CHAPTER 3 AIRCRAFT FUELING FACILITIES

3.1 Fueling Receiving and Storage Facilities

3.1.1 The following changes in the design of the fuel receiving and storage facilities were made from the basic design to the detailed design.

No.	Category	Contents		Basis of and reasons for changes
		Basic design	Detailed design	
1.	No. of storage tanks	8 sets	6 sets	Due to Chinese side comments after design apprisal. The design change is due to the reduction in the initial construct-ion cost. But tanks will be successive-ly expanded according to the fuel supply volume.
2.	Tank general arrange-ment in storage depot	The south side of the site will be used for the tank area	The north side of the site will be used for the future tank area	Due to the Chinese Side comment after design apprisal. (After discus-sions,the south side was finalized, as the future tank area)
3.	Duplexity of tank outlet valves	Install one electrical-ly-operated valve.	Install one electrical-ly-operated valve and one manual valve on one system	Due to the Chinese Side comment after design apprisal. Two valves will be installed to ensure reliabili-ty of valves
4.	Delete tank check valve	Install check valve at the tank suction nozzle	The check valve will not be installed.	The Chinese Side comment after the design apprisal

3.1.2 Study team's confirmation of design changes

(a) Studies on fuel storage volume

According to the current fuel supply plan, the yearly fuel supply volume in the Phase-1 project year is 756,000 tons. Therefore, the daily fuel supply rate is as follows:

	Considering peak fuel supply volume	Without considering peak fuel supply volume
Daily fuel supply volume	756,000/365 x 1.2*=2,485ton 2,485/0.78=3,186m3/day *1 Peak rate of the average daily fuel supply volume (general value)	756,000/365=2,071 ton 2,071/0.8=2,655m3/day

Number of storage days*2

	Considering Peak fuel supply volume	Without considering Peak fuel supply volume
Tank maintenance is considered.	50,000/3.186=15.7 days	50,000.2,655=18.8 days
Tank maintenance is not considered.	60,000/3,186=18.8 days	60,000/2,655=22.6 days

*2 According to the Chinese standard, the required number of fuel storage days within the airport is established at 30 days. However, this number was decided to be unnecessary as a result of the Chinese design apprisal.

In consideration of the peak of fuel supply volume and the tank's maintenance, a minimum of 15.7-days-worth of fuel volume and also a maximum of 22.6-days-worth of fuel volume are secured, as shown in the foregoing table during the completion of the Phase-1 Project. Therefore, it is considered that the required fuel storage volume will be secured to operate aircraft fueling facilities, on condition that the aircraft fueling facilities are generally operated. Thus, the Chinese Side comment after design apprisal that the number of tanks to be installed should be 6, is no problem.

(b) Studies on change in tank general arrangement

The background to the decision of tank general arrangement is as follows:

(1) Study Team proposed that tanks be provided south of the airport site during the basic design stage.

(2) According to the comment offered by Shanghai Pudong International Airport, Construction Headquarters, the arrangement area of tanks has been changed from the south side to the north side of the airport site with the south side left open.

(3) According to the Chinese Side comment after design apprisal, a plan to install tanks on the south side, as proposed by Study Team, was finalized.

Therefore, Study Team considers that the Chinese Side comment after design apprisal is no problem with regard to the tank arrangement.

(c) Duplexity of tank outlet valve

As a result of the Chinese Side Design Apprisal, they commented, according to their experience, that the shutoff performance of an electrically-operated valve (made in China) would be unsatisfactory, and one valve could not completely shut off fuel, the maintenance work of the valve must be carried out at the great frequency, and a spare valve would be required, thus requiring the duplexity of the outlet valve.

Study Team explained that a spare outlet valve would not be provided in Japan, etc. for the following reasons:- (1) there is no problem with the shutoff performance if a valve of satisfactory fabrication accuracy is adopted and (2) the installation of a spare valve will increase not only cost but also loads on the nozzle. However, the Chinese Side reached the conclusion that the valves would be duplexed. Therefore, Study Team stated that they cannot agree to the Chinese Side comment after technical apprisal, but will duplex the valve according to the Chinese duplex valve system.

(d) Deletion of a check valve (20") for tank suction nozzle

The Chinese Side explained, after design apprisal, that check valves made in China would not be provided in this project, as they have not yet been installed for fuel shutoff purposes in other airports, because their shutoff performance is unsatisfactory. Study Team explained that a check valve would be required to prevent the back flow of fuel from a high liquid level tank to a low liquid level tank, during the switch-off operation of tanks. However, the Chinese Side arrived at the conclusion, after design apprisal, that the check valves at the outlet of the tanks would be deleted. Therefore, Study Team cannot agree to this conclusion, but has accepted to delete the check valves under the Chinese system.

3.2 Hydrant Facility

3.2.1 Change summary

The design of the hydrant facility was changed from the basic design to the detailed design as in the following table.

No	Category	Detail		Basis and reason for change
		Basic design	Detailed design	
1	flow rate control system	control of No. of pumps	The first one pump shall be operated under the rotation control system. The second and subsequent pumps shall be operated under the pump-quantity control system.	Due to the Chinese Side comments after design apprisal. Pumps are operated under the same systems as in the detailed design at Hong Qiao Internatio-nal Airport from October 1994
2	Periodical cleaning of hydrant piping	No plan	The system shall be such that the in-pipe flow rate can be increased periodically, to clean in-hydrant piping. The flow rate shall be 2000m^3.	Comments from SPIACH* and CACC

*SPIACH=Shanghai Pudong International Airport Construction Headquarters

3.2.2 Study Team Confirmation of Changes

(a) Flow-rate control system

Background to decision of pump's flow-rate control system

(1) At the time of the commencement of the basic design in May 1996, the Chinese SPIACH and CACC proposed, at the design meeting with the Study Team, that a pump-quantity control system be adopted for the pump flow-rate control system.

(2) In July 1996, Study Team decided to adopt the pump-quantity control system for the following reasons, in consideration of the Chinese Side proposal.
The fuel supply volume at the new international airport is very much smaller than in Narita and Kansai Airports.

As simple a control system as possible is preferable in consideration of the systems maintenance after operation in such a developing country as China.

A number of pump-quantity control systems have been adopted at the Chinese airports. However, the pump-rotation control system has not yet been adopted.

(3) In October 1996, the rotation control of pumps was commenced with one pump under the fuel supply system at Shanghai Hong Qiao Airport.

(4) At the design apprisal of February 1997, it was decided that the adoption of the pump-rotation control system would be studied.

(5) In May 1997, CACC advised Study Team that the rotation control of two pumps (one pump for each system) was decided.

Study Team explained the following matters regarding the adoption of the rotation control system of hydrant fueling pumps and accepted the pump-rotation control system:

(1) Experience in the adoption and operation of the pump-rotation control system is small in China.

(2) The cost of the pump-rotation system is higher than that of the pump-quantity control system. It is considered that the pump-rotation system is uneconomical in consideration of the fuel supply volume in Pudong.

(3) In Japan, the rotation control of only one pump under the one system (the remaining four sets will be operated under the pump-quantity control system) has not yet been implemented. Therefore, Study Team explained that it would be possible to evaluate the pump-rotation system only after technical evaluation, and confirmation of operational experience, etc.

Reference:
Summary of Pump-quantity Control System and Pump-rotation System under Aircraft Fueling System at Shanghai Pudong International Airport, and comparison between these two systems

	pump-q'ty control system	pump-rotation control system
fuel flow pattern	Flow rate increases/falls stepwise.	Flow rate increases in proportion to the pump's rotation. But the rotation of the third pump and subsequent pumps will not be controlled, and the flow patterns of these pumps are the same as under the pump-q'ty control system.
Supply of small amount of fuel to aircraft	This requirement can be met with the combination of a small flow-rate pump ($50m^3/h$) pump and a large flow-rate pump ($200m^3/h$).	As a large flow-rate pump ($200m^3/h$)can be used, a small flow-rate pump is not necessary.

Problems at small flow-rate	A bypass line will be installed to prevent the shutoff operation. Thus, there is no problem.	As the rotation of a pump is controlled according to the flow rate (pressure), there is problem.
Follow-up to large flow rate	The follow-up is favorable as the number of pumps in operation is increased	The same as in the left-hand column.

3.3 Ancillary facilities

3.3.1 Slop facility

The design of the slop facility was changed from the basic design to the detailed design as follows:

In the basic design, the type of a slop tank was established as the 'CRT" (cone apprisal tank). According to the Chinese Side proposal, this tank type was changed to an elevated tank.

The reasons for the change in the tank type;

(1) Total amount of fuel can be sent by gravity flow.

(2) Elevated tanks were adopted at other Chinese airports in the past, and were favorably evaluated by airport operators.

Study Commission offered the following comments and decided to accept the Chinese Side proposal.

(1) If elevated tanks are to be adopted, tank structures will require greater strength in consideration of normal loads and seismic loads. As a result, large structures will be required. Also, detailed structure strength studies will be required including studies on the loads in case of an earthquake.

(2) In consideration of fire, structures supporting tanks must be of fireproof construction.

(3) For the above reasons, the construction cost of elevated tanks is larger (about double, according to Study Team trial calculation) than that of non-elevated tanks.

3.3.2 Drain facility

The design of the slop facility was changed from the basic design to the detailed design as follows:

In the basic design, one 200m^3-capacity drain drum will be installed in the fuel storage depot. One 5m^3-capacity drain drum will be installed in the fuel supply depot. According to the Chinese Side proposal, one 25 m^3-capacity drain drum will be installed in the fuel storage depot, with one 25 m^3-capacity drain drum in the fuel supply depot. Study Team accepted this change.

3.4 Fire fighting and water supply/drainage systems

3.4.1 Fire fighting system

The design of a fire fighting system was changed from the basic design to the detailed design. In the basic design, it was planned that one 4,000m^3 -capacity fire fighting water tank would be installed. In the detailed design, this tank was changed to two 2,000m^3 -capacity fire fighting water tanks. The reason for this change was that the number of water tanks provided should preferably be two sets, in consideration of tank maintenance.

3.5 Electrical and instrumentation system

3.5.1 Electrical system

The design of an electrical system was changed from the basic design to the detailed design as follows:

No.	Category	Details		Basis of and reason for change
		Basic design	Detailed design	
1	Pump power system	All pumps shall be operated under the pump-quantity control system.	VVVF shall be added as two pumps will be operated under the pump-rotation control system.	Due to the Chinese Side comments after design apprisal

3.5.2 Instrumentation system

The design of the instrumentation system was changed from the basic design to the detailed design as follows:

No.	Category	Details		Basis of and reason for change
		Basic design	Detailed design	
1	Pump control system	All pumps shall be operated under the pump-quantity control system.	Two pumps will be operated under the pump-rotation control system.	Due to the Chinese Side comments after design apprisal

3.6 Civil and architectural facilities

3.6.1 Civil

The items of work shall be carried out for the civil facilities:

Soil preparation work

Soil shall be prepared at the required elevation.

Rain water drainage work

The rain water drain pipes shall be buried. The drain shall be discharged t hrough the open channel and conduit.

Tank foundation work

The foundation work for the storage tanks and slop tanks shall be conducted. The deep mixing method shall be adopted for soil improvement.

The foundation shall be of ring-type construction, and shall be reinforced in case of earthquake.

Oil dike work

The oil dike conforming to the Chinese standard shall be provided. The dike shall be of reinforced concrete construction.

Team foundation work

The team foundation for pumps and filters shall be installed. The foundation shall be of reinforced concrete construction.

Piping burial work

The piping shall be buried. Good-quality sand shall be filled around piping, to protect it from outside. The soil of the sections under the apron pavement and

taxiway shall be fully rolled during back-filling, to prevent uneven settlement of paved ground.

Piping support (ground) work

Supports shall be provided for the piping to be installed on the ground. The supports shall be of reinforced concrete construction, and shall be fully reinforced in case of earthquake.

Fire fighting water storage tank work

Two 2,000m^3-capacity water storage tanks shall be installed to store fire fighting water. These tanks shall be of reinforced concrete construction, and shall be fully reinforced in case of earthquake.

Header pit work

A header pit shall be installed to provide the branch valves of hydrant piping in the restricted area within the airport. The pit shall be of water-sealed construction, and leakproof sealing shall be provided for the penetrating piping to prevent the leak of ground water.

Valve box work

According to the Chinese practice, a valve box for switch-off of the hydrant piping shall be installed.

Operating platforms and access way work

An operating platform and an access way shall be provided at operationally required areas. These platform and access way shall basically be of reinforced concrete construction, and shall be provided as far as possible at the minimum required areas in consideration of maintenance after construction. In addition, they shall be of simple construction to reduce maintenance work.

Pavement work

The pavement work shall be done within the airport site. The types of the pavement shall be concrete pavement, asphalt pavement, and gravel pavement. The application scope of each pavement is as follows:

Concrete pavement : where oil may drop
Asphalt pavement : where vehicles will run

Gravel pavement : tanks

Landscaping work

Landscaping work shall be done except in the foregoing pavement areas. Basically, lawns shall be planted. As necessary, plants will be planted. Also, a water spray system for the plants shall be provided.

3.6.2 Architectural facilities

The types and areas of the architectural facilities to be provided are as follows:

Office building (fuel storage Depot) 3,540m^2
Administration office

Office building (fuel supply depot) 1,480m^2
Administration office

Canteen 708m^2
For employee dining

Fuel pump room 892m^2
Housing the fuel pump.

Fire pump room 345m^2
The fire pump, foam feed tank, and water foam mixing facility will be installed here.

Fuel supply vehicle shed 1,883m^2
This shed will be provided with a parking lot for servicers and refuellers, and also motor vehicle repair shops.

Electrical room and control room 604m^2
The electrical room will be installed to house the electrical system, and the central control room , on the first floor. The central control room will be installed to control the operation of the aircraft fueling facility, on the second floor.

Oily water drainage treatment room 59m^2
This room will house the drainage treatment facility.

Gate-house 36m^2

Laboratory 302m^2
This laboratory will be installed to test and confirm the quality of fuel.

Team repair room 306m^2
This repair room will be used to make small-scale repairs.

Hazardous material storage warehouse 332m^2

This warehouse will be used to house such hazardous materials as oil, and shall be of such construction that the warehouse will be free from fire due to oil leakage, etc. and will be oil leak-free.

Refueler loading shed

Shed where fuel will be loaded onto the Refueler

CHAPTER 4 CONSTRUCTION PLAN AND FLUSHING PLAN

4.1 Division of work areas of aircraft fueling facility in the 1st-phase project

(1) Fuel storage depot
(2) Hydrant piping
(3) Fuel supply depot

4.1.2 Construction plan summary

As all items of work associated with the aircraft fueling facility at Shanghai Pudong International Airport are new installation work, constructional constraints,etc. are few.

Therefore, construction plans can be economically worked out, in consideration of the work safety and period.

As the work areas for the fuel storage depot and fuel supply depot are distant from other airport work areas, it is scarcely necessary to perform schedule coordination with other aspects of airport work. Consequently, the work can be executed according to the work schedule solely for these depots. However, the schedule for hydrant work must be coordinated with that for other work (mainly airport civil work). Thus, satisfactory work scheduling constitutes a key to successful execution. Therefore, it is necessary to coordinate the detailed schedule for the aircraft fueling facility once the specific schedule for the airport work has been prepared.

The work for the aircraft fueling facility at Shanghai Pudong International Airport will be executed according to the following procedure:

(1)Fuel Storage Depot

- Site Preparation Work
- Rain Water Drainage
- Underground Work
- Tank Foundation
- Equipment Foundation
- Piping Support
- Tank Fabrication
- Fire Dike
- Equipment Installation
- Piping Work
- Electrical Work
- Instrument and Control
- Building Work

- Operation Stage and Walk Way
- Painting Work
- Pavement
- Flushing
- Test Operation

(2)Fuel Hydrant Piping

- Survey of Pipe Line route
- Right of Way
- Excavation
- Pipe Installation
- Backfilling
- Flushing
- Test Operation

(3)Fuel Supply Depot

- Site Preparation Work
- Rain Water Drainage
- Underground Work
- Equipment Foundation
- Piping Support
- Equipment Installation
- Piping Work
- Electrical Work
- Instrument and Control
- Building Work
- Operation Stage and Walk Way
- Painting Work
- Pavement
- Flushing
- Test Operation

4.1.3 Work schedule

The total project period of the aircraft fueling facility is 22 months after commencement of the work. The work schedule for each of the following facilities is shown in the attached schedule (refer to the attachment).

. Fuel storage depot
. Hydrant facility
. Fuel supply depot

4.2 Flushing plan

4.2.1 Notes prior to flushing work

(1) Full protection shall be provided to prevent dust, soil, and sand from entering the equipment and piping during assembly and work.

(2) Water shall not used for tests on the pressure of piping. (The pressure tests shall be conducted using nitrogen gas or pneumatic pressure.)

(3) Soft pig cleaning shall be done to clean the inside of the piping after assembly of the piping (hard pigs shall not be used, to protect the in-pipe painting).

4.2.2 Basic policy of flushing

(1) Flushing will be done using JET fuel.

(2) The in-pipe flow rate during flushing shall basically be the maximum flow rate during operation or larger.

(3) After completion of flushing, fuel sample will be tested inside the laboratory. Flushing will be deemed complete only after the sample passes the test.

4.2.3 The following flushing work will be carried out based on the foregoing basic policy.

(1) The storage tank for flushing will be determined.

(2) Temporary piping, blind plate and temporary strainer will be provided for flushing.

(3) Filter cartridges for flushing will be installed in filters.

(4) Required amount of fuel will be stored within the storage tank.

(5) The quality inspection of fuel within the storage tank will be done.

(6) After confirming the results of quality inspection, the flushing work will proceed per the following steps:

(a) Filling within the piping and drain out

(b) Fuel will be successively and gently filled into the piping from tanks by gravity flow. The flow rate will be adjusted to 1m/s or less using valves. Initial

feed fuel will include a large amount of dust, etc., within the piping. This fuel will therefore be removed from piping.

(c) Pump-aided circulation flushing work
Fuel flow rate will be increased using a pump to carry out in-pipe flushing. The first pump will be started up, and the number of pumps in operation will be successively increased while ensuring safety. Finally, flushing will be carried out at the maximum flow rate. Fuel will be repeatedly drawn off from each of the points where fuel cannot be circulated using pumps, for in-pipe flushing.

(d) Checks on fuel sample

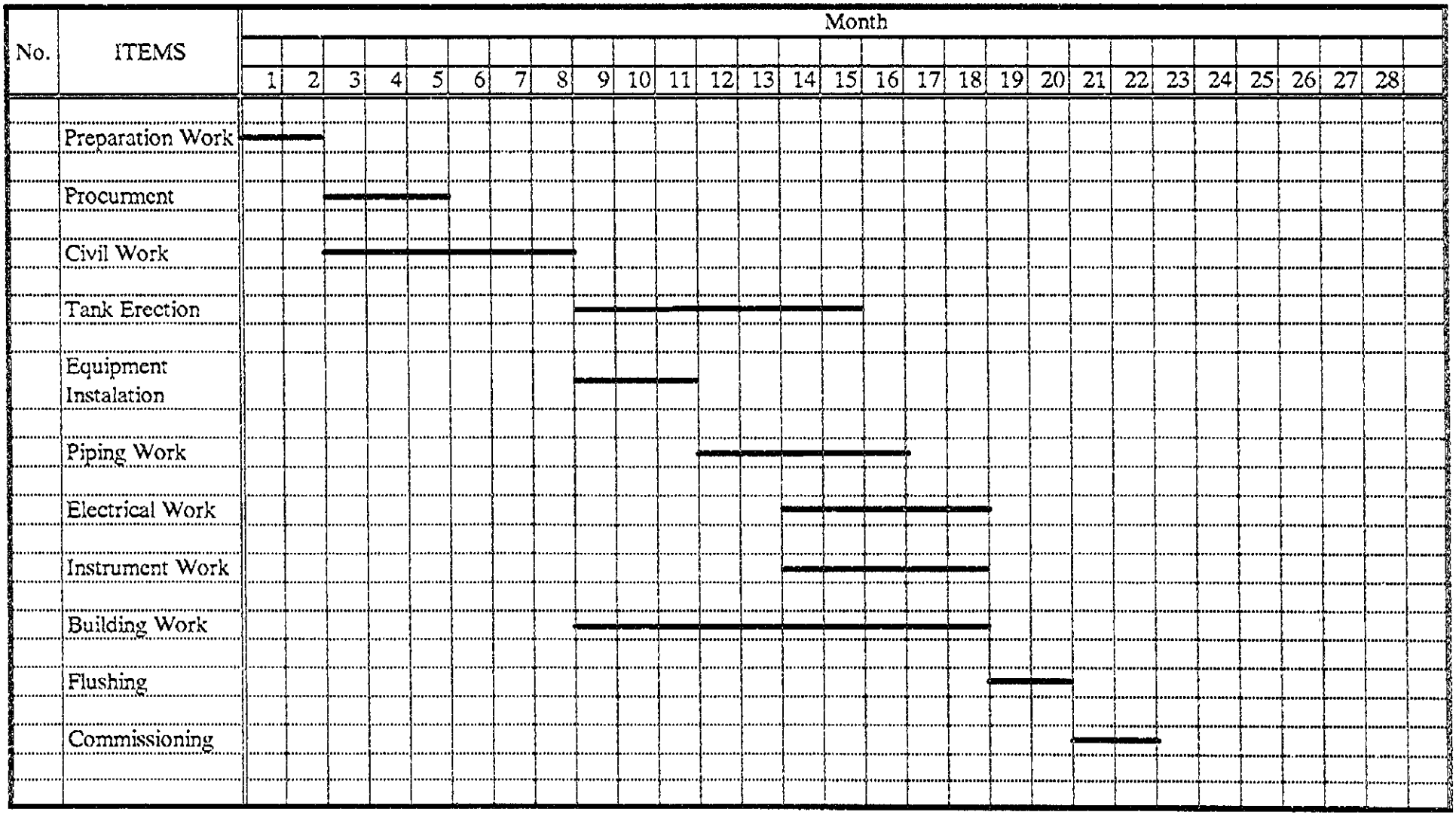
Fuel sample will be taken when the volume of fuel becomes more than 30 times the in-pipe volume after in-pipe flushing. The cleanliness of in-pipe fuel will be checked and flushing will be completed if this cleanliness satisfies the stipulated value.

(e) Replacement of filter cartridges

After completion of flushing, the contamination of filter cartridges will be checked and all the old cartridges shall be replaced with new ones, if necessary.

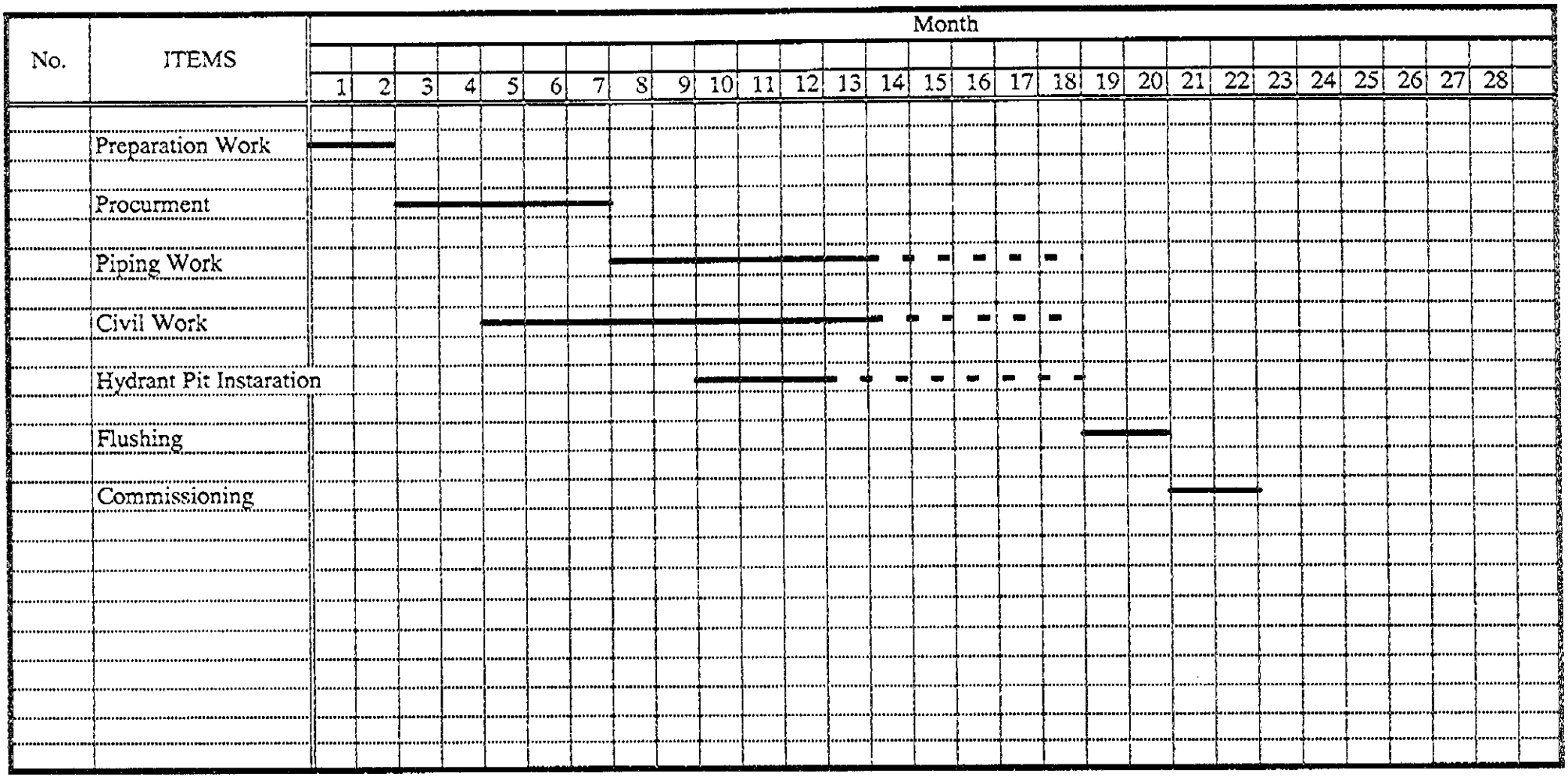
SHANGHAI PUDONG INTERNATIONAL AIRPORT
FUEL STORAGE DEPOT

CONSTRUCTION SCHEDULE



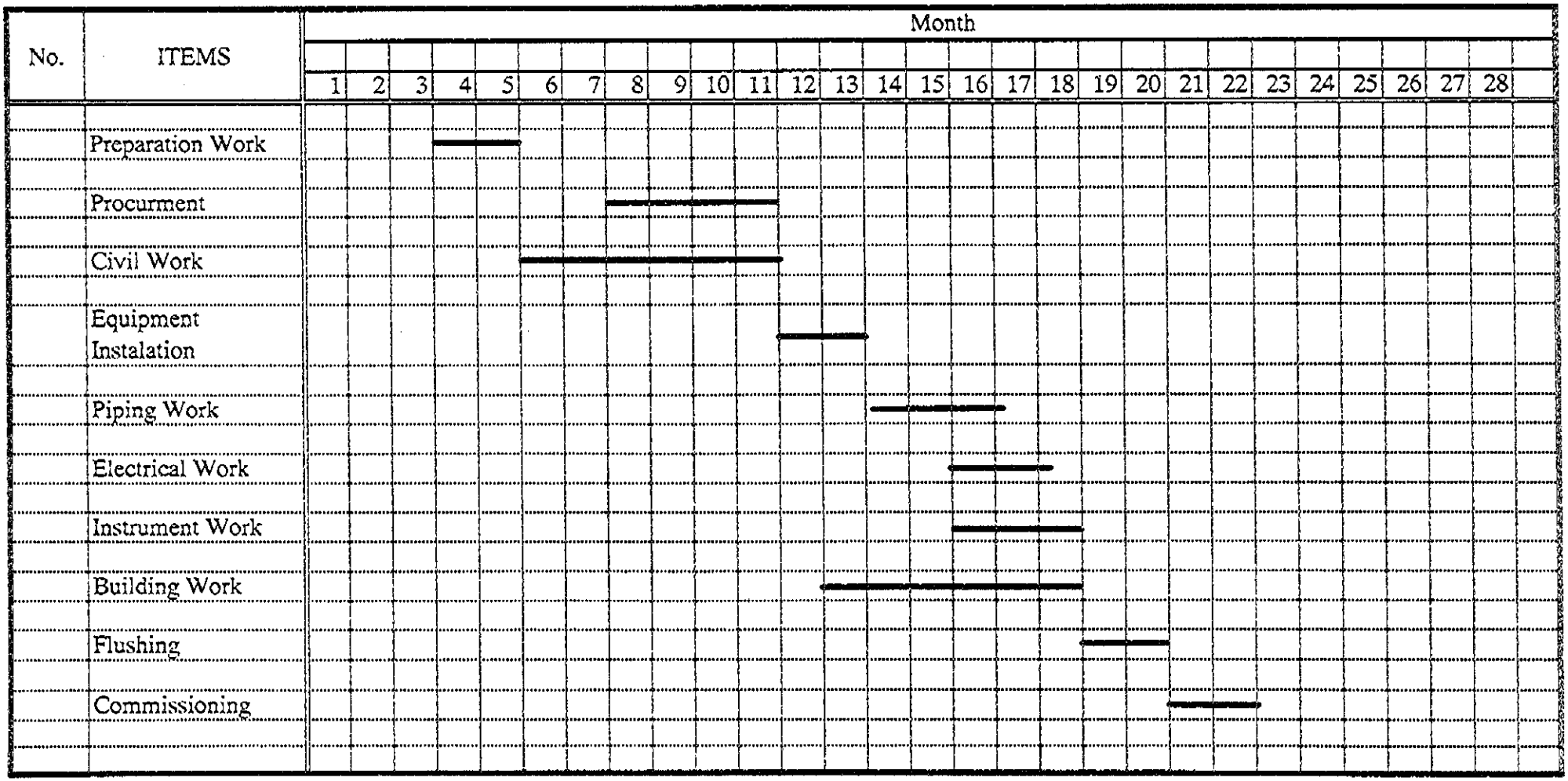
SHANGHAI PUDONG INTERNATIONAL AIRPORT
FUEL HYDRANT PIPING

CONSTRUCTION SCHEDULE



SHANGHAI PUDONG INTERNATIONAL AIRPORT
FUEL SUPPLY DEPOT

CONSTRUCTION SCHEDULE



CHAPTER 5 ESTIMATION OF CONSTRUCTION COST

Estimation of Construction Cost are as follows;

Item	Equipment x10³RMB	Installation x10³RMB	Building x10³RMB	Total x10³RMB	Include Foreign x10³USD
Fuel Storage Depot	76,980	41,170	26,980	145,130	6,650
Fuel Supply Depot	2,250	58,060	6,430	66,740	9,830
Hydrant Facility	34,070	48,780	-	82,850	4,300
Total	113,300 (1,586,000)	148,010 (2,072,000)	33,410 (468,000)	294,720 (4,126,000)	20,780 (2,410,000)

()JPY X10³ (Reference)

The following are the basis for our cost estimation.

(1) Unit Cost

- Machinery: Foreign portion* : Calculated based on data available in Japan.
  Local portion : Calculated based on data available in China.
- Installation cost : Calculated based on data available in China (Installation cost of foreign portion: Calculated based on data available in China.)
- Building cost : Calculated based on data available in China.

Note: *Foreign and local portions were determined through discussions with China.

(2) Difference between rough construction cost during basic design and construction cost during detailed design:

Construction cost calculation basis during basic design:

(a) Classification of local and foreign portions remained unsettled, and construction cost was calculated based on data available in Japan.
(b) Since we were not able to obtain unit costs available in China, we used unit costs available in Japan.

Construction cost calculation basis during detailed design:

(a) Local and foreign portions have been classified clearly. (Many Chinese products were employed unlike estimation in Japan during basic design.)
(b) Local portion was calculated during detailed design based on unit costs available in China.
(c) The number of storage tanks was reduced by two and amounted to six in all.

(d)The area of the site to be prepared was reduced as a result of design review by China.
(e)The size of the building was reduced as a result of design review by China.

(3) Estimated Exchange Rate(Reference)

1USD = 8.3RMB, 14Yen = 1RMB, 116Yen = 1USD

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SCIENCE AND TECHNOLOGY COMMISSION OF
SHANGHAI MUNICIPAL PEOPLE'S GOVERNMENT,
PEOPLE'S REPUBLIC OF CHINA

DETAILED DESIGN OF SHANGHAI PUDONG INTERNATIONAL AIRPORT FINAL REPORT

VOLUME I
MAIN REPORT

PART III-4
DETAILED DESIGN
OF
FIRE FIGHTING AND RESCUE FACILITIES

SEPTEMBER 1997

NIPPON KOEI CO., LTD.
NIKKEN SEKKEI LTD.

CHAPTER 1 FIRE FIGHTING AND RESCUE PLAN

1.1 Design Conditions

1.1.1 Fire Fighting · Rescue System

According to the results of examinations by the People's Republic of China on basic design and operating policy, etc., the following changes have been made in the detailed design:

(1) Changes in the Rescue Center

As a result of examinations and consultation with Shanghai Pudong International Airport Construction Headquarters and related authorities on basic design, it was decided to separate these facilities and construct them as individual facilities, which is different from conventional domestic rescue structures in the People's Republic of China, in order to arrange more effective and integrated structures for rescue, medical services and health and hygiene. With respect to rescue and first aid structures, they are to be dealt with by the dispositioning of large-scale rescue and medical service vehicles in a manner similar to those of Kansai International Airport and New Tokyo International Airport in Japan, and by developing rescue and medical service structures around the airport. Therefore, in the flight district, garages for rescue vehicles, including rescue and medical services vehicles, instead of the first aid center and equipment store, are to be planned.

(2) Changes in the layout of facilities

As a result of changes in the first aid center, the layout of the main fire fighting station shall be adjusted accordingly, together with the adjacent oil supply facility and the aeronautical light source facility, and shall be planned so the site can be effectively utilized.

(3) Changes in the energy supply system

As a result of the review of the layout of facilities in the airport management area and changes in the energy supply system, the following changes have been made with the heat source systems of the facilities:

- The low-voltage power supply of the main fire fighting station shall come directly from the power supply facility.
- The heat supply system of the main fire fighting main station shall be a centralized air conditioning system.
- The air conditioning of the sub fire fighting station shall have an electrical separate-type air conditioning mode.

1.1.2 Facilities to be designed as a result of the above changes include the following:

1) Main Fire Fighting Station (included Training Tower)

2) First Aid Garage

3) Sub Fire Fighting Station

4) Flight District Fire Hydrant and Fire Fighting Pump Room

1.1.5 Categories of ICAO

From the forecast demand of the frequency of takeoffs and landings of large aircrafts in the year 2005, the plan will be made on Category 9 of ICAO. As to Category 10 which deals with future large aircrafts, ICAO is supposed to establish new standards now, consequently, these alterations will be taken into consideration for the plan.

1.1.4 Design Standard

The plan will conform to the standards of ICAO and domestic standards of China. The main standards are as follows.

ICAO-ANNEX14	Annex 14, International Civil Aviation Treaty of International Civil Aviation Organization
MH7002-94	Standard of equipment in the fire-fighting station of Civil Aviation Transportation Airport
MH7003-95	Construction standard of security and protection installation of Civil Aviation Transportation Airport
GBJ16-87	Fire defence code for architectural design of The People's Republic of China
GBJ52-83	Code for industrial and civil electrical supply system design
GBJ116-88	Code for automatic fire alarm system design
GNJ1-81	Building design standard for fire stations
GBJ15-88	Code for water supply and drainage design of buildings
GBJ67-84	Fire defence code for garage design
GBJ7-89	The People's Republic of China standard foundation design code
DBJ08-11-89	Shanghai standard foundation design code
DBJ08-9-92	Shanghai aseismic design code for buildings

1.2 Facility Layout Plan

1.2.1 Fire Fighting Facility

Fig. Ⅲ4-1.2.1 shows the scope of Phase I work and the layout of the fire fighting facility. The layout of the main fire fighting station shall be closer to the runway side than in the basic design for more effective utilization of the management district and because of changes in the first aid center.

1.2.2 Rescue Facility

The garage for rescue vehicles, etc. shall face the apron adjacent to the Main Fire Fighting Station.

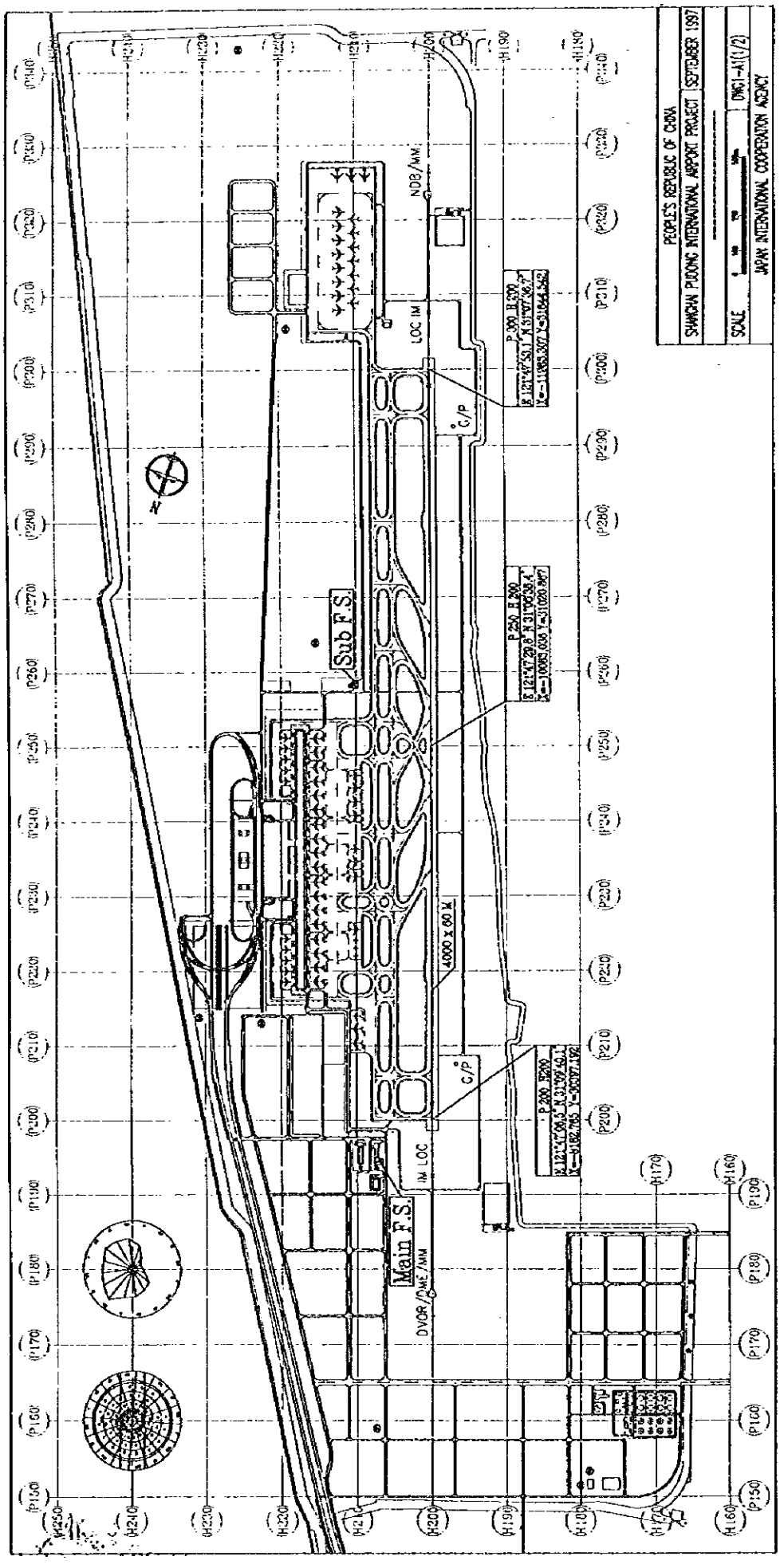

PEOPLE'S REPUBLIC OF CHINA
SHANGHAI PUDONG INTERNATIONAL AIRPORT PROJECT
SEPTEMBER 1997
SCALE
DWG I-A1(1/2)
JAPAN INTERNATIONAL COOPERATION AGENCY
Sub F.S.
Main F.S.
4000 x 60 M
C/P
C/P
LOC IM
IM LOC
NDB/MW
DVOR/DME/MM
N

Fig. III-4-1.2.1

1.3 Personnel Disposition And Scale Plan

1.3.1 Fire Fighting Facility

The disposition of personnel and the scale plan for the Phase I work shall be as shown in Table Ⅲ4-1.3.1

Table Ⅲ4-1.3.1 Scale of the Fire Fighting Facility

Facility	Personnel Disposition			Facility Scale (m²)		
	Fire fighting crew	Management personnel	Total	1F	2F	Total
Main Fire Fighting Station	117	24	141	2,040	1,710	3,750
Sub Fire Fighting Station	33	6	39	640	510	1,050

1.3.2 Rescue Facility

The scales and main equipment to be accommodated in the first aid garage, rescue vehicle garage, equipment storage room, on-duty room, etc. Heat exchanger room for hot and cool water supply to the circumferential facilities put side by side with rescue vehicle garage.

Facility scale and installed equipment shall be as shown in Table Ⅲ4-1.3.2.

Table Ⅲ4-1.3.2 Scale of the Rescue Facility

Facility	Subjects, vehicles, equipment, etc.	Area (m²)
Garage	Ambulance units 6 Large First Aid Medical Service Vehicle 1	270
Equipment storage room	Medicines and Stretchers for 190 sets	15
Heat exchanger room On-duty room	Person-duty 1～2, toilet, etc.	40

CHAPTER 2 VEHICLE DISPOSITION PLAN

2.1 Fire Engines

Disposition of the fire engines shall be as shown in Table Ⅲ4-2.1.1 based on the basic design, of which the disposition of the Foam Discharge Vehicle for spraying fire extinguishing agent on runways shall meet the disposition requirements of the Civil Aviation Standards of the People's Republic of China (MH7002-94) and not those of ICAO Standards. However, there are no examples of disposition within the country at this time. Nor are there examples of disposition in Japan, and none from manufacturers are available. Therefore, in the event of need, use of a Chemical Fire Extinguisher Vehicle shall be considered realistic. Consequently, for this plan the matter shall be left to the judgment of the Chinese side and in the facility plan necessary garage space shall be secured.

2.2 First Aid Vehicle

Due to the changes in the rescue and first aid systems, in addition to ambulances, a large First Aid and Medical Services Vehicle will be dispositioned.

Since the introduction of the large First Aid and Medical Services Vehicle into airports within the People's Republic of China is to be done for the first time, the specifications thereof shall be based on vehicles used in Japan, which can correspond to Vehicle Standards within the People's Republic of China.

Based on the result of the study by the Chinese side, the large First Aid and Medical Services Vehicle is to handle 60 persons. However the large First Aid and Medical Services Vehicle for 60 persons will not load an air tent system.

The investigators recognize that this air tent system is efficient to the rescue and first aid systems the large First Aid and Medical Services Vehicle performs. Therefor we recommend that the disposition of air tent system should be re-considered when the Chinese side study on the operation system.

Table Ⅲ4-2.2.1 shows the disposition plan for the First Aid Vehicle.

Table III 4-2.1.1 Fire Engine Disposition Plan

Type of vehicle	Gross weight kg	Acceleration performance	Max. speed km/h	Water volume l	Volume of chemical l	Discharge volume l/min	External dimensions l x w x h (mm)	No. (Staff /car)
1. High-speed fire engine (import)	33,000	25 s/0-80 km	105	5000	600	4000 5100	11000 x 2900 x 3700	1 (3)
	High Intervention Vehicle							
2. Main chemical fire engine (import)	42,000	40 s/0-80 km	100	10000	1200	4000 51000	12000 x 3100 x 3800	4 (3)
	Main Chemical Fire Engine							
3. Fire engine for powder extinguisher	11,000	40 s/0-80 km	90	-	-	-	7100 x 2500 x 3600	1 (3)
	Dry Chemical Fire Extinguisher Vehicle							
4. Large chemical fire engine	16,000	40/0-80	90	4500	1500	3000	8000 x 2550 x 3400	1 (6)
	Large Chemical Fire Fighting Vehicle							
5. Large water supply car	20,000	50/0-80	90	7000	-	3000	8500 x 2560 x 3800	2 (5)
	Large Water Tanker							
6. Lighting car	3,500	50/0-80	90	-	-	-	5400 x 2000 x 2700	1 (3)
	Lighting Vehicle							
7. Communication /Control car	2,600	-	120	-	-	-	4900 x 1850 x 2000	1 (2)
	Fire Fighting Commander's Vehicle							
8. Disaster rescue car (import)	9,000	-	100	-	-	-	7600 x 2300 x 3200	1 (5)
	Demolition Rescue Vehicle							
9. Rear support car	9,000	-	90	-	-	-	6900 x 2400 x 3100	1 (2)
	Rear Support Vehicle							
10. Foam undiluted solution transport car	12,000	-	90	-	4000	-	7200 x 2500 x 3000	1 (3)
	Foam Agent Tanker							
11. Chemical Form Sprinkler	Assumed about the same size with large chemical fire engine							1 (2)

Table Ⅲ4- 2.2.1 First Aid Vehicle Disposition Plan

Type of vehicle		Shape, dimension l x w x h (mm)	Number (personnel, vehicles)
1. Rescue Commander's Vehicle		4900 x 1850 x 2000	1 (2)
2. Ambulance		5400 x 1700 x 2500	5 (2)
3. Large Medical Services Vehicle	Handling of 60 persons	8000 x 2500 x 3500	1 (3)

CHAPTER 3 FACILITY PLAN

3.1 Main Fire Station

3.1.1 Layout Plan

The facility layout of the Main Fire Station shall be as shown in Fig. Ⅲ4-3.1.1 due to considerations for the effective utilization of the management district site and as a result of changes in the first aid center.

Basic Design

Detailed Design

3.1.2 Facility Composition

The fire fighting on-duty room shall be laid out near the garage on 1F in consideration of its application in the People's Republic of China. Other rooms shall be laid out mainly on 1F, which includes a garage, a maintenance room, an equipment storage room, a dining room, a bathroom, etc., attached thereto. Provided on 2F shall be a firefigher's quarters, a key personnel quarters, a chemical storage library, etc.

3.1.3 Structural Design

1) Foundation work

- The foundation are strip footing system. As the result of site investigation there is no former water channel in the construction site and the soil bearing capacity is confirmed to be sufficient to support the building. Pile foundation system is judged not to be used together.
- Spans of the building are almost equal and there are no big differences between the vertical loads imposed on the foundations. By the analysis of soil test result, the amount of the foundation settlement is very small . Therefore the possibility of the differential settlements is judged to be negligibly low.
- Materials to be used are C25 concrete and Grade 1&2 Steel bar.

2) Structural work

- Structural materials are reinforced concrete and structural systems are rigid frames.
- Aseismic design grade of the building is #7 and the importance design grade is 乙.

- Materials to be used are C25 concrete and Grade 1&2 steel bar. Interior and exterior walls are stone masonry or brick masonry.
- Expansion joints are to be located in every approximately 50m.

3.1.4 Equipment Plan

Items changed from the basic design due to changes made in the equipment supply mode shall be as follows:

(1) As a hot water distribution system to kitchen, an electric hot water heater shall be provided.

(2) Chilled water and hot water shall be received from the heat exchanger room in the rescue vehicle garage and a convector for the heating in the garage and fan coil unit for heating cooling shall be provided in each room. Therefore, ceiling fans will not be provided in each room.

(3) The kitchen and the garage shall have forced ventilation, but the toilet, store, etc., shall have natural ventilation.

(4) As a hot water distribution system to Bath room, a hot water boiler shall be provided.

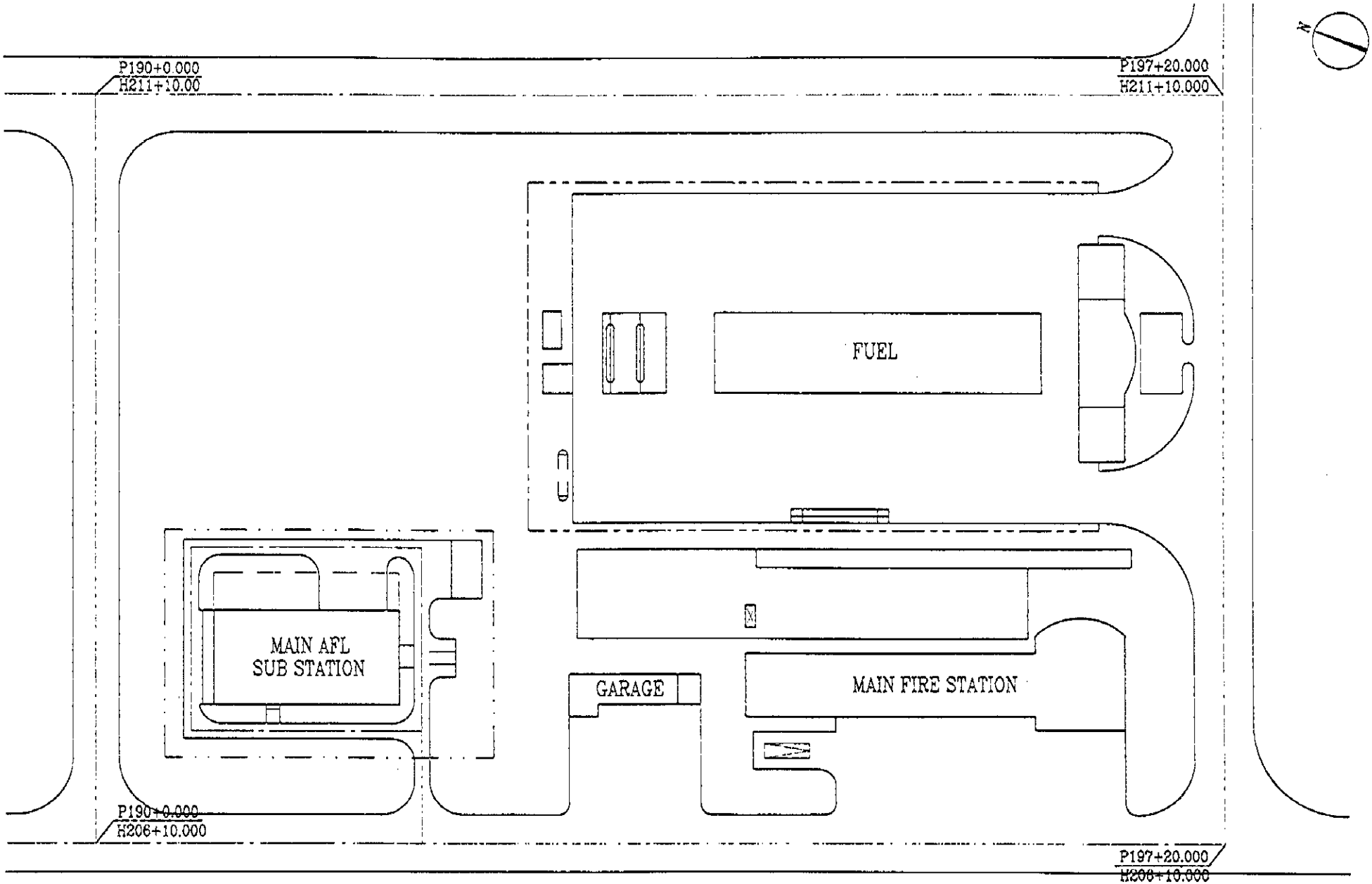

P190+0.000
H211+10.00
P197+20.000
H211+10.000
FUEL
MAIN AFL
SUB STATION
GARAGE
MAIN FIRE STATION
P190+0.000
H206+10.000
P197+20.000
H206+10.000

Fig. III4-3.1.1

Table Ⅲ4-3.1.1 Building Summary of the Main Fire Station

Items		Summary
Building summary	Title of building	International Airport Main Fire Fighting Station
	Construction, scale	Reinforced concrete construction 2 storeys above ground
	Foundation	Reinforced concrete strip footing
	Total floor area	1F 2,088.02m^2 2F 1,800.48m^2 Total 3,888.50m^2
	Main exterior finish	Roof: Rubber seat Water proofing /w Cement Block External walls: Ceramic tile Fittings: Aluminum sashes steel door
	Main interior finish	Floor: Mortar w/floor coating Walls: Mortar w/paint Finish Ceiling: Direct Ceiling
	Training building	Reinforced concrete construction 4 storeys One building
Summary of air conditioning ventilation equipment	Heat source equipment	The chilled water and hot water supply shall be received from the heat exchanger room (in rescue vehicle garage)
	Air conditioning equipment	Fan coil unit and convector for heating only
	Ventilation equipment	Ventilation type-3 in kitchen, garage and battery room

Summary of plumbing & sanitary equipment	Water supply equipment	Directly supplied from water main of facility
	Hot water supply equipment	Bathroom system: hot water boiler Kitchen system: electric hot water heater
	Drainage system	Combining of waste water and misc. drain water, storm water, kitchen waste water, equipment drainage, etc., 4 systems in total
Summary of electrical equipment	Power source system	3 ϕ 4W 0.4 kV (two-line service system)
	Earthing system	Lightning arrester system: a receiving copper wire shall be installed on roof. Arrester conductor: lead down conductor
	Load system	General lighting system: illumination intensity shall be according to "Private Building Architectural Lighting Design Standards." Emergency light, outside light, socket outlet system.
	Communication and information systems	Public Address System, Master Antena Television System
	Indicator system	Emergency indicator system: control board shall be installed in on-duty room. Lamps with buzzers shall be installed in each room.

3.2 First Aid Garage

3.2.1 Layout Plan

The first aid garage shall be laid out adjacent to the fire fighting headquarters building out of consideration for the integration of rescue activities with the fire fighting headquarters. (refer to Fig. Ⅲ4-3.1.1)

3.2.2 Facility Composition

In addition to the garage for first aid and rescue vehicles, the first aid vehicle garage shall have the following rooms:

(1) On-duty room .....Heat exchanger room, and for the manager

(2) Restroom .....For the vehicle manager

(3) Warehouse, equipment storage room .....Storage of vehicle parts, rescue equipment, etc.

(4) Heat exchanger room .....Cold and hot water from the local cooling & heating facility in the airport will be heat-exchanged and supplied to the fire station and oil terminals.

(5) Toilet .....For the person on duty.

Also, rescue equipment shall be provided for the major rescue and medical services vehicle for 60 persons, and for coping with accident of large aircraft stretchers for 130 persons shall be provided (for 190 persons in total, including the stretchers for 60 persons provided in the large First Aid and Medical Services Vehicle).

3.2.3 Structural Design

1) Foundation work

- The foundation are strip footing system. As the result of site investigation there is no former water channel in the construction site and the soil bearing capacity is confirmed to be sufficient to support the building. Pile foundation system is judged not to be used together.
- Spans of the building are almost equal and there are no big differences between the vertical loads imposed on the foundations. By the analysis of soil test result, the amount of the foundation settlement is very small . Therefore the possibility of the differential settlements is judged to be negligibly low.

- Materials to be used are C25 concrete and Grade 1&2 Steel bar.

2) Structural work

- Structural materials are reinforced concrete and structural systems are rigid frames.
- Aseismic design grade of the building is #7 and the importance design grade is 乙.
- Materials to be used are C25 concrete and Grade 1&2 steel bar. Interior and exterior walls are stone masonry or brick masonry.

3.2.4 Equipment Plan

(1) A toilet shall be installed and the water supply thereof shall be lead-in directly from the drain in the facility and drainage shall be combined waste water and miscellaneous drainage.

(2) A power source shall be provided so that a cooling and heating system can be installed in the future in the on-duty room and restroom.

(3) The garage shall be ventilated by means of forced ventilation using an exhaust fan; the toilet shall use natural ventilation.

(4) Power is received by low voltage from the Main Fire Fighting Station.

(5) General lighting and emergency lighting shall be installed.

(6) Socket outlets shall be installed where necessary in the garage and on-duty room, etc.

Table Ⅲ4-3.2.1 Building Summary of First Aid Garage

Item		Summary
Building summary	Title of building	First Aid garage
	Construction · scale	Reinforced concrete construction one storey building
	Foundation structure	Reinforced concrete strip footings
	Total floor area	323.8m^2
	Main exterior finish	Roof: Polyurethan coating Water Proofing External walls: Ceramic tile Fittings: Aluminum sashes steel door
	Main interior finish	Floor: Mortar w/floor coating Walls: Mortar w/paint Finish Ceiling: Direct Ceiling
Summary of air conditioning equipment	Air conditioning equipment	Power source shall be provided so that an air-cooled heat pump air conditioner can be installed.
	Ventilation equipment	Ventilation type 3 : garage
Summary of plumbing and sanitary equipment	Water supply equipment	Water shall be supplied directly from water main in the facility.
	Drainage system	2 systems, combining waste water and miscellaneous drainage and storm drainage
Summary of electrical equipment	Power source system	Power shall be received from the Main Fire Fighting Station with low voltage.
	Load system	General lighting, emergency lighting, and socket outlet system

3.3 Sub Fire Station

3.3.1 Layout Plan

Layout of the facility shall be as shown in Fig. Ⅲ-4-3.3.1 based on the basic design.

3.3.2 Facility Composition

The composition of each room, the items of change and the reasons for changes from the basic design shall be as follows:

(1) Fire fighting on-duty room ..... Changed to adjacent to the garage on 1F from 2F due to Chinese operation.

(2) Training room ..... As a result of changes in (1) the location shall be changed to the inner part of the garage on the east side.

3.3.3 Structural Design

1) Foundation work

- The foundation are strip footing system. As the result of site investigation there is no former water channel in the construction site and the soil bearing capacity is confirmed to be sufficient to support the building. Pile foundation system is judged not to be used together.
- Spans of the building are almost equal and there are no big differences between the vertical loads imposed on the foundations. By the analysis of soil test result, the amount of the foundation settlement is very small . Therefore the possibility of the differential settlements is judged to be negligibly low.
- Materials to be used are C25 concrete and Grade 1&2 Steel bar.

2) Structural work

- Structural materials are reinforced concrete and structural systems are rigid frames.
- Aseismic design grade of the building is #7 and the importance design grade is 乙.
- Materials to be used are C25 concrete and Grade 1&2 steel bar. Interior and exterior walls are stone masonry or brick masonry.

3.3.4 Equipment Plan

Items changed from the basic design due to changes in the equipment supply mode shall be as follows:

(1) The air conditioning system shall have air-cooled heat pump air conditioners in all rooms

(2) The garage shall use forced ventilation by means of exhaust fans, but the toilet shall use natural ventilation.

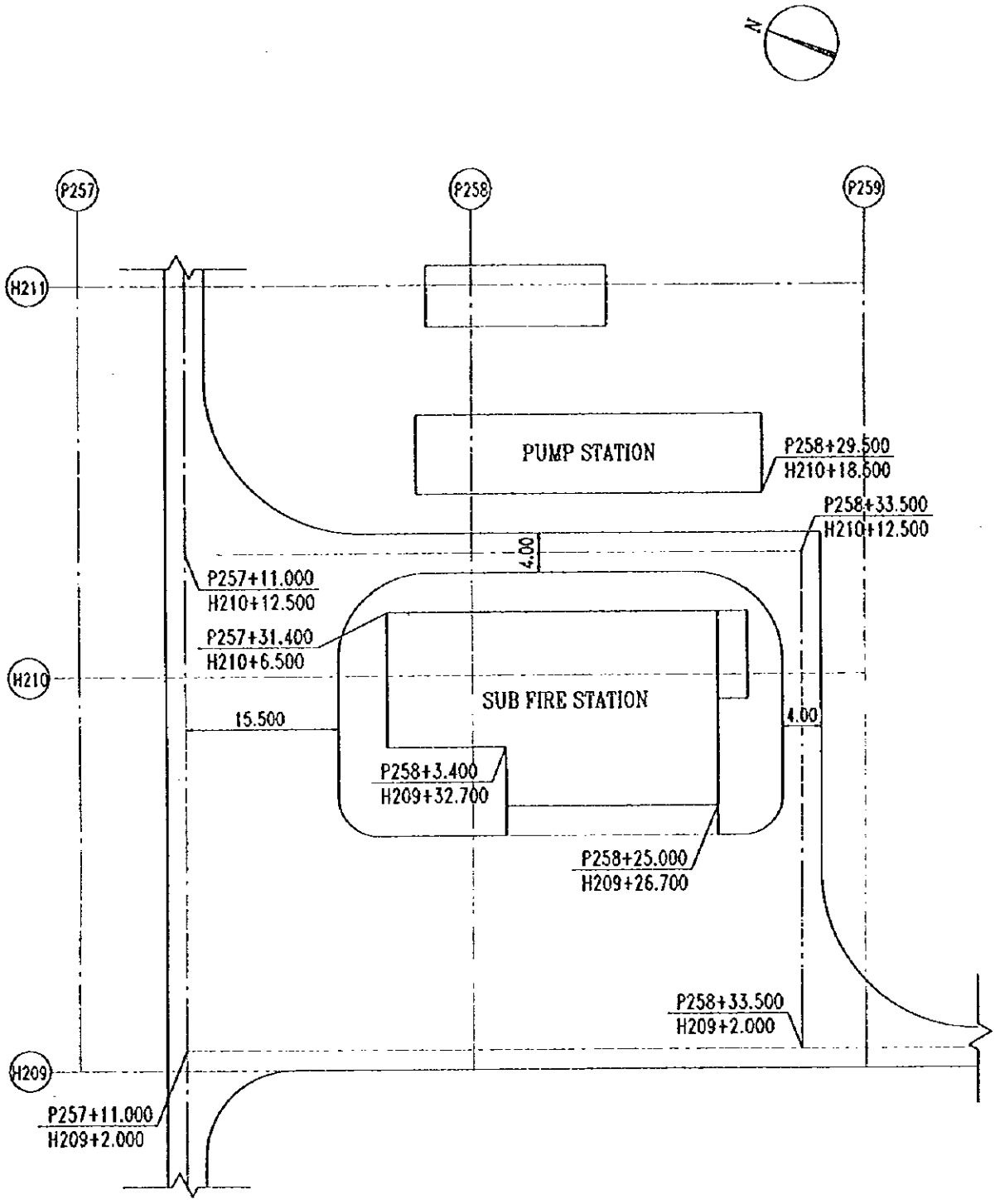

N
P257
P258
P259
H211
H210
H209
PUMP STATION
P258+29.500
H210+18.500
P258+33.500
H210+12.500
4.00
P257+11.000
H210+12.500
P257+31.400
H210+6.500
SUB FIRE STATION
15.500
4.00
P258+3.400
H209+32.700
P258+25.000
H209+26.700
P258+33.500
H209+2.000
P257+11.000
H209+2.000

Fig. III4-3.3.1

Table Ⅲ-4-3.3.1 Building Summary of the Sub Fire station

Item		Summary
Building summary	Title of building	Sub Fire station Reinforced Concrete
	Construction & scale	Construction 2 Storeys above ground
	Foundation structure	Reinforced concrete strip footing
	Total floor area	1F 620.23m^2 2F 526.63m^2 Total 1,146.86m^2
	Main exterior finish	Roof: Rubber seat water proofing /w Cement Block External walls: Ceramic tile Fittings: Aluminum sashes sted door
	Main interior finish	Floor: Mortar w/floor coating Walls: Mortar w/paint Finish Ceiling: Direct Ceiling
Summary of air conditioning and ventilation equipment	Air conditioning equipment	Air-cooled heat pump air conditioner
	Ventilation equipment	Ventilation type-3: garage
Summary of plumbing and sanitary equipment	Water supply equipment	To be directly supplied for water main of the facility
	Hot water supply equipment	Electric hot water heater
	Drainage system	3 systems, combing of waste water and miscellaneous drainage, storm water, and equipment drain
Summary of electrical equipment	Power source system	3ϕ4W 0.4 kV two-line service system from fire extinguishing pump substation
	Earthing system	Earthing resistance smaller than 4 Ω
	Load system	General lighting: illumination intensity according to "Private Building Lighting Design Standards" Emergency lighting, Socket outlet system, and outside lighting.
	Communication and information systems	Public Address System, Master Antenna Television System
	Indicator system	Emergency indicator system: control board shall be installed in on-duty room, lamps with buzzer shall be installed in each room

3.4 Fire Hydrant System and Fire Pump Room

3.4.1 Layout

The Layout will be based on the Basic Design scheme. (refer to Figure-III-4-3.3.1)

3.4.2 Components of the Facility

The Facility is composed of the Fire Pump Room and Fire Fighting Tanks. The Fire Pump Room has a Pump Room, Power Room and Control Room. Intergrated operation and control are conducted from a central control room. No operational personnel are stationed in the Facilities.

3.4.3 Fire Hydrant System

The Fire Hydrant System will be designed based on the following parameters.

(1) Design Standards

GBJ13-86	Code for Exterior Water Supply
GBJ16-87	Fire defence code for architectural design of The People's Republic of China
MH7003-95	Construction standard of security and protection installation of Civil Aviation Transportation Airport

(2) The Fire Pump Room will be a dedicated Fire Pump Room connected to the Flight Area Fire Fighting Water Supply System.

(3) The minimum exhaust water pressure will be not less than 0.10 Mpa.

(4) The rated output of the Fire Pumps will be 150l/sec. , as was noted in the Basic Design and 3 units, one of which is a spare, will be installed.

(5) An elctric valve will be installed on the outlet side of the Fire Pumps and automatic operation will be activated by the water pressure gauge. Manual operation will also be possible.

(6) The water source for the Fire Fighting System will receive water from the general water supply system for the airport. The water will be connected to the Fire reservoirs in the Airport Compound. The Apron water supply line will be connected to one Fire Pump MainLine. The Connection will have check valve and a cut off valve to control flow volume.

(7) The Fire Fighting Tanks will be Category 9 (500m^3), or larger and have more than 1 hour capability to supply at 15l/sec, (540m^3). The Design capacity will be 600m^3.

(8) The Fire Pump Room will have dedicated communication facilities and Internal Airport Telephone lines connecting to the Airport and Fire Center.

(9) The Fire Hydrant System Piping will be Ductile Cast Iron pipes. The pipng under the runway pavement will be seamlesssteel pipes(anti-corrosion type) protected by cement lined steel pipes.

Table Ⅲ-4-3.4.1 Summary of Fire Hydrant System and Fire Pump Room

Item		Description
Architectural Facilities	Name	Fire Pump Room
	Structure	reinforced concrete single story structure
	Foundation	reinforced concrete continous footing
	Floor Area	294.74㎡
	Main Exterior Finishes	Roof:Polyurethane coating water proofing Wall:Ceramic Tile Windows:Aluminium windows Door:steel doors
	Main Interior Finishes	Floor:Towelled Mortar w/ poured floor covering finish Wall:Trowelled mortar w/ paint finish Ceiling:
Electrical Systems	Power Supply	2 Circuits high tension recieving lines
	Grounding System	Lighting Arrestors: Ariels will be placed on the roof and connected to grounding by wiring.
	Power Requirements	General lighting facilities: luminosity by Lighting Design Standards for Civil Architecture
Mechanical Systems	Air Conditioning System	Air-cooled heat pump Type Air conditioning : Rest Room
	Ventilation System	Natural ventilation
Water Supply and Sanitary System	Water Supply System	Direct connection to water mains on site
	Waste Water System	2 drainage lines for general waste and storm water
Fire Fighting Tanks	Structure	reinforced concrete semi-underground 600t capacity
Fire Hydrant System	Layout	Based on China, Security Facilities Construction Standards (MH7003-95)
	Pumps	3 units Double Suction Volute Pumps (1 unit spare)
	Fire Hydrant	Concealed Single Connection Fire Hydrant ϕ100

CHAPTER 4 ESTIMATE OF CONSTRUCTION COSTS

4.1 Method of Estimation

4.1.1 Architectural Facility

In the same way as the Basic Design phase, the settlement was made by means of an estimate mode based on the fixed budget used by the People's Republic of China. In other words, settlement was found by calculating direct construction costs first, then correcting them according to the fixed budget using labor price differences and material price differences, and adding the prescribed various direct expenses to them.

4.1.2 Fire Fighting And Rescue Vehicles

With respect to the vehicles to be imported, calculations was made with consideration for the records of purchase in the People's Republic of China from Japan in recent years, and with reference to hearings from manufacturers or reference estimates. Vehicles made in the People's Republic of China shall be calculated based on prices surveyed by the Chinese side.

As to the points altered from the Basic Design phase, which we have mentioned in Chapter 1 and 2, alteration of types of vehicles and reduction of numbers are large in First Aid vehicles. As to the way of provision, one vehicle (fire engine for powder extinguisher) shall be imported by request of the Chinese side. Concerning the unit prices, adjustment on reduction was done for the vehicles made in the People's Republic of China, however, the unit prices of imported vehicles, which amount to about 80% of the total price, made little difference from the prices presumed in the Basic Design phase, and the total price is settled within the range of presumed estimation.(As to First Aid vehicles, the total price was reduced by 40-50%,due to the large reduction of the number of vehicles.)

4.2 Construction Costs

Table Ⅲ-4-4.2.1 Architectural Facility & Fire Hydrant System

Name of facility	Type of work	Construction (RMB)	Unit price (RMB/m^3)
Main Fire Station RC+2/3,888.50 m^2	Architectural work Equipment work Paving	6,811,000	1,752
First Aid Garage RC + 1/323.8 m^2	Architectural work Equipment work	422,000	1,303
Training Tower	Architectural work	100,000	-
Sub Fire Station RC + 2/1,146.86	Architectural work Equipment work Paving	1,917,000	1,672
Pump Room RC + 1/294.74 m^2	Architectural work Equipment work Power Supply System	3,434,000	-
Water tank	Lump sum	189,000	-
Fire hydrant system	Lump sum	12,550,000	-
Total	-	25,423,000	

4.2.2 Fire Fighting and First Aid Vehicles

Table Ⅲ4-4.2.2 Fire Fighting Vehicles

	Type of vehicle	Number	Unit price(RMB)	Total(RMB)
1.	High-speed fire engine (import)	1	5,560,000 (US$ 670,000)	5,560,000
2.	Main chemical fire engine (import)	4	6,390,000 (US$ 770,000)	25,560,000
3.	Fire engine for powder extinguisher(import)	1	4,150,000 (US$ 500,000)	4,150,000
4.	Large chemical fire engine	1	550,000	550,000
5.	Large water supply car	2	680,000	1,360,000
6.	Lighting car	1	350,000	350,000
7.	Communication/Control car	1	310,000	310,000
8.	Disaster rescue car (import)	1	2,324,000 (US$ 280,000)	2,324,000
9.	Rear support car	1	150,000	150,000
10.	Foam undiluted solution transport car	1	200,000	200,000
	TOTAL	14		40,514,000

Table Ⅲ4-4.2.3 First Aid Vehicles

Type of Vehicle	No.	Unit price(RMB)	Total(RMB)
1. FirstAid Commander's Vehicle	1	415,000 (US$ 50,000)	415,000
2. Ambulance	2(Import)	373,500 (US$ 45,000)	747,000
	3	340,000	1,020,000
3. Large First Aid Medical Service Vehicle	1(Import)	3,154,000 (US$ 380,000)	3,154,000
TOTAL			5,336,000

· CIF Shanghai Port, exclusive of import TAX and BAT.

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