-1.08%	16.97%	136.72%	10.42%	-11.59%	-14.03%	-13.25%
5)Output Red.(90 D)	3,490	3,436	6,374	379	367	354	382	559	344	236	226	225	241
F.IRR	176.10%	70.49%	43.60%	H	16.07%	11.64%	16.03%	31.68%	H	29.51%	5.05%	3.38%	2.58%
Collection Amount Required for IRR=8%	555	977	2,588	56	289	325	302	287	31	127	266	283	313

Note: At SIAPE, Catalyst Input Cost is Included in the Construction Cost of Exhaust Gas Treatment Facilities(478).
X : No Profitability H : Calculation Overflow caused by too High Rate of Return

Table VIII-10 (2) Financial Internal Rate of Return by Case

	S A T H O P						S T S				U P O T S			O N A S
	CASE 1A	CASE 2A	CASE 3A	CASE 3B	CASE 4	E.Gas T.	CASE 1A	CASE 2A	CASE 3A	E.Gas T.	CASE 1A	CASE 2A	CASE 3A	
(1)Construction Cost (Total Investment)	410	1.980	2.255	2.192	1.994	233	178	324	444	60	9.225	10.743	11.109	1.008
(2)Economic Benefits														
1)Evasion of Loss from Output Red.(2M)	97	97	97	97	97	97	117	117	117	117				
2)Evaluayion of By-product					228						310	310	310	
3)Evasion of Penalty Payment	50	50	50	50	50	50	50	50	50	50	50	50	50	
4)Evasion of Sewage Treatment Fee				26										
5)Effect of Corporate Tax Exemption	22	104	118	115	105	12	9	17	23	3	484	564	583	3
Total	169	251	265	288	480	159	176	184	190	170	844	924	943	3
(3) Cost	5	20	21	21	13	9	1	2	2	1	69	75	77	40
1)Utility Expense	13	32	34	34	18	0	0	1	1	0	23	54	61	166
2)Cemical Expense	14	14	14	14	19	0	3	3	3	0	27	27	27	0
3)Labor Expense	12	59	68	66	60	7	5	10	13	2	277	322	333	30
4)Maintenance Exp.	41	198	226	219	199	23	18	32	44	6	922	1.074	1.111	101
5)Depreciation Rxp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6)Catalyst Depre.	7	27	31	30	28	3	3	5	6	1	123	142	147	13
7)Plant Overhead	14	66	75	73	66	8	6	11	15	2	307	358	370	34
8)Interrest	106	417	468	457	404	50	36	63	86	12	1.748	2.052	2.126	384
Total														
(4)Profit & loss	62	-166	-203	-169	75	109	140	121	104	158	-904	-1.128	-1.183	-380
(5)Collection Amount per Annum														
1)Output Red.(60 D)	117	98	98	123	341	140	163	164	164	166	326	304	299	-246
F.IRR	30.17%	X	X	-23.33%	12.35%	84.94%	168.93%	66.48%	43.00%	H	X	X	X	X
2)Output Red.(30 D)	69	50	49	74	293	91	105	105	105	108	268	246	240	-304
F.IRR	11.70%	X	X	X	8.13%	46.92%	82.65%	36.36%	22.78%	H	X	X	X	X
3)Output Red.(15 D)	44	25	25	50	269	67	76	76	76	79	239	217	211	-333
F.IRR	0.29%	X	X	X	5.86%	30.62%	52.45%	22.60%	12.38%	H	X	X	X	X
4)Output Red.(45 D)	93	74	74	99	317	116	134	135	134	137	297	275	270	-275
F.IRR	21.15%	X	X	X	10.28%	64.76%	120.25%	50.76%	32.78%	H	X	X	X	X
5)Output Red.(90 D)	166	147	146	171	390	188	222	222	222	224	385	362	357	-188
F.IRR	49.42%	-9.03%	-13.57%	-7.36%	17.10%	135.75%	329.09%	104.24%	65.90%	H	X	X	X	X
Collection Amount Required for IRR=8%	61	295	336	327	297	35	27	48	66	9	1.375	1.601	1.656	150

Note: X : No Profitability H : Calculation Overflow caused by too High Rate of Return

Table VIII-11 FIRR by Factory

	SIAPE			SIOS-ZITEX			SATHOP			STS			SMCP	UPOTS
	CASE 1B	E.Gas T.	Total	CASE 1A	E.Gas T.	Total	CASE 1A	E.Gas T.	Total	CASE 1A	E.Gas T.	Total	CASE 1A	CASE 1A
(1)Construction Cost	3,727	17,364	21,091	379	208	587	410	233	643	178	60	238	853	9,225
(Total Investment)														
(2)Economic Benefits														
1)Evasion of Loss from Output Red.(2M)	4,188	4,188	4,188	234	234	234	97	97	97	117	117	117	132	
2)Evaluayion of By-product		236	236		0	0			0			0		310
3)Evasion of Penalty Payment	50		50	50		50	50	50	100	50	50	100	50	50
4)Evasion of Sewage Treatment Fee	111		111			0			0			0		
5)Effect of Corporate Tax Exemption	196	861	1,057	20	11	31	22	12	34	9	3	12	45	484
Total	4,545	5,285	5,642	304	245	315	169	159	231	176	170	229	227	844
(3) Cost														
1)Utility Expense	66	282	348	5	8	13	5	9	14	1	1	3	3	69
2)Cemical Expense	2,898	0	2,898	11	0	11	13	0	13	0	0	0	7	23
3)Labor Expense	21	0	21	9	0	9	9	0	9	3	0	3	9	27
4)Maintenance Exp.	112	507	619	11	6	17	12	7	19	5	2	7	26	277
5)Depreciation Rxp.	373	1,641	2,014	38	21	59	41	23	64	18	6	24	85	922
6)Catalyst Depre.	0	96	96	0	0	0	0	0	0	0	0	0	0	0
7)Plant Overhead	51	215	266	6	3	9	7	3	10	3	1	3	12	123
8)Interrest	124	579	703	13	7	20	14	8	21	6	2	8	28	307
Total	3,645	3,320	6,964	93	45	138	106	50	156	36	12	48	172	1,748
(4)Profit & loss	900	1,965	-1,322	211	200	177	62	109	75	140	158	181	56	-904
(5)Collection Amount per Annum														
1)Output Red.(60 D)	1,397	4,281	1,490	262	228	256	117	140	160	163	166	213	170	326
F.IRR	44.04%	24.41%	-10.60%	104.94%	241.40%	54.02%	30.17%	84.94%	24.63%	168.93%	H	160.92%	16.82%	X
2)Output Red.(30 D)	-697	2,187	-604	145	111	139	69	91	112	105	108	154	103	268
F.IRR	X	4.51%	X	45.44%	71.55%	22.71%	11.70%	46.92%	12.76%	82.65%	H	95.09%	3.12%	X
3)Output Red.(15 D)	-1,744	1,140	-1,651	87	53	81	44	67	88	76	79	125	70	239
F.IRR	X	-12.79%	X	21.62%	25.18%	6.31%	0.29%	30.62%	6.08%	52.45%	H	-190.49%	-6.91%	X
4)Output Red.(45 D)	350	3,234	443	204	169	197	93	116	136	134	137	183	137	297
F.IRR	-3.37%	15.07%	X	72.33%	136.72%	37.93%	21.15%	64.76%	18.82%	120.25%	H	124.79%	10.42%	X
5)Output Red.(90 D)	3,490	6,374	3,584	379	344	372	166	188	209	222	224	271	236	385
F.IRR	176.10%	43.60%	13.11%	199.65%	955.56%	92.55%	49.42%	135.75%	36.88%	329.09%	H	263.87%	29.51%	X

Note: At SIAPE, Catalyst Input Cost is Included in the Construction Cost of Exhaust Gas Treatment Facilities(478).
X : No Profitability H : Calculation Overflow caused by too High Rate of Return

On these three items, the influenced amount of income by 10% increase (or decrease) has been calculated. Table VIII-12 summarizes the results of sensitivity analysis. The results show the largest influence on the profit and loss by the change of construction cost. This indicates that the construction cost must be reduced.

(7) Evaluation by financial analysis

As is clearly seen from Table VIII-7 (Financial analysis (analysis of present state of enterprise)), the present investment can not be implemented without the managerial efforts of the objective enterprises. For the enterprises, the investment can be an adjustment of their infrastructure, and the investment must also be in an optimum scale within the range of correction of a long-term management plan.

At the same time, the subject investment must enable each enterprise to recover a healthy state of management through a self-supporting effort. The investment must also be an executable plant investment for each enterprise as the source of the pollution to conform to the environmental criteria.

The results of evaluation of the financial analysis and examination are summarized below.

1) Case evaluation and case setting of waste water facility

As explained above, the reinforcement work at ONAS is an improvement to solve the current problems. It is indispensable for any case where the waste water standard is adopted. Thus, the investment amount does not change with the case selection at each factory, without being affected by the adoption.

On the other hand, the case settings by several discharge standards can be regarded as based on the same standard, provided the settings satisfy the INNORPI standard at the final stage (discharge to the sea). Therefore, the cases by factory are antinomy plan that can be compared easily by F.IRR. That means a selection of most effective investment plan.

Meanwhile, in order to minimize the financial effect after the investment, it is also important to select a plan with characteristics of 'initial investment = minimum' and 'working expenses (management load) = minimum'.

According to the result of financial analysis, CASE 1 is the best plan for every enterprise.

Table VIII-12 Sensitivity Analysis

(Unit : 1000 TD)

		Net Pro. for '91	BASE (Out Put Reduction of 60 Days)								Sensitivity Analysis Profit Increase/Decrease by 10% Increase			
			Const. Cost	Economic Benefit	Evasion V. of Loss	Total Cost	Variable Cost	Profit & Loss	Collect. per Year	F. IRR	Const. Cost	Economic Benefit	Variable Cost	Total (Compound)
SIAPE	CASE 1B	-13,674	3,727	4,545	4,545	3,645	2,964	900	1,397	44.04%	-207	455	-296	-49
	CASE 2&3B	-13,674	6,553	4,680	4,680	4,211	3,032	469	1,343	17.81%	-364	468	-303	-199
	E.Gas T.	-13,674	16,886	5,285	5,049	3,320	282	1,973	4,281	24.41%	-937	529	-28	-437
UPOTS	CASE 1A		9,225	844	534	1,748	92	-904	326	MINUS	-512	84	-9	-437
	CASE 2A		10,743	924	614	2,052	129	-1,128	304	MINUS	-596	92	-13	-517
	CASE 3A		11,109	943	633	2,126	138	-1,183	299	MINUS	-617	94	-14	-536
SIOS-ZITEX	CASE 1A	279	379	304	304	93	16	206	262	104.94%	-21	30	-2	8
	CASE 2A	279	1,939	386	386	395	37	-9	250	4.71%	-108	39	-4	-73
	CASE 3A	279	2,180	398	398	452	52	-54	237	0.43%	-121	40	-5	-86
	CASE 3B	279	2,026	419	419	423	50	-4	266	5.19%	-112	42	-5	-76
	CASE 4A	279	1,925	613	385	427	67	186	443	21.70%	-107	61	-7	-52
	E.Gas T.	279	208	245	245	45	8	211	228	241.14%	-12	25	-1	12
SATHOP	CASE 1A	22	410	169	169	106	18	62	117	30.17%	-23	17	-2	-8
	CASE 2A	22	1,980	251	251	417	52	-166	98	MINUS	-110	25	-5	-90
	CASE 3A	22	2,255	265	265	468	55	-203	98	MINUS	-125	27	-6	-104
	CASE 3B	22	2,192	288	288	457	55	-169	123	-23.33%	-122	29	-6	-98
	CASE 4A	22	1,994	480	252	404	31	81	341	12.35%	-111	48	-3	-66
	E.Gas T.	22	233	159	159	50	9	121	140	84.94%	-13	16	-1	2
SMCP	CASE 1A	60	854	227	227	172	10	62	170	16.82%	-47	23	-1	-26
	CASE 2A	60	1,782	276	276	355	25	-68	159	-4.68%	-99	28	-3	-74
	CASE 3A	60	1,901	282	282	377	26	-83	159	-6.49%	-106	28	-3	-80
	CASE 3B	60	2,103	322	322	428	42	-118	174	-6.61%	-117	32	-4	-89
STS	CASE 1A	-51	178	176	176	36	1	140	163	168.93%	-10	18	0	8
	CASE 2A	-51	324	184	184	63	3	121	164	66.48%	-18	18	0	0
	CASE 3A	-51	444	190	190	86	3	104	164	43.00%	-25	19	0	-6
	E.Gas T.	-51	60	170	170	12	1	159	166	MAX	-3	17	0	14
ONAS			1,008	3		384	206	-381	-246	MINUS	-56	0	-21	-76

Note: From UPOTS, No Information was Available so that the Evasion from Out Put Reduction Loss was not Calculated.

In the cases other than CASE 1 and CASE 4 (tentative standard proposed by Japan base), a standard almost equal to the ONAS emission standard is required at the exit of each factory. This as a whole will determine a rather severe emission standard.

Consequently, investment are duplicated in some part of the ONAS and in each factory, resulting in a larger initial investment compared with CASE 1, so that the target amount for managerial efforts is heightened to implement the investment.

Table VIII-13 compares the construction cost with the target amount of Managerial Efforts.

Table VIII-13 Construction Cost and Target Amount of Managerial Efforts

(Unit: 1000 TD)

Case	SIAPE			SIOS-ZITEX etc.			UPOTS			Economic efficiency per enterprice
	Required profit increase			Required profit increase			Required profit increase			
	Construction cost	Deficit elimination	Present plan	Construction cost	Deficit elimination	Present plan	Construction cost	Deficit elimination	Present plan	
CASE1A	-	-	-	1,821	0	407	9,225	?	1,748	◎
CASE1B	3,727	13,674	3,645							◎
CASE2A	-	-	-	6,023	0	1,230	10,743	?	2,052	× Large initial investment
CASE2B	6,553	13,674	4,211							× Large initial investment
CASE3A	-	-	-	6,715	0	1,383	11,109	?	2,126	× Large initial investment
CASE3B	6,553	13,674	4,211	6,763	0	1,394	-	-	-	× Large initial investment
CASE4A	-	-	-	4,950	0	1,039				× Large initial investment

As mentioned above, while the process improvement in CASE 4 (tentative standard proposed by Japan base) improves the quality of the waste water discharge, it cannot reduce the cost of constructing the waste water treatment facilities. The glycerol that is collected by improving the manufacturing process can help obtain some profit from variable cost. However, such profit hardly absorbs the fixed cost.

Therefore, the investment must be withheld until such time as the added value of product is increased by effective utilization of the glycerol so that the plan can be evaluated as a single plan of process improvement from the economic viewpoint.

2) Evaluation from financial internal rate of return

As described above in the preconditions of financial analysis and economic benefits, the profit has been calculated based on the subsidiary steps, provided that the investing enterprise itself is assured of a profit that is enough to absorb the additional expenses. This will not give so much influence on the overall evaluation of the superiority in the case selection by factory, even on the assumption that the profit can be actually improved only some years later.

For comparing the investment cases of the factories, Table VIII-14 lists the extracts of F.IRR in a case of 60 days' suspension of operation (evasion of output reduction loss of 60 days).

Table VIII-14 F.IRR (case of 60 days' operation suspension)

(Unit: %)

Case	SIAPE	SIOS-ZITEX	SMCP	SATHOP	STS	UPOTS	Individual evaluation
1. Waste water treatment facilities							
CASE1A: Tentative standard proposed by Japan	–	104.9	16.8	30.2	168.9	Minus	◎
CASE1B: Tentative standard proposed by Japan	44.0	–	–	–	–	–	◎
CASE2A: Tentative standard proposed by Tunisia	–	4.7	Minus	Minus	66.5	Minus	×
CASE2B: Tentative standard proposed by Tunisia	17.8	–	–	–	–	–	Δ
CASE3A: INNORPI ONAS	–	0.4	Minus	Minus	43.0	Minus	×
CASE3B: INNORPI SEA	17.8	5.2	Minus	Minus	–	–	×
CASE4A	–	21.7	–	12.4	–	–	○
2. Exhaust gas treatment facilities	24.4	241.4	–	84.9	200 or more	–	◎

① Since the required fund depends on external accommodation, the case where IRR is larger than 8% (equivalent to interest on borrowing) is determined as profitable from the investment.

Therefore, in CASE1 of waste water treatment facilities and exhaust gas treating facilities, a result of considerably high F.IRR can be expected for the enterprises other than UPOTS which has some specific factors, provided the preconditions are satisfied.

② For the waste water treatment facilities, the cases are antinomy to each other, so that CASE1 with the high F.IRR must be selected.

Table VIII-15 summarizes the evaluation results of financial analysis.

3) Consideration from the present status of enterprises

① To improve the management state of the enterprises, fairly hard self-supporting efforts are required, also considering the external factors such as the raw material supply. The present study tried the comparison and evaluation under such uncertain preconditions. Therefore, the investment in question must also require a further improved rate of return.

In more details, the increased rate of return must be ensured at the execution planning stage, by reducing the cost such as the construction cost (reduction of import ratio, in-house undertaking of constructions).

② Operating cost must also be reduced. For example, the number of operating personnel included in the calculation of the operating cost must not be increased, but be arranged from the existing production personnel. Since this is a non-productive facility, possibilities must be examined for a drastic cost reduction for each enterprise: for example, management at the marginal cost, apart from a possible control over the increase in factory overhead.

③ For the procurement of chemicals, a cooperative buying at lower price by grouped enterprises must be studied and implemented.

Table VIII-15 Evaluation from the Financial Analysis Result

(Unit : 1000T D)

		Net Pro. for '91	BASE (Out Put Reduction of 60 Days)								Evaluation of Financial Analysis				
			Const. Cost	Economic Benefit	Evasion of Loss	Total Cost	Variable Cost	Profit & Loss	Collect. per Year	F.IRR	Scale of Req. Fund	Net Pro. Amount to be Improved	Profit-ability of Individual Plan	Overall Evaluation	Evaluation Point
SIAPE	CASE 1B	-13.674	3.727	4.545	4.545	3.645	2.964	900	1.307	44.04%	100.0	17.319	◎	◎	Small Fund Required-High Economic Efficiency
	CASE 2&3B	-13.674	6.553	4.680	4.680	4.211	3.032	469	1.343	17.81%	175.8	17.885	○	X	Relatively High Economic Eff.-Large Fund Required
	E.Gas T.	-13.674	16.886	5.282	5.049	3.320	282	1.973	4.281	24.41%		16.750	◎	◎	High Economic Efficiency
UPOTS	CASE 1A		9.225	844	534	1.748	92	-904	326	Minus	100.0	1.438	X	◎	No Economic Efficiency-Relatively Small Fund Required
	CASE 2A		10.743	924	614	2.052	129	-1.128	304	Minus	116.5	1.742	X	X	No Economic Efficiency-Large Fund Required
	CASE 3A		11.109	943	633	2.125	138	-1.183	299	Minus	120.4	1.816	X	X	No Economic Efficiency-Large Fund Required
SIOS-ZITEX	CASE 1A	279	379	304	304	93	16	206	257	104.94%	100.0	0	◎	◎	Small Fund Required-High Economic Efficiency
	CASE 2A	279	1.939	386	386	395	37	-9	250	4.71%	511.6	116	△	X	No Economic Efficiency-Large Fund Required
	CASE 3A	279	2.180	398	398	452	52	-54	237	0.43%	575.2	173	△	X	No Economic Efficiency-Large Fund Required
	CASE 3B	279	2.026	419	419	423	50	-4	266	5.19%	534.6	144	△	X	No Economic Efficiency-Large Fund Required
	CASE 4A	279	1.925	613	385	427	67	186	215	21.70%	507.9	0	○	X	Relatively High Economic Eff.-Large Fund Required
	E.Gas T.	279	208	245	245	45	8	211	454	241.40%		0	◎	◎	High Economic Efficiency
SATHOP	CASE 1A	22	410	169	169	106	18	62	117	30.17%	100.0	85	◎	◎	Small Fund Required-High Economic Efficiency
	CASE 2A	22	1.980	251	251	417	52	-166	98	Minus	482.9	395	X	X	No Economic Efficiency-Large Fund Required
	CASE 3A	22	2.255	265	265	468	55	-203	98	Minus	550.0	446	X	X	No Economic Efficiency-Large Fund Required
	CASE 3B	22	2.192	288	288	457	55	-169	123	-23.33%	534.6	435	X	X	No Economic Efficiency-Large Fund Required
	CASE 4A	22	1.994	480	252	404	31	81	347	12.35%	486.3	149	○	○	Relatively High Economic Eff.-Large Fund Required
	E.Gas T.	22	233	159	159	50	9	121	139	84.94%		0	◎	◎	High Economic Efficiency
SMCP	CASE 1A	60	854	227	227	172	10	62	175	16.82%	100.0	105	◎	◎	Small Fund Required-High Economic Efficiency
	CASE 2A	60	1.782	276	276	355	25	-68	169	-4.68%	208.7	284	X	X	No Economic Efficiency-Large Fund Required
	CASE 3A	60	1.901	282	282	377	26	-83	170	-6.49%	222.6	305	X	X	No Economic Efficiency-Large Fund Required
	CASE 3B	60	2.103	322	322	428	42	-118	162	-6.61%	246.3	380	X	X	No Economic Efficiency-Large Fund Required
STS	CASE 1A	-51	178	176	176	36	1	140	163	168.93%	100.0	87	◎	◎	Small Fund Required-High Economic Efficiency
	CASE 2A	-51	324	184	184	63	3	121	164	66.48%	182.0	114	○	X	Relatively High Economic Eff.-Large Fund Required
	CASE 3A	-51	444	190	190	86	3	104	164	43.00%	249.4	137	○	X	Relatively High Economic Eff.-Large Fund Required
	E.Gas T.	-51	60	170	170	12	1	159	166	MAX		62	◎	◎	High Economic Efficiency
DNAS			1.008	3		384	206	-381	-247	Minus				◎	

Note: From UPOTS. No Information was Available so that the Evasion from Output Reduction Loss was not Calculated.

(Evaluation)
(1)Scale of Required Fund : Represented by Minimum Amount = 100
(2)Amount Need to be Improved from Net Profit : Absolute Amount to be Indicated (0 is to be Indicated when it can be Absorbed within the Current Range).
(3)Evaluation Grade of Individual Plan
Over the F.IRR Standard and Best :◎
Over the Standard and Second :○
Less than the Standard Level :△
Below the Standard :X

4. Economic Analysis

The financial analysis concentrated on the economic efficiency of the objective enterprises and factories themselves, and examination was given as to what economic influences would be expected when the waste water treatment facilities and exhaust gas treatment facilities were introduced. With the economic analysis, the study is directed to the question how the social economy of Tunisia or the region of Sfax will be influenced by such introduction.

Therefore, about the economic benefits and expenses that can be calculated quantitatively, the profit and loss have been calculated as with the financial analysis to obtain the economic internal rate of return (E.IRR).

Table VIII-16 summarizes the examination results by the economic analysis.

(1) Economic benefits

1) Direct benefit

In principle, the direct benefit has been studied with the same concept as that of the financial analysis, except the following benefits. These are excluded from the economic analysis because they will not generate any profit or loss for the society as a whole.

① Reduction of cost for excessive part of waste water quality standard

The penalty calculated here means a reduction of expenditure for an enterprise, but it is a reduction of revenues for the local area or country, resulting in zero income and outgo for the whole society.

② Tax exemption effect by execution of special depreciation

The result is zero income and outgo, same as in ① above, considering the tax exemption for the enterprises and the national subsidies.

The reduction of waste water treatment expense at ONAS was evaluated to be 50% as only variable cost will become a consumption logically. Other economical benefits are as same as those described in financial analysis. Therefore, their duplicate explanation will be avoided.

2) Indirect benefits

Indirect benefits are expected as listed below, while they can hardly be measured into the numerical data as in the case of the direct benefits.

① Increased chances for employment

By the introduction of the planned facilities, there will be newly created opportunities of employment not only for the personnel directly related to the operation, analysis, and maintenance of the equipment, but also for the personnel required for the construction and maintenance work. The nationwide and stepwise projects will have far-reaching effects by increasing the employment chances to shift toward a high income level.

② Resource utilization and improvement of environment

It is highly important for the society to save the water resource which is running short, and to eliminate the harmful influence by the waste water discharge and exhaust gas (such as injuries to the health, decrease in marine products, and reduction of values for tourism). Further, utilization of useful materials collected during the treatment process will not only generate a direct economic effect, but also will offer the chances to acquire the techniques to improve various production processes.

③ Contribution to the community economy

It is highly significant to contribute to the enhancement of the standard of living of the community by eliminating the pollution for the industrial development.

Implementation of the present project also means an acquisition of know-how related to the countermeasures of industrial pollution. It will offer opportunities for creating and developing an environmental industry. That will in the long run encourage the regional and environmental industries, and ensure a reduction of construction cost across the country. Another promising possibility is contribution to the promotion of export and acquisition of foreign currencies thanks to the high cost performance.

(2) Economical expenses

Out of the expenses under the economic analysis, some items have been calculated by a method different from that of the financial analysis as detailed below. Those items are the wage differences that largely enhance the social economic level and the part of fixed utility cost and factory overhead that are not considered to marginally increase.

1) Labor expense

The personnel to serve the planned facilities are assumed to be shifted from the worker operating on the production facilities. Also the worker vacancy can be filled by temporary workers. Accordingly, the personnel expenditure has been calculated marginally on the basis of an extra worker: 150 TD/month•person.

2) Utility expense

On the electric power supplied to inside the area, the fixed cost equivalent is not considered to be increased marginally. From this, the power cost has been calculated at 60% of the level in the financial analysis.

3) Factory overhead

The factory overhead includes various costs of utilizing the social facilities. Such cost has been calculated to 30% of the result of the financial analysis, considering the fact that these costs are not subject to a proportional increase by the increase in the number of personnel, and that the planned facilities require no increase in the office work staff.

(3) Results of economic analysis

As shown in Table VIII-16, the economic analysis has had a worse result for the individual item than the result of the financial analysis. However, considering the indirect benefits, the decision making will not be affected.

Table VIII-16 EIRR by Factory

	SIAPE			SIOS-ZITEX			SATHOP			SMCP	STS			UPOTS
	CASE IB	E.Gas T.	Total	CASE IA	E.Gas T.	Total	CASE IA	E.Gas T.	Total	CASE IA	CASE IA	E.Gas T.	Total	CASE IA
(1)Construction Cost (Total Investment)	3.725	17.359	21.084	378	208	586	409	233	642	854	178	60	238	9.213
(2)Economic Benefits														
1)Evasion of Loss from Output Red.(2%)	4.188	4.188	4.188	234	234	234	97	97	97	132	117	117	117	
2)Evaluayion of By-product		236	236		0	0			0				0	310
3)Evasion of Penalty Payment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4)Evasion of Sewage Treatment Fee	55	0	55	0	0	0	0	0	0	0	0	0	0	0
5)Effect of Corporate Tax Exemption	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	4,243	4,424	4,479	234	234	234	97	97	97	132	117	117	117	310
(3) Cost														
1)Utility Expense	40	169	209	3	5	8	3	6	9	2	1	1	2	41
2)Cemical Expense	2,898	0	2,898	11	0	11	13	0	13	7	0	0	0	23
3)Labor Expense	14	0	14	5	0	5	9	0	9	5	2	0	2	16
4)Maintenance Exp.	112	506	618	11	6	17	12	7	19	26	5	2	7	276
5)Depreciation Rxp.	373	1,640	2,013	38	21	59	41	23	64	85	18	6	24	921
6)Catalyst Depreciat.	0	96	96	0	0	0	0	0	0	0	0	0	0	0
7)Plant Overhead	15	65	80	2	1	3	2	1	3	3	1	0	1	36
8)Interrest	124	579	703	13	7	19	14	8	21	28	6	2	8	307
Total	3,576	3,054	6,630	82	40	122	94	44	138	158	33	11	43	1.622
(4)Profit & loss	667	1,369	-2,151	152	194	112	3	53	-41	-25	84	106	74	-1.312
(5)Collection Amount per Annum														
1)Output Red.(60 D)	1,163	3,684	660	203	222	190	58	84	44	89	108	114	105	-83
E.IRR	36.53%	22.33%	-9.30%	73.14%	228.59%	38.38%	12.09%	43.45%	-0.02%	6.28%	86.77%	H	56.77%	X
2)Output Red.(30 D)	-930	1,590	-1,433	86	105	74	9	35	-4	22	49	56	47	
E.IRR	X	X	X	24.41%	X	X	X	X	X	-11.07%	31.53%	172.81%	20.28%	X
3)Output Red.(15 D)	-1,977	543	-2,480	27	47	15	-15	11	-29	-11	20	26	18	
E.IRR	X	X	X	0.75%	X	X	X	X	X	X	7.90%	56.39%	1.20%	X
4)Output Red.(45 D)	116	2,637	-387	144	164	132	33	59	20	56	79	85	76	
E.IRR	-9.33%	X	X	46.91%	-193.68%	24.17%	2.43%	28.29%	-9.38%	-0.81%	56.53%	482.16%	37.70%	X
5)Output Red.(90 D)	3,257	5,778	2,754	319	339	307	106	132	93	155	166	172	164	
E.IRR	155.35%	39.55%	10.54%	H	874.13%	70.96%	28.96%	79.15%	12.61%	17.97%	174.85%	H	104.86%	X

Note: At SIAPE.Catalyst Input Cost is Included in the Construction Cost of Exhaust Gas Treatment Facilities(478).
X : No Profitability H : Calculation Overflow caused by too High Rate of Return

(4) Economic influence

According to the result of the financial analysis, SIAPE and UPOTS require a large increase in the net profit of the enterprise even though the plan is implemented on the basis of CASE1 which is the most advantageous. Therefore, the economic influence has been analyzed by comparing the analysis results with a result assuming that the current state were continued.

1) Countermeasures for waste water and exhaust gas at fertilizer factory (SIAPE):

Running of production activities will inevitably produce some industrial pollution, apart from the extent and causal relationships. To some extent, the drainage is affecting the marine pollution and the exhaust gas affecting the air continuously.

If, therefore, the present state continues, there will be the time when the operation must be stopped or suspended, as is seen from the precedents in some foreign countries.

Bearing this in mind, the economic state is compared the case where the fertilizer factory continues production activities by implementing the anti-pollution countermeasures with the case where the fertilizer industry is inhibited from further production activities from economical side as follows:

① Annual output and price of rock phosphate and TSP

Phosphate rock: 6,610,000 tons ('89) US$31/T ('91)

TSP: 1,000,000 tons ('87) US$140/T ('91)

② Added value by fertilizer industry: Estimated from SIAPE information ('91)

Phosphate rock ===> TSP		Nationwide TSP output
681,120 T/Y	363,000 T/Y	1,000,000 T/Y

[calculated on the basis of 'Yield = 53.3%' and 'energy consumption value = 1/2 of the raw material cost']

Added value of SIAPE = (363,000 * 140) – (681,120 * 31 * 1.5)
= approx. US$19,148,000

Nationwide added value scale = 19,148 * (1,000/363)
= approx. US$52,749,000/Y
= approx. 47,449,000 TD/Y

Assuming the operation stop of nationwide fertilizer industry, a direct economic effect of approx. 47,000,000 TD/Y will be canceled.

③ The total amounts to approximately 705,000,000 TD when the added values by the TSP production are cumulated for fifteen years as the object period of the present investment.

Suppose that no countermeasures were taken against the industrial pollution so that the production must be completely stopped in the fertilizer industry, that will obviously affect the target growth rate 8.7% for the manufacturing industry under the eighth five-year plan. The tax revenue will also be reduced considerably as a result.

④ According to the examination by SIAPE, the expenditure of industrial antipollution countermeasures for the whole fertilizer industry is as follows (unit: 1,000 TD):

	(SIAPE)	(Estimate for whole fertilizer industry)
TSP output	363,000 tons	1,000,000 tons
Waste water treatment facilities	3,725	10,262
Exhaust gas treatment facilities	17,359	47,821
Total	21,084	58,083
Annual depreciation	2,013	5,545
Annual running cost	6,630	18,264

From the above result, although the expenditure of industrial antipollution countermeasures requires a substantial investment scale, annual running cost of whole fertilizer will be less than the nationwide yearly added value scale. Therefore, it is desirable that the antipollution countermeasures be implemented gradually step by step, considering the economic effect by reserving the existence of such industries and the secondary influence over the other industries.

2) Countermeasures for the margin (waste liquid after olive oil expression) at olive factory (UPOTS)

In the study, concentrated treatment facilities for discharged margin in the whole region of Sfax were examined based on the survey result of UPOTS. From the result, the economic comparison for the entire olive industry between margin reclamation treatment and waste water treatment was evaluated as follows:

① Margin discharge:

UPOTS:	50 m^3/day * 100 days/year	= 5,000 m^3/Y(year)
Sfax area:	1,000 m^3/day * 100 days/year	= 100,000 m^3/Y
Nationwide total:		= 225,000 m^3/Y

② Estimation of margin treatment cost without waste water treatment facilities:

(Preconditions)

It is assumed that a land must be procured separately from the general area via a green buffer zone, to cover the annual treatment quantity of the waste liquid, and the waste liquid will be discharged to a concentration pool with 1.5 m depth. Then the waste liquid must be left for ten years to cause a natural evaporation and underground penetration. For the eleventh and subsequent years, it will be recycled for reuse.

(225,000 m^3/Y)/1.5m = 150,000 m^2 → A site of 200,000 m^2 per year is procured, including green buffer zone ==> Assuming that the site is adjoining an industrial site, the cost is 20 TD/m^2, that is: 4,000,000 TD/Y (in the buffer zone, olive tree planting is assumed, for the harvest after ten years' time).

The land will cost during ten years: 40,000,000 TD plus management cost (alpha)

③ Estimated construction cost of treatment facilities installed in the olive factories across the country (unit: 1,000 TD):

	Case 1A	Case 2A	Case 3A
Construction cost for Sfax area	9,225	10,743	11,110
Cost of nationwide construction	20,756	24,172	24,998
Annual depreciation of nationwide facilities	2,076	2,417	2,500
Annual operating cost of nationwide facilities	3,650	4,520	4,682

Even by simply comparing the facility investment plan with the result of continued current state, the annual depreciation expenses are lower in any cases than the land acquisition cost. Moreover, considering the fact that 60% of the invested amount (15% × 4 years) is subject to exemption of corporate tax by the special depreciation, implementation of the present plan ensures an economic efficiency that is worth studying positively as a whole olive industry.

④ From another standpoint, influence over other industries:

The eighth five-year plan sets the targets of economic growth to 2% for agriculture, 8.7% for manufacturing industry, and 22.3% for tourist industry. Assuming a continuation of the present state, there will be a demand for the land of at least 2 km^2 for the coming ten years only for these industries (which means an estimated expenditure of 40 million TD). In view of the expected growth rate of the whole manufacturing industry and the tourist industry, the land supply will have to be considerably restricted.

- Difficulties expected for output increase of olive oil as a high value-added product of olive
  - → Difficulty in achieving 2% growth rate target for agriculture
  - → Difficulty in increasing the by-product as a cheap raw material for soap production
  - → Affects the promotion of export and acquisition of foreign currencies
- Acquisition of vast site for throwing waste away
  - → Affects the acquisition of new industrial site, causing difficulty to achieve the growth target for other industries
  - → Negative effect to the geographical and meteorological resources suitable for the tourism, causing difficulty to achieve the growth target of 22.3% for tourism
  - → Affects the acquisition of foreign currencies

⑤ The above problems may threaten the whole olive industry, so that the possibility of increasing the sales (by about 70,000,000 TD estimated from the quantity of the margin) or absorption of 2% annual growth (= approx. 24,000,000 TD for 15 years) (*1) might be abandoned.

*1: Estimated from UPOTS 1991 information (scale of UPOTS = 5/225 of the whole industry)

Olive purchase ====> Sale of olive oil

5,633 tons (260,000 TD) 1,162 tons (1,564,000 TD)

Supposing that the energy consumption is almost equal to the olive purchase cost, (1,564 – (260 * 2)) * (5/225)

Value added by olive oil production amounts to approx. 47,000,000 TD. The cumulative total of the 2% growth for 15 years amounts to approx. 24,000,000 TD.

(1,564 * (5/225)) * coefficient of annuity closing price (15 years, 2% = 17.29342) equals approx. 24,342

⑥ Implementation of the present plan will completely cancel all these fears. Combined with the aforesaid indirect benefits, a large economic effect is expected for the olive industry from the viewpoint of industrial promotion.

Also from the standpoint of achieving the eighth five-year plan and ensuring the source of tax revenues, the investment must be promoted.

5. Financial and Economic Evaluation

From the results of the financial and economic analysis, the waste treatment and recycling plan of selected industries in the region of Sfax is evaluated as follows:

(1) By the countermeasures proposed by the present study, the investment reached a large amount for SIAPE (drainage from scrubber) and the treatment of the margin at UPOTS because of the excessively polluted waste water. Moreover, by the radical nature of the present study, a new investment had to be made resulting in an excessive financial burden at a time. In other factories, even if the additional cost is borne by the related enterprise, the cost can be absorbed through some managerial support.

However, considering the future development, permanent continuity, and industrial promotion of each enterprise, it is necessary to implement the present plan without killing the active power of these enterprises. From this viewpoint, those factors such as the construction cost (initial investment) must be reduced by all means.

(2) To improve the economic efficiency and to enhance the possibility of implementing the present plan, the point is to lighten the burden of expenses and to reserve the fund for construction. For this purpose, the following steps are considered:

① The industrial antipollution countermeasures mean nonproductive facilities. Therefore, if the plans are left to the spontaneous action of individual enterprises, the execution is threatened to be delayed or abandoned owing to the management conditions. Also, reduction of the construction cost may result in failure. For fear of this, the administration must take the initiative to enforce a thorough control of the items listed below, as with the present study, to establish a system to eventually attain the real goal. - - - Control on the estimation and assessment of materials and equipment, purchase negotiations, and supervision of field construction. For example, a system of appointing the dealer or construction company (even for the appointed dealer or constructor, chances must be offered for a "narrow profit margin and large sales volume" policy to train them into the specialists).

② The implementation plan shall be executed step by step to gradually satisfy the total regulation volume on the waste water quality standard as the decisive factor of the construction scale and process. For example, to attain the target by the total volume, the number of the objective enterprises shall be increased, while easing the standard for individual enterprises. Consequently, for each enterprise, the initial investment and cost for managerial improvement can be reduced to provide a better condition for investment.

③ To encourage each enterprise to promote the present plan, some steps shall be examined to offer a direct incentive for reducing the expenditure such as the construction cost. For example, penalty for the enterprises not taking countermeasures would be partially increased, and the collected money would be reimbursed to those who executed the countermeasures, thus establishing a system concentrating the reimbursement on the execution period. Thus, profitability of the investment would be enhanced by subsidizing by the whole beneficiaries widely and lightly so as to eventually reduce the running cost.

④ Examination shall also be given to rationalization of a collective treatment of industrial waste water (at the primary treatment stage) by several enterprises or regions. When the possibility is expected, organizing a jointly operated company (or association) shall also be examined for the purpose of reducing the expenses per enterprise such as the construction cost.

VOLUME IX

CONCLUSION AND RECOMMENDATION

VOLUME IX CONCLUSION AND RECOMMENDATION

To complete the present study, we describe a conclusion and recommendation in this volume. The object of the study is to assure the environmental protection in the region through the countermeasures for the industrial pollution.

Therefore, it is necessary to make the result of the present study be a model and spread it all over the Tunisia to make a working plan.

1. Outline of the Present State of Selected Factories

It is concluded that, except some factories, no antipollution measures are undertaken. Some factories are studying the possibility, while some others in the process of constructing the equipment. In fact, however, full-scale countermeasures for the waste water or exhaust gas are not taken at the moment.

On the waste water, there is the INNORPI emission standard specifying the standard for the discharge to rivers, sea area, and sewage treatment plant. However, such standard goals have not yet been attained.

For the exhaust gas, no standard exists, and no countermeasure is taken.

2. Conclusion of the Study

To protect the environment and enhance the economic efficiency of each enterprise, the cost of constructing and operating the antipollution facilities must be reduced. For this purpose, the following points must be examined:

(1) Every factory produces polluted substances at a high density. Polluted substances are originally valuable substances such as raw materials. The valuable substnaces must be collected as much as possible through rationalization of the factory, so as to reduce the polluted content in the drainage. To that end, the numerical data in each section at the factory must be grasped first. The present study has been made temporarily, and further data must be collected continuously on a long-term basis.

(2) Waste water treatment facilities must be examined based on the tentative standard proposed by Japan. While the standard is tentative, the drainage from all factories except those from the SIAPE factory is accepted by ONAS, and its quality becomes to fulfill the sea area emission standard of INNORPI by ONAS. In the tentative standard proposed by Japan to be applied for SIAPE, SO_4 exceeds the standard value for sea area of INNORPI standard. However, since removal of SO_4 requires an expensive device, it will have to be studied in the next stage.

(3) For the INNORPI standard of the inflow into ONAS, Cl and SO_4 are subject to regulations. However, the tentative standard proposed by Japan does not satisfy these regulations. Therefore, if a part of the ONAS treated waste water is used for irrigation, the salt content will be increased. However, in view of the high investment cost required for the removal of salt, reservation of the irrigation water must be studied from an overall point of view.

(4) By the INNORPI standard of discharge to sea area, SO_4 is subject to regulation. SO_4 also exists in the sea water, so we raised the question about the reason of the SO_4 regulation, without a clear response being received so far. In our opinion, the SO_4 regulation has to be reexamined.

(5) Treatment of margin at UPOTS is a problem not only for Tunisia, but also for the entire world. In the present study, study was mainly concentrated on a treatment by anaerobic bacteria as treatment methods.

Although the method of anaerobic treatment is being researched in various countries of the world, there is no record of the actual plant. It is desired that the research will be further promoted in Tunisia.

(6) At the sulfuric acid plant in SIAPE, the DCDA method should be adopted to cope with the soaring sulfur price. At the same time, countermeasures for the pollution should be taken along with the efforts to improve the rate of collecting the sulfuric acid.

Furthermore, the modification of scrubber in phosphoric acid plant and TSP plant should be implemented to remove fluorine and to be a countermeasure for pollution.

(7) As the countermeasures for the particles of soot dust from soap factories and STS, installation of cyclone is proposed. As a preparatory step, training of the operating engineers should be projected in order to improve the method of controlling the combustion technique.

3. Recommendation and Considerations

3.1 Recommendation

As a conclusion of the present study on waste treatment and recycling plan, the following items are recommended:

(1) The construction cost indicated for each case in the present study was first calculated on the cost level in Japan then converted into Tunisian base by taking account of the field survey results. Therefore, the indicated values do not fully reflect the conditions unique to Tunisia. Hence, before executing the plan, the construction cost has to be reexamined from an overall standpoint.

(2) Efforts should be made to reduce the polluted substance at the discharge outlet of each factory. Generally, there is a high density of the polluted substance at the discharge outlet of factory. The problems are that a large expense will be required to treat such polluted substance, and that some useful substances are discharged and wasted. It is recommended that the complete numerical data at the production processes be grasped so as to reduce the quantity of the polluted substance.

(3) Establishment of reasonable emission standard

It is important to enforce a strict emission standard to protect the healthy environment. However, it is also important to set a standard to be harmonized with the industrial development. Especially, removal of salt requires a high cost of investment and operation. Preparation of the irrigation water standard and re-examination of salt regulation in the sea area are recommended.

3.2 Considerations on Plan Execution

After examining the items in the foregoing sections, the following notes must be taken into consideration in executing the plan:

(1) Organizing of the committee

As the countermeasures for the industrial pollution in the region of Sfax, it is desirable to organize a committee consisting of the governmental and civil personnel and men of learning and experience, to execute the countermeasures for the entire community.

(2) The present study has been made on some selected local factories. For the next study, it is desirable to cover the whole area, and execute the project step by step by assigning the priority.

(3) Reconfirmation of quality of waste water

Quality of waste water from each factory should be analyzed again to reconfirm the preconditions for design.

(4) Treatment test by actual drain

To obtain the basic numerical data for design, a simple test should be conducted on the actual drain sample. For example, the following data should be confirmed with the actual drain sample:

- Preparation of neutralization curve
- Preparation of coagulating sedimentation curve

(5) Confirmation by pilot plant or demonstrative facility

It is desirable to test the following items through a pilot plant to implement the research and development as they are big problems in Tunisia:

- Anaerobic treatment of margin
- Removal of salt by reverse osmosis

(6) Overseas technical survey

It is desirable that the technical contents of the following items be grasped by inspecting the overseas technology:

- Anaerobic treatment equipment
- Reverse osmosis equipment

(7) It is recommended that LARSEN be expanded into an environmental technology center (or an environmental training center) to serve as a core organization for training the environmental engineers in Tunisia.

ANNEX

ANNEX-1

SCOPE OF WORK

FOR

THE STUDY ON WASTE TREATMENT AND RECYCLING PLAN
OF SELECTED INDUSTRIES IN THE REGION OF SFAX

IN THE REPUBLIC OF TUNISIA

AGREED UPON BETWEEN

THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF TUNISIA

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

TUNIS, DECEMBER 14, 1990

MR. BAOUENDI ABDELKADER
PRESIDENT DIRECTOR-GENERAL
AGÉNCE NATIONALE POUR LA
PROTECTION DE L'ENVIRONNEMENT,
LE GOUVERNEMENT TUNISIEN

MR. NOBUYOSHI KAKUMA
LEADER,
THE JAPANESE PRELIMINARY
STUDY TEAM,
JAPAN INTERNATIONAL
COOPERATION AGENCY

I. INTRODUCTION

In response to the request of the Government of the Republic of Tunisia (hereinafter referred to as "GOT"), the Government of Japan decided to conduct the Study on Waste Treatment and Recycling Plan of Selected Industries in the Region of Sfax (hereinafter referred to as "the Study")in accordance with the relevant laws and regulations in force in Japan.

Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, shall undertake the Study in close cooperation with the authorities concerned of GOT.

The present document sets forth the scope of work with regard to the Study.

II. OBJECTIVE OF THE STUDY

The objective of the Study is to formulate treatment and where applicable, recycling plans of the industrial waste from the selected factories and industrial facilities in the region of Sfax in order to cope with industrial pollution in the region thereby contributing to the region's sound industrial development and environmental protection.

III. SCOPE OF THE STUDY

Based on the primary study carried out by the Laboratory of Environment Science in the National Institute of Engineering in Sfax (hereinafter referred to as "L.A.S.E.N."), the Study shall be conducted with regard to treatment and, where applicable, recycling palns of the industrial liquid waste and exhaust fume from the following factories and facilities:

- Societé Industrielle pour la Fabrication de l'Acide Phosphorique et Engrais (S.I.A.P.E.) Unitès A et B
- Societé National pour la Distribution du Pétrole (S.N.D.P.)
- Selected small-scale factories

The scope of the Study shall be the following:

1. Review of general conditions for the Study (Environmental policies and regulations, Demographic, socio-economic, meteorological, topographic conditions of the region, Present

water resources and analysis of its future demand and supply)

2. Analysis of the production process of the factories and facilities
3. Analysis of liquid waste and exhaust fume from the production process both within and outside the factories and facilities.
4. Formulation of treatment and, where applicable, recycling system alternatives
5. Preparation of the implementation plan and schedule of the above systems
6. Cost estimation
7. Financial and economic analysis (where applicable)
8. Conclusion and recommendations

IV. PROCEDURE OF THE STUDY

The Study shall be implemented in accordance with the following procedure:

Step 1. Preparatory study (in Japan)
Step 2. Preliminary field survey (in Tunisia)
Step 3. Field survey and analyses (in Tunisia)
Step 4. Continued analytical work (in Japan)
Step 5. Presentation of Interim Report and supplementary field survey and analyses (in Tunisia)
Step 6. Continued analytical work (in Japan)
Step 7. Presentation of Draft Final Report (in Tunisia)
Step 8. Submission of Final Report

V. SCHEDULE OF IMPLEMENTATION

A tentative schedule of the Study implementation shall be as attached in the Appendix.

VI. REPORTS

JICA shall prepare and present the following reports in English to GOT.

Ten (10)copies of the Inception Report
Ten (10)copies of the Progress Report
Thirty(30)copies of the Interim Report
Thirty(30)copies of the Draft Final Report
Thirty(30)copies of the Final Report

VII.UNDERTAKINGS BY THE GOVERNMENT OF TUNISIA

1.To facilitate smooth conduct of the Study, GOT shall take the necessary measures:

1.1 To secure safety of the Japanese Study Team (hereinafter referred to as "the Team")

1.2 To permit the members of the Team to enter, leave and sojourn in Tunisia for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees

1.3 To exempt the members of the Team from taxes, duties and other charges on equipment, machinery and other materials brought into, and out of, Tunisia for the conduct of the Study

1.4 To exempt the members of the Team from income tax and charges of any kind imposed on, or in connection with, any emoluments or allowances paid to them for their services for the implementation of the Study

1.5 To provide necessary facilities to the Team for remittance as well as utilization of the funds introduced into Tunisia from Japan for the implementation of the Study

1.6 To facilitate permission for entry into private properties or areas relevant for the conduct of the Study

1.7 To secure permission for the Team to take all data and documents related to the Study out of Tunisia

1.8 To provide medical service as needed.(Its expenses can be charged to the members of the Team.)

2.GOT shall bear claims, if any arises against the members of the Team resulting from, occuring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or wilful misconduct on the part of the Team members.

3.Agence National pour la Protection de l'Environnement (heareinafter referred to as "A.N.P.E.") shall act, in cooperation with L.A.S.E.N., as the counterpart agency to the Team as well as the co-ordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

4.A.N.P.E. shall, at its own expense, provide the Team with the following, in cooperation with L.A.S.E.N. and other organizations concerned:

4.1 Available data and information related to the Study
4.2 Counterpart personnel
4.3 Suitable office space with necessary equipment in Sfax
4.4 Credentials or identification cards
4.5 Vehicles

VIII.UNDERTAKINGS BY JICA

For the implementation of the Study, JICA shall take the following measures:

1.To dispatch, at its own expenses, a series of study teams to Tunisia

2.To pursue technology transfer to the Tunisian counterpart personnel

IX.CONSULTATIONS

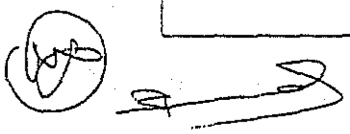
JICA and A.N.P.E. shall consult with each other in respect of any matters that may arise from, or in connnection with, the Study.

TENTATIVE SCHEDULE OF THE STUDY

Order of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Month	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.
Year	1991											1992								
Work in Japan	Step1											Step4	Step4	Step4				Step6	Step6	Step6
Work in Tunisia		Step2							Step3	Step3						Step5				
Report Output		IC/R									P/R				IT/R					DF/R

Order of Month	21	22	23
Month	Oct.	Nov.	Dec.
Year	1992		
Work in Japan			
Work in Tunisia	Step7		
Report Output			F/R Step8

Abreviations: IC/R: Inception Report
P/R: Progress Report
IT/R: Interim Report
DF/R: Draft Final Report
F/R: Final Report



MINUTES OF MEETING

FOR

THE STUDY ON WASTE TREATMENT AND RECYCLING PLAN
OF SELECTED INDUSTRIES IN THE REGION OF SFAX
IN THE REPUBLIC OF TUNISIA

AGREED UPON AMONG

AGENCE NATIONALE POUR LA PROTECTION DE L'ENVIRONNEMENT,
LE GOUVERNEMENT TUNISIEN,

THE LABORATORY OF ENVIRONMENT SCIENCE IN THE NATIONAL
INSTITUTE OF ENGINEERING IN SFAX

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

TUNIS, DECEMBER 14, 1990

MR. MEDHIOUB
DIRECTOR OF DEPARTMENT OF GEOLOGY,
LABORATORY OF ENVIRONMENTAL SCIENCE,
NATIONAL INSTITUTE OF ENGINEERING IN SFAX

MR. BAOUENDI ABDELKADER
PRESIDENT DIRECTOR-GENERAL
AGENCE NATIONALE POUR LA
PROTECTION DE L'ENVIRONNEMENT,
LE GOUVERNEMENT TUNISIEN

角間 信義

MR. NOBUYOSHI KAKUMA
LEADER,
THE JAPANESE PRELIMINARY
STUDY TEAM,
JAPAN INTERNATIONAL
COOPERATION AGENCY

1. The Preliminary Study Team organized by Japan International Cooperation Agency visited Tunisia from December 6, 1990 to December 15, 1990 for the purpose of discussing the Scope of Work regarding the Study on Waste Treatment and Recycling Plan of Selected Industries in the Region of Sfax in the Republic of Tunisia, with the authorities concerned of the Tunisian Government.

2. In connection with the above, a series of meetings were held between the Tunisian side represented by Mr. Baouendi Abdelkader, President Director-General, Agence Nationale Pour La Protection de L'Environnement and the Japanese side headed by Mr. Nobuyoshi Kakuma, Leader of the JICA Preliminary Study Team. (The attendance list is found in the Appendix.)

3. These records should be read in conjunction with the "Scope of Work" agreed upon between GOT and JICA.

4. SPECIAL ISSUES HIGHLIGHTED

4.1 Regarding III. SCOPE OF THE STUDY, selected small-scale factories shall be the following:

-SATOP Societe Anonyme Tunisienne Des Huiles Olives Pures
-SIOS-ZITEX Societe Industrielle Des Olives de Sfax
-TMS Tannerie Moderne de Sfax (Ben Arab)
-STS Societe Tissage a Sfax
-Societe Huilerie UPOTS

The field study in SNDP shall be the examination of its facilities and equipment in premise with a view to detecting the causes for possible leakage of hydro-carbon and making recommendations for its prevention.

4.2 Regarding VI. REPORTS, reports shall include supporting data collected during the field studies.

4.3 Regarding VII. 1.6 and 1.7 , ANPE shall assist the Japanese Study Team in every possible way including issuance of official letters of permission for entry into the factories and facilities necessary for the Study and for exportation of the collected data and information. For this purpose, the Team shall consult with ANPE for permission of exportation thereof.

4.4 The "documents" referred to in 1.7 shall include photographs.

4.5 Regarding VII.1.8, ANPE shall bear the cost for first-aid medical service in Tunisia in the case of accidents or deseases incurred on the members of the Team.

4.6 Regarding VII.4.5, ANPE shall make every possible effort to secure vehicles to the study team. However, in case difficulty is anticipated in procuring vehicles in Tunisia in time for the implementation of the Study, ANPE will request JICA to prepare the budget to hire or purchase vehicles for the Study Team.

4.7 Regarding VII.4.2, the counterpart personnel assigned by ANPE in cooperation with LASEN shall include three (3) technicians for water quality measurement and analysis.

4.8 Regarding VII.4.3, LASEN shall provide suitable office space in Sfax for the Study Team.

4.9 Regarding VIII.2., ANPE requested JICA to invite its counterpart officials to Japan for the purpose of participating in the analytical work in Japan and facilitating technological transfer with regard to the Study.

4.10 Due to the limited inventory of analytical equipment at the disposal of ANPE, ANPE requested that JICA provide the Study Team with the necessary equipment for the field study at its own expense.

ANNEX-2

1. Alternative Plan of Waste Water Treatment Facilities

Out of the several cases assumed by the present study, the main text described Case 1: tentative standard proposed by Japan and Case 2: tentative standard proposed by Tunisia as emission standard. This Annex describes Case 3 and subsequent case.

As shown in Table V-9 in Volume V, Case 3A proposes to conform to the INNORPI standard of discharge to ONAS and Case 3B proposes for soap factories and SMCP to conform to the INNORPI standard of discharge to sea area. Case 4A assumes a case where the production equipment of soap factories was improved (collection of glycerol from soap production section). Table ANNEX-1 summarizes the water quality to be examined, and emission standard of each factory by case. The flowchart and layout drawing are omitted, since they are almost the same as those appearing in the main text. Table ANNEX-2 summarizes the block flowchart and the site areas.

Also for comparison, contents of Case 1 and Case 2 are also described.

Quality of Waste Water for Study and Emission Standard by Factory and Case

	Case	STREAM No.	Flow m³/D	Quality of Waste Water COD mg/l	N-HEX mg/l	PHENOL mg/l	F mg/l	P mg/l	T-N mg/l	NH4-N mg/l	T-Cr mg/l	Cl mg/l	SO4 mg/l	Discharge	Remarks
1. Waste Water Quality for Study															
SIAPE	1, 2, 3	I II	1,056 432	276 150	— —	— —	5,848 4.2	108 0.1	— —	— —	— —	3,700 3,100	1,125 1,800	SEA SEA	
UPOTS	1, 2, 3		1,000	190,000	300	5	—	2,300	Kj-N 920	—	—	8,900	3,050	ONAS	
SIOS-ZITEX	1, 2, 3	I II	45 202	14,267 324	— —	— —	— —	— —	— —	— —	— —	6,259 2,820	3,282 2,086	ONAS SEA ONAS SEA	
	4	I II	46 202	12,214 324	— —	— —	— —	— —	— —	— —	— —	6,259 2,820	3,282 2,086	ONAS ONAS	Production Facility Improved
SATHOP	1, 2, 3	I II	54 140	14,267 356	— —	— —	— —	— —	— —	— —	— —	6,259 7,312	3,282 3,259	ONAS SEA ONAS SEA	
	4	I II	55 140	12,692 356	— —	— —	— —	— —	— —	— —	— —	6,259 7,312	3,282 3,259	ONAS ONAS	Production Facility Improved
SMCP	1, 2, 3		300	4372	251	—	—	—	Kj-N 555	386	318	2,400	3,480	ONAS SEA	
STS	1, 2, 3	I II III	4.6 7.0 33.4	2,6276 282 504	— — —	— — —	— — —	— — —	— — —	— — —	— — —	1,133 4,800 363	5,476 5,800 595	ONAS ONAS ONAS	
2. Emission Standard															
Emission Standard Proposed by Japan	1A 1B			2,000 90	50 20	5 0.05	14 5	— PO4 0.1	— —	— 30	2.5 2.5	— —	— —	ONAS SEA	Applied for SIAPE
Emission Standard Proposed by Tunisia	2A 2B			2,000 90	50 20	5 0.05	15 5	— PO4 0.1	— —	— 30	2.5 2.5	2,000 —	1,000 1,000	ONAS SEA	
INNORPI Standard	3A 3B			1,000 90	30 20	1 0.05	3 5	PO4 10 PO4 0.1	— —	100 30	2.5 2.5	700 —	400 1,000	ONAS SEA	
Emission Standard Proposed by Japan	4A													ONAS	Production Facility Improved

Block Flow Sheet of Waste Water Treatment by Factory and Case

Factory Name	Case	Block Flow Sheet	Site Area Required
SIAPE	1B	Stream I → CA → PH → PF → (joins Stream II before BT) Stream II → AR → BT → ST → TO SEA; branch after ST → TO PA PLANT	40m x 80m=3,200m²
SIAPE	2B 3B	Stream I → CA → PH → PF → (joins Stream II before BT) Stream II → AR → BT → ST → SF → MF → RO → TO SEA; branch after ST → TO PA PLANT; RO → Concentrated Water	40m x 80m=3,200m²
UPOTS	1A	Dilution Water → ST-1 MARGIN → OP → ABT-1 → ST-1 → ABT-2 → BT → ST-2 → TO ONAS	50m x 80m=4,000m²
UPOTS	2A 3A	Dilution Water → ST-1 MARGIN → OP → ABT-1 → ST-1 → ABT-2 → BT → ST-2 → CA → SF → MF → RO → TO ONAS; RO → Concentrated Water	50m x 80m=4,000m²
SIOS-ZITEX & SATHOP	1A	Stream I → CA → TO ONAS Stream II → (joins Stream I after CA)	SIOS-ZITEX 16m x 30m=480m² SATHOP 16m x 28m=448m²
SIOS-ZITEX & SATHOP	2A	Stream I → CA → BT → ST → SF → MF → RO → TO ONAS; RO → Concentrated Water Stream II → CA → SF → MF → RO → (joins Stream I to ONAS); RO → Concentrated Water	SIOS-ZITEX 35m x 55m=1,925m² SATHOP 30m x 53m=1,590m²
SIOS-ZITEX & SATHOP	3A	Stream I → CA → BT → ST → SF → MF → RO → TO ONAS; RO → Concentrated Water Stream II → CA → BT → ST → SF → MF → RO → (joins Stream I to ONAS); RO → Concentrated Water	SIOS-ZITEX 35m x 55m=1,925m² SATHOP 30m x 53m=1,590m²

Factory Name	Case	Block Flow Sheet	Site Area Required
SIOS-ZITEX & SATHOP	3B	Stream I → CA → BT → ST → SF → MF → RO → TO SEA; RO → Concentrated Water Stream II → CA → BT → ST → SF → MF → RO → TO SEA; RO → Concentrated Water	SIOS-ZITEX $35m \times 55m = 1{,}925m^2$ SATHOP $30m \times 53m = 1{,}590m^2$
	4A	Stream I → CA → TO ONAS Stream II → TO ONAS	$16m \times 28m = 448m^2$
SMCP	1A	Waste Water → CA → TO ONAS	$16m \times 28m = 448m^2$
	2A	Waste Water → CA → SF → MF → RO → TO ONAS; RO → Concentrated Water	$16m \times 40m = 640m^2$
	3A	Waste Water → CA → SF → MF → RO → TO ONAS; RO → Concentrated Water	$16m \times 40m = 640m^2$
	3B	Waste Water → CA → BT → ST → SF → MF → RO → TO SEA; RO → Concentrated Water	$20m \times 60m = 1{,}200m^2$
STS	1A	Stream I → CA → TO ONAS Stream II+III → TO ONAS	$12m \times 20m = 240m^2$
	2A	Stream I+II → CA → SF → MF → RO → TO ONAS; RO → Concentrated Water Stream III	$12m \times 28m = 336m^2$
	3A	Stream I+II → CA → SF → MF → RO → TO ONAS; RO → Concentrated Water Stream III	$12m \times 28m = 336m^2$