(3) Murun Site

The location is 560 km northeast of Ulaanbaatar. It takes over 20 hours by car. Majority of the road is not paved.

(4) Choybalsan Site

The location is about 650 km east of Ulaanbaatar and it takes more than 25 hours by car. Usually, people stay one night at Undrkhan on the way.

Conditions of infrastructure is as mentioned in Table 3-13. Special attention must be paid on the transportation of equipment and material from Ulaanbaatar during construction period because the sites are in remote areas. There are problems in transportation of equipment and material from Ulaanbaatar to Murun and Choybalsan. Roads to both sites are not good. It would take two days, 20-25 hours by cars.

Difficulties and risks in the transportation are expected. A branch line from the Siberian Railway comes to the inside of the flour mill yard in the case of Choybalsan. Compared to Murun and Choybalsan, Construction works are easier in Harhorin and Undrkhan sites as much as they are nearer to Ulaanbaatar.

The distance from Ulaanbaatar to both sites are about same but the road to Harhorin is paved up to 300km from Ulaanbaatar. Transportation would be that much easier.

Although the government of Mongolia is trying to improve electricity supply, power failures are frequent in Ulaanbaatar. Harhorin is covered by Central Energy System through Eldenet (110 KV) but in the year of 1994, power failures occurred 282 times and in total 352.2 hours according to the record of Harhorin flour mill. On the other hand, Ulaanbaatar relies on local generator but in the same year, power failures continued for 132 hours. This difference is due not only to the generating capacity but also to the management on priority supply system. Generally, the power failures are concentrated in winter when heating stations operate for areal heating.

Table 3-13 Infrastructure of Surveyed Site

Item	Harhorin	Undrkhan	Murun	Choybalsan
Location	About 360 km west of Ulaanbaatar, about center of Mongolia	About 340 km east of Ulaanbaatar	About 560 km north west of Ulaanbaatar	About 650 km east of Ulaanbaatar, near the China boarder
Access from Ulaanbaatar	Up to 300km from Ulaanbaatar, road is paved. After that under construction. About 7 hours by 4 wheel drive car	Only 60 km from Ulaanbaatar is paved. 8~10 hours by 4 wheel drive car	Flight time 1.5 hours from Ulaanbaatar, 4 flight per week. About 10 km from airport. About 20 hours by 4-wheel drive car	About 2 hours flight from Ulaanbaatar, 3 domestic flights per week. 20 km from the airport, about 25 hours by 4-wheel drive car
Area	175,600 m²	47,500 m²	26,700 m²	53,500 m²
Proposed area for construction	16,000 m² (200mx80m)	4,950 m² (90mx55m)	2,500 m² (60mx25mx40mx25m)	6,500 m² (100mx65m)
Front road	Blacked road of 20 m width	A blacktop road of 10-12 m width, often paddled	A blacktop road of 10-12 m width	A blacktop road of 10-12 m width
Topography height ground	Site is plain but not paved	Site is plain but not paved, underground water level about -2.4 m	Site is plain but not paved underground water level about -12m	Site is plain but not paved
Present facility	• Semi-underground flat warehouse (11,000 ton) • Flat warehouse (5,600 ton) • Product(bagged flour) warehouse • Feed mill • Receiving , drying facilities, etc. • Warehouses and equipment are badly worn out	• Semi-underground flat waterhouse (3,800 ton) • Product(bagged flour) warehouse • Feed mill • Receiving,drying facility, etc. • Warehouse and equipment are badly worn out	• Semi-underground flat warehouse (5,600 ton) • Product(bagged flour) warehouse • Feed mill • Receiving, drying facilities, etc. • Warehouse and equipment are badly worn out	• Semi-underground flat warehouse (6,000 ton) • Product(bagged flour) warehouse • Feed mill • Receiving, drying facilities, etc. • Warehouse and equipment are badly worn out
Railway	NO	NO	NO	A railway sidetrack comes into the site
Electricity	• Supplied by Ulaanbaatar energy center • Often power failure in winter • Receiving capacity needs to be increased	• Power station is adjacent few power failures • Receiving capacity needs to be increased	• Power station is adjacent often power failures • Receiving capacity needs to be increased	• Power station is adjacent often power failures • Receiving capacity needs to be increased
Telephone	At times, out of order Switchboard type	At times, out of order Switchboard type	At times, out of order Switchboard type	At times, out of order Switchboard type
Water supply	Supplied by well in the yard	Supplied by well in the yard	Supplied by well in the yard	Supplied by well in the yard
Drainage	Through waterways collected into a water tank, then draw up by tank lorries	Through waterways collected into a water tank, then draw up by tank lorries	Through waterways collected into a water tank, then draw up by tank lorries	Through waterways collected into a water tank, then draw up by tank lorries
Office, Waiting rooms, warehouse	Facilities exist	Facilities exist	Facilities exist	Facilities exist

3-5-3 Climate and Calamity

Climatic data such as temperature and humidity for the past five years have been obtained by the cooperation of whether observatories in each area. They are as shown in the Appendix 8. In every site, the temperature recorded is below 0°C up to May. It goes back to below zero again in the end of September. Construction works must suit this condition. Especially, concrete works and painting of materials to be buried underground must be completed within this period.

The velocity of the wind in each site is about 20 m/s maximum. It is rare that strong wind continues for long periods of time.

The climatic conditions are an important factor in the process of construction. Therefore, a concrete transportation plan shall be made such as the transportation of equipment and material which must be completed by the thawing of frozen soil, etc.

In Mongolia, there is a soil-freezing phenomenon peculiar to severe cold climate. All four sites under this project have seasonal freezing, in which it freezes in winter but melts in summer.

The climate in this region is the typical continental climate. It has following features:

- Winter is long, dry, little snow.
  Mostly clear or semi-cloudy days
- Spring starts in April, wind is strong and mostly cloudy days.
- Summer is for three months, hot and mostly rainy days.
- Autumn is short and dry.

Mongolia is situated in Mongol Altai Stratum, where there are many faults. Following earthquakes are recorded:

July	9, 1905	Khangal earthquake (epicenter: 49.5°N, 96°E, Magnitude 8.4)
July	23, 1905	Khangal earthquake (epicenter: 49.2°N, 96.06°E, Magnitude 7.9)
August	10, 1931	Fu Yun earthquake (epicenter: 46.89°N, 90.06°E, Magnitude 7.9)

December 2, 1957 Gobi-Altai earthquakes
(epicenter: 45.31°N, 99.21°E, Magnitude 8.3)

It this project, Harhorin and Murun are nearer to the active faults. Figure 3-03 show distribution of faults.

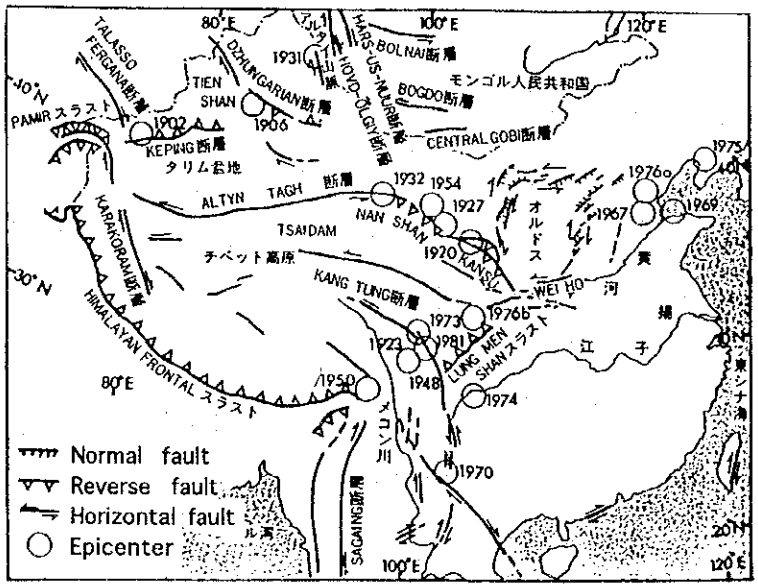


Figure 3-03 Distribution of Active Faults

Source: "Science of Earthquake and Active Dislocation"
Stratigraphy section, Geology Dept.
Geology Research Laboratory, Agency of Industrial Science and Technology,
Ministry of International Trade and Industry

Chapter 4 Content of the Project

Chapter 4 Content of the Project

4-1 Policy of Assistance

- Due to a shortage of material wheat storage facilities at the flour mills in the areas surveyed, a lot of wheat is piled outdoors and subjected to a large loss. The policy of the cooperation is to solve this problem.

- To conduct field surveys on all four sites on the infrastructure, the shortage and urgency of its need for the storage facility, importance as a key station of distribution, capacity of flour mill, etc. Then, select one or two priority site/s and construct the grain storage facility. However, as the policy of conducting actual survey, Harhorin and Undrkhan will be a priority object of basic design study to construct grain storage facility in view of their advantage in infrastructure.

- Two other sites shall be studied from the viewpoint of taking emergency measures such as supply of necessary equipment and material to improve their management. The minimum assistance will be used for improvement of the existing facility until the time new facility will be constructed.

- Appropriate capacity in designing storage facility will be decided by operating condition of each flour mill, trends in wheat marketing policy, etc. However, in consideration of measures for present open yard wheat piling, future expansion of flour mill that might be necessary by a change in marketing, which is uncertain in the long run, shall not be taken into consideration in the present design.

- A planned storage facility shall be of minimum necessity that matches local marketing and storage technology in Mongolia. Equipment and material should be of low recurrent cost.

- In designing, grains's storage quality in severe cold shall be considered.

- In construction, method and period of construction considering short summer and severe cold shall be adopted.

- This project shall include not only the supply of equipment and material but also construction and civil works as part of Japanese assistance.

4-2 Study on the Content of Request

4-2-1 Project Site

Requested sites are Harhorin (Ovör-Hangay pref.) Undrkhan (Hentiy pref.), Murun (Hövsgöl pref.) Choybalsan (Dornodo pref.), four sites in total, all of which are located at the important positions of wheat distribution.
Harhorin is adjacent to an irrigated wheat producing area.
Areas where wheat flour is supplied by flour mills at project sites and annual estimated demand in those areas are shown in Table 4-01.

An analyzed in the section of "Project Scale Study", it is judged that priority of each project site should not be decided based on degree of shortage of storage capacity, because the storage capacity of facility located at each project site is qualitatively short.

Table 4-01 Areas Where Wheat Flour Is Supplied By Project Sites and Their Estimated Demand (ton)

Project Site	Supply Areas (Prefecture)	Demand (ton/year)	Population (1991)
Harhorin	Bayan-Hongor	9,300	86,500
	Dundgovi	6,000	56,000
	Ovör-Hangay	11,200	104,800
	Govi-Altay	7,900	73,800
	Arhangay	10,400	92,300
	Sub-total	44,800	413,400
Undrkhan	Hentiy	9,500	88,500
	Suhbaatar	3,100	29,000
	Sub-total	21,600	117,500
Murun	Hövsgol	13,100	122,100
	Dzavhan	11,800	110,500
	Sub-total	24,900	232,600
Choybalsan	Dornodo	9,600	90,100
	Suhbaatar	3,000	28,000
	Sub-total	12,600	118,100

Source: Ministry of Food and Agriculture

There are differences in geographical conditions and infrastructure in each project site as shown in Table 3-13. All project sites are located at relatively remote areas and generally road conditions are not good. How to transport the equipment and materials in the implementation stage and the availability of stable electric supply are important factors in the site

selection. From these viewpoints it is appropriate to decide the order of priority as Harhorin, Undrkhan, Murun and Choybalsan.
Out of total distance 360 km to Harhorin site, 300 km is a paved way and the rest is under construction. It is scheduled to be completed by the end of 1995. The electricity to Harhorin site is supplied by Central Electricity Supply System from Ulaanbaatar. The electricity to Undrkhan will also be supplied by Central Electricity Supply System from Ulaanbaatar in and around 1995.
The city offices of Harhorin and Undrkhan both promised the supply of electricity and steam for heating rooms for use by these projects.
There is no problem in getting adequate supplies of these energies.

Murun and Choybalsan are both far away both in distance and time. Infrastructure is not favorable and they are not suitable as the objects of grant aid assistance of Japan.

4-2-2 Detail of the Site

The project sites are inside of flour mill compound and they are secured already and ready for construction now. In the basic design study, topographic survey and soil analysis were made for two sites of high priority as a study on natural condition. Both sites of Harhorin and Undrkhan have sufficient and flat areas for the project as shown in Figure 4-07, 17. The soil analysis by boring tests also show that there would be no problems in the construction works.

Authorities in both city offices already permitted the flour mills to use the sites for construction of storage facilities according to city area plan.

4-2-3 Details of Project Size

The size (capacity) of storage facility can be decided by calculating necessary storage capacity from the quantity of grain handled by the facilities under this project, then deducting the effective capacity of existing storage facility. In this project, the increase of marketing quantity due to increase of production and consumption in future and the resultant increased supply of flour and increased capacity requirement for storage shall not be considered. Only the present conditions of flour mill and the recent record of handling material wheat shall be taken into consideration in setting the size of the storage facility. The purpose of

this project shall be confined to solving the problems of open yard piling only, as mentioned before.

(1) Estimate of Handling Quantity

Based on the above-mentioned idea, the handling quantity of each flour mill may be estimated by following 3 methods.

1) Necessary Quantity of Wheat Estimated from the Capacity of Flour Mill

The storage capacity must be balanced with the milling capacity of the mill. It must be matched with the scale of milling business, namely quantity of procured material wheat and the sales volume of flour. A flour mill should therefore own the storage capacity that suite the capacity of milling process.
Mongolian Ministry of Food and Agriculture set the target quantity of handling and the necessary storage capacity from the capacity of wheat flour milling equipment at each flour mill. Milling yield from wheat to flour is based on 67%. Milling capacity and necessary quantity of material wheat for the flour mills in the area studied this time are as shown in Table 4-02.

Table 4-02 Capacity of flour milling equipment and necessary quantity of material wheat

Project Site	Capacity of Flour Milling Equipment (ton/year)	Necessary Quantity of Material Wheat (ton/year)
Harhorin	16,000	23,900
Undrkhan	9,000	13,400
Murun	9,000	13,400
Choybalsan	9,000	13,400

Source: Ministry of Food and Agriculture

2) Record of Actual Quantity handled

Actual record of wheat quantity handled by flour mills at project site for the past five years (1989 - 93) is as shown in Table 4-03. Handled quantity in the Table 4-03 is more than the quantity of material wheat needed by milling capacity. It is because the handled

quantity of material wheat includes some quantity conveyed to the feed mills and/or resold to others before milling. In this case, the flour mills are acting as collecting agents or brokers. In order to clarify the necessary storage capacity of material wheat for each flour mills, this discrepancy should be taken into the account.

Table 4-03 Quantity Handled Annually by Flour Mill at Each Site

(ton)

Flour Mill	1989	1990	1991	1992	1993	Average
Harhorin	35,800	32,600	20,200	15,200	20,000	24,760
Undrkhan	24,200	22,800	20,000	6,300	14,000	17,460
Murun	14,800	18,200	12,600	8,500	11,000	13,020
Choybalsan	38,900	14,400	13,500	6,300	8,000	16,220

Source: Ministry of Food and Agriculture

3) Incoming/outgoing Quantity and Stock

Material wheat are collected by flour mills after harvest to just before the severe cold season, usually from the end of September to the middle of December, and processed throughout the year. However, planting time may differ and harvesting and collection by flour mill may delay about one month due to yearly fluctuations in rainfall, sunshine, temperature, etc. Further, collection by flour mills may delay by the worsening road conditions between the flour mill and farm depending on the quantity of rain in the summer. Generally, yearly change in amount of stock follows the same pattern almost every year, stock is full after harvest and is gradually discharged throughout the year.

Grains are fed while some are being discharged. Therefore, amount of maximum stock is not equal to annual quantity handled or the annual quantity needed by milling capacity. Table 4-04, -05, -06, -07 shows amount of stock at the end of the month at flour mills in 4 sites for the past five years (1990-94). Reflecting the yearly change in wheat crops, not only there are large yearly fluctuations but also stock amount at its peak is reducing following the recent decreasing trend in wheat production.

Table 4-04 Yearly/Monthly Change in Stock (ton) at Flour Mill in Harhorin (ton)

Year / Month	1990	1991	1992	1993	1994
1	25,647.1	**28,217.1**	**18,841.2**	6,930.2	**13,941.2**
2	22,159.3	25,942.3	17,268.0	5,540.8	13,477.5
3	18,502.5	23,847.4	14,949.4	4,159.2	13,477.5
4	14,180.9	18,703.2	11,724.7	2,318.2	12,833.3
5	12,127.0	16,212.1	9,224.9	1,369.9	12,422.3
6	9,794.3	11,354.2	6,532.6	14.0	10,781.3
7	9,794.3	9,230.5	4,867.6	14.0	10,235.9
8	9,794.3	9,230.5	4,867.6	14.0	9,885.5
9	7,278.0	7,592.0	6,261.2	0	10,400
10	28,975.6	26,303.1	11,981.7	12,356.8	12,844.5
11	**32,067.4**	25,290.1	10,538.9	13,524.5	12,407.8
12	30,124.5	21,956.4	8,774.6	**14,507.3**	12,205.8

Source: Harhorin Flour Mill

Note: Data for December 1994 is estimate.
Boldfaced numbers are maximum in each year.

Table 4-05 Yearly/Monthly change in Stock (ton) at Flour Mill in Undrkhan (ton)

Year / Month	1990	1991	1992	1993	1994
1	**12,565.1**	6,580.3	**11,503.6**	1,519.4	**9,959.6**
2	10,029.3	5,273.8	10,373.1	1,892.7	9,419.4
3	8,960.8	3,071.3	8,744.8	2,139.2	8,752.7
4	7,653.6	2,490.3	7,096.7	1,163.4	7,664.9
5	6,495.4	2,350.7	5,203.3	782.1	6,651.2
6	5,315.7	2,350.7	5,203.3	983.3	6,651.2
7	5,315.7	1,148.4	3,589.5	0	6,256.8
8	3,817.3	343.3	2,027.6	0	5,754.8
9	2,182.5	1,871.6	120.6	0	5,009.6
10	951.0	410.4	190.1	**11,648.9**	6,000.8
11	3,629.4	**13,764.8**	159.1	10,484.4	9,882.8
12	8,038.0	12,648.0	2,237.3	10.294.5	8,656.5

Source: Undrkhan Flour Mill

Note: Data for 1994 are up to the end September.
Boldfaced numbers are maximum in each year.

Table 4-06 Monthly and Yearly Stock at Murun Flour Mill (ton)

Year / Month	1990	1991	1992	1993	1994
1	7,578.8	10,149.0	**8,769.6**	4,776.3	9,078.7
2	6,920.5	9,246.8	7,635.7	3,950.1	8,897.7
3	6,690.4	7,663.2	6,251.3	2,682.5	**9,408.5**
4	4,262.6	5,639.4	5,491.2	1,278.8	8,390.0
5	4,250.8	3,875.1	4,172.5	1,163.1	7,434.2
6	3,821.4	2,537.1	3,799.8	1,315.9	7,300.6
7	2,500.5	1,426.7	2,584.1	998.0	6,339.5
8	858.2	1,002.9	1,090.2	326.1	5,385.5
9	766.7	539.9	332.3	962.4	-
10	12,782.2	11,013.5	4,749.9	9,588.4	-
11	**13,019.2**	**11,500.1**	6,408.9	9,772.9	-
12	11,642.7	10,055.7	5,843.5	**9,776.1**	-

Source: Murun Flour Mill

Note: Data for 1994 are up to end August.
Boldfaced numbers are maximum in each year.

Table 4-07 Monthly and Yearly Stock at Choybalsan Flour Mill(ton)

Year / Month	1990	1991	1992	1993	1994
1	6,001.7	6,342.3	**13,122.3**	**5,365.3**	**8,153.1**
2	4,895.7	5,319.3	12,726.8	4,164.3	8,153.1
3	3,695.7	4,149.3	11,606.8	3,087.3	7,548.1
4	2,526.7	3,048.3	10,047.8	1,866.3	7,433.1
5	1,700.7	2,072.3	8,605.5	1,148.4	6,594.3
6	948.8	1,252.3	6,567.0	563.4	5,750.3
7	587.3	852.9	5,758.0	0.4	5,510.3
8	186.3	395.3	4,828.0	0.4	4,681.9
9	1,776.1	584.3	3,255.5	0.4	3,852.9
10	4,854.4	7,792.3	5,266.3	3,483.3	-
11	7,027.5	12,612.3	7,604.9	4,614.0	-
12	**7,453.3**	**14,265.7**	6,614.3	4,003.7	-

Source: Choybalsan Flour Mill

Note: Data up to September in 1994.
Boldfaced numbers are maximum in each year.

Necessary capacity of storage facility may be same as the largest stock amount among those of yearly peak in the above list. If properly and adequately handled, problems caused by open yard piling may be solved.

In setting the size of this project, as a measure to cope with the difference in the time of yearly peak stock amount, mean value of each year's peak amount shall be taken. Therefore, if more than average amount is collected, some amount must be stored in an open yard piling method. It is justified, however, from the viewpoint of maximum utilisation, limited fund and to avoid building a facility of excess capacity.

(2) Capacity of Existing Storage Facility

Data from the Ministry of Food and Agriculture do not always reflect actual conditions of the site as Table 3-08. According to the result of aforementioned field surveys, they need to be collected as Table 4-08. However, the storage capacity for Harhorin shown below is the one after repair and modification works. The capacity is reduced due to a change in design.

The mechanized facility with the capacity of 11,000 tons in Harhorin site, which is the one of the existing facilities is confirmed by the Mongolian side to be re-used according to the renovation plan. The other facility is not scheduled to be renovated, because it is not mechanized.

All existing facilities of four flat warehouses in Choybalsan site are not mechanized and are old-fashioned. They are not useful and are inconvenient, so that the wheat are transferred directly from outdoor storage site to flour mill. Based on this circumstances, the options of renovating the existing facilities for mechanization and re-building whole facilities are considered. A few years ago, mechanization of the facilities were tried. However, it was not in success, because the structure of the facilities were not suitable, for example the floor height was too low. With the additional reason that appearance of the old-fashioned facilities are unpleasant, it is judged to be better to consider re-building the whole facilities.

Table 4-08 Capacity of Existing Facility (ton)

Project Site	Existing Storage Facility (ton)		Total Capacity of Storage Facility
	Mechanized Flat Warehouse	Flat Warehouse	
Harhorin	11,000 After repair	-	11,000
Undrkhan	3,800	-	3,800
Murun	5,600	-	5,600
Choybalsan	-	-	-

Source: The Study Mission

(3) Design of Appropriate Capacity

1) Necessary Storage Capacity for Each Flour Mill

As stated before, appropriate capacity of the storage facility attached to the flour mill is decided by the yearly quantity handled and the effective capacity of existing facility.

In this project, as mentioned in the 4-1 Policy of Assistance, Harhorin and Undrkhan were chosen as the object of the basic design study for construction of storage facility. However, for Murun and Choybalsan sites also, appropriate capacity shall be discussed from the analysis made as far. Necessary capacities of the storage facility at the flour mills in the areas studied and described so far are tabulated as Table 4-09.

Table 4-09 Necessary Capacity of Storage Facility (ton)

Project Site	Harhorin	Undrkhan	Murun	Choybalsan
Necessary quantity from milling capacity /year	23,900	13,400	13,400	13,400
Actual quantity handled/year	24,760	17,460	13,020	16,220
Amount of stock from incoming/outgoing	21,514	11,888	10,494	9,671

Mongolian party does not account the quantity of wheat to be moved from open-piling to the empty space in the warehouse due to the hardness of the handling work in severe cold season of minus 20 to 30°C. Therefore, they consider the necessary quantity from milling

capacity in the above list or the actual quantity handled to be the necessary scale of the storage capacity.

2) Optimum Scale (Capacity)

In order to set the scale of this project, if we deduct the effective capacity of existing storage facility from the above-mentioned necessary storage capacity based on incoming/outgoing quantity of grains at each flour mill, pre-supporting on the mechanized handling for bulk wheat, they will be as shown in Table 4-10.

Table 4-10 Setting Optimum Capacity for This Project

(ton)

Flour Mill Site	Harhorin	Undrkhan	Murun	Choybalsan
Amount of stock by incoming/outgoing	21,514	11,888	10,494	9,671
Effective storage capacity in Existing facility	11,000	3,800	5,600	0
Necessary size (capacity)	10,514	8,088	4,894	9,671
Capacity requested	7,000-10,000	7,000-8,000	7,000	7,000
Capacity for this project	10,000	8,000	-	-

As optimum capacity for this project, necessary capacities calculated for each site were 10,514 tons for Harhorin site and 8,088 for Undrkhan site. However, in view of the characteristics of grain silos and practical design works, the following points need to be considered.

- Upon scrutiny, capacity of one silo in this project was decided as 1,000 ton because silos of odd number capacity cause difficulty and waste in fabrication and cost increase. Generally, 1,000 ton multiplied by even number shall be taken as a capacity of one storage facility.

- As long as the wheat is of agricultural produce, there is a difference in quality and weight per volume (apparent specific gravity) due to conditions of crop, varieties, etc. It is inevitable. Besides, quantity is controlled by weight, its container, a silo is a vessel and its capacity is decided by its

volume. The grain put in this container is not always same quantity (weight). Since there is difference in weight per volume of wheat, object of storage, actual storage capacity of silo in weight (ton) differs. In this project, mean value was taken as a practical method for designing.

As a conclusion, it is appropriate to set the size of storage capacity in this project at 10,000 ton for Harhorin site and 8,000 ton for Undrkhan site.

4-2-4 Study on the Type of Storage Facility

According to the request, the type of planned storage facility is silo. Considering the natural condition of wheat in distribution and in storage, consistent and rational flow of flour mill, wheat storage facility attached to flour mill in Mongolia needs following functions and conditions.

- Must be capable of handling bulk wheat, not bagged.
- Before being put into storage, received wheat must be cleaned and wet grains must be dried.
- Capable of storing wheat for one year maximum.
- Capable of storing grains separately for each 700 ~ 1,000 ton around according to its grade, moisture content, etc.
- Grains stored separately can be interchanged.
- Capable of first-in first-out freely for material wheat.
- Quality control inside the storage facility can easily be made.

Storage facility that satisfies all above conditions and can prevent quality deterioration, rottenness and damage by insects, birds and rats of the grain in storage is a silo. There are several kinds of silo, different in specifications. In order to scrutinise the suitability of storage facility for this project, function of the flat warehouse and silo were compared in Table 4-22, specifications of each type silo were compared in Table 4-23. The storage performance, constraint in construction time, period of construction, cost of construction, etc. were compared. In conclusion, as explained later, corrugated steel silo which can be assembled at site was found to be superior in every field and most suitable.

4-2-5 Study on the System of Storage Facility

The storage facility is not just a container, they must be equipped with the necessary functions to store grains safely and it must be the one completed as a system to supply material wheat to milling process safely and stably. According to the request, equipment for receiving, cleaning, weighing, drying, etc. are requested. This is the most common equipment found in ordinary flour mill and wheat storage facility. Equipment for quality control found the request of Mongolian side through the site study and were not included in the request but were added because they are necessary for better management of the flour mill. Contents of request were discussed as above and compiled concisely in the list below, as Table 4-11.

Table 4-11 Comparison of the Contents of the Request and the Results of Examination

Contents of Request		Result of Discussion
Facility 1,600m²		
Receiving/Drying Room	400m²	Necessary
Dust Collecting Room	125m²	Necessary
Control Room	40m²	Necessary, but receiving and transformer
Distributor Room	405m²	stations are common with distribution room
Silo (1,200 ton/unit)	115m² x 6 bins	8-10 units, small type unit
Equipment		
Receiving Hopper	2 ton x 2	1 set
Belt Conveyor (Receiving)	2 lines	Receiving, Precleaner, Weighing are in one line.
Precleaners	10 ton x 2 lines	Conveyor is chain type.
Weighers	10 ton x 2 lines	
Bucket elevators (for weighing)	2 lines	
Rotary Dryer	20 ton x 2 lines	Drying is in one line. Fuel is coal.
Bucket elevator (for dryer)	1 line	
Belt Conveyor (Recirculation)	1 line	
Aspirator	1 line	Feeding to and discharging from silo are one line.
Bucket elevator (for Silo)	1 line	Necessary
Chain Conveyor	1 line	Necessary
Chain Conveyor (for discharging)	1 line	Necessary
Bucket elevator (for discharging)	1 line	Necessary
Control Panel	1	Necessary
Dust Collecting System	1	Necessary
Dump Truck (8 ton)	2	Unnecessary Transportation is entrusted to other company.
Inspection Equipment	1 lot	Necessary for Quality inspection of material wheat

4-2-6 Study on Emergency Storage

(1) Prior Condition of Study

As the study policy, the mission studied the necessity of emergency measures to be taken at the sites where new facilities will not be constructed.

(2) Cope with Existing Warehouse

According to the study, buildings and machines and equipment in the existing facility are all over 30 years old and very badly state of repair. Partial repair is difficult in practice. For instance, the existing facility in Murun was built in 1967 and is quite old. Rain water leaks from the roof and needs repair. Beams, props and the foundations would soon be in need of repair. In the eyes of Japanese engineers who seriously consider safety, the time for repair is overdue. In these circumstances, each flour mill did some repairs within the budget allowed. At the time the study mission visited the site, the flour mill in Harhorin was repairing the walls of dryer house and reroofing the warehouse for flour product.

It is very difficult for Japanese contractor to accept repair works because method of construction is different, drawings were lost, etc. There is no other way except making large repair works or reconstruct the facility. Partial repairs or replacement are judged impractical.

Existing warehouse in Choybalsan lacks consideration in lay-out design for integral system of whole milling operation. It is giving adverse influence in warehouse utilization degree. It is a matter of flour mill operation in general and should not be solved by emergency measures.

(3) Cope with Equipment for Quality Inspection of Material Wheat

As stated in the study on content of request, Mongolian side requested grain inspection equipment for all four flour mills sites, object of study.

Material wheat procured by flour mills are the wheat harvested by combines and is transported to flour mills before drying and cleaning.

The flour mills test the quality of the unprocessed grains by sampling and using a moisture meter, specific gravity tester and separator for testing purpose. By referring to the grade standard, they decide the grade and procurement prices. Therefore, quality inspection at receiving stage is very important. Quality testing equipment in the existing flour mills are of low measuring accuracy, take much time in testing and lack the items and quantity. Therefore, necessary measurements are not carried out adequately.

In the present situation regarding quality inspection of received wheat at flour mill which is mentioned before, shortage of quantity and quality of inspection equipment exist as problems. Moisture content, specific gravity, dockage and gluten content are subjects of quality inspection. With the consideration of technical level of inspectors and existing inspection equipment which are presently in use, procurement of limited equipment which are urgently and certainly necessary shall be planned in the project. The equipment plan is possible to be executed with following reasons:

- operation of quality inspection can be executed off-line
- size of inspection equipment are small and they are easy to be transported
- construction works related to equipment are considered to be minimum

Therefore, as an emergency measure for the aforementioned assistance policy of Japanese side, a plan was made to supply quality inspection equipment for all four sites.

4-2-7 Study on Project Implementation Period

According to the request, this project covers four sites and will be implemented in two phases. However, as a result of site survey and policy of assistance, project covers only two sites now. It is judged practical to implement one site in one phase and complete the works of two sites in two phases for the reasons mentioned below.

- Labours and material are both insufficient in the situations of construction works in Mongolia. If construction works of two sites proceed at the same time, it may invite steep rise in prices of material and labour cost.

- The two project sites are situated in remote areas. Difficulties and problems in works are anticipated.

- The two sites are several hundred km away from each other, and it takes two days to move from one to another. It is difficult to manage and control the works of two sites at the same time.

- In the severe cold season, outdoor work will become impossible. Therefore, the actual work period is about six months. Carry-over of works to next year will not only cause loss in time, but also an increase in expense.

- Executing organisation, the Ministry of Food and Agriculture and also flour mills do not specialize in construction works. Number of personnel who take charge of construction work is limited. They would be unable to attend the problems.

The inspection equipment for Harhorin, Undrkhan and Murun shall be procured in first phase, and the inspection equipment for Choybalsan shall be procured in second phase.

Based on the results of above-mentioned study, this project is considered appropriate to be executed as an Japan's Grant Aid Assistance Project with following reasons:

- the effectiveness and the realism of the project, and the executing ability of Mongolian side are confirmed

- the effectiveness of the project matches with the Grant Aid Assistance System

Considering that the project will be executed in Grant Aid Assistance System, outline of the project shall be studied in the following chapters as a Basic Study. However, as mentioned in the section of "Component of Project" and "Study of Requested Facility and Equipment" regarding the contents of the project, changing parts of the request is appropriate.

4-2-8 Construction Work in Mongolia

The request from the government of Mongolia does not mention on the period of construction works and the construction materials to be procured locally. However, natural conditions of Mongolia, comparing with Japanese, are quite unique and some studies were made as follows:

Natural conditions largely affects the construction works in Mongolia. Works become impossible in the cold season, November to March, due to the adverse effects of freezing. It is confined to six months of April to October. Therefore, in Mongolia, foundation work by pre-cast concrete and processing of columns, beams, walls, roof material, etc. are made in winter time and in the period of April to October, assembling of these components are made. Such method of construction is well developed in Mongolia. Main components are made by the casting of concrete into the steel made frame in which reinforcing rods are placed. Joint sections are connected either by bolts or welding the exposed reinforcing rods and concrete casting on the spot.

Precast concrete parts are relatively heavy and cracks may be resulted in long distance transportation, although there is no problem in the works at nearby places. For other materials for construction, such as cement, sand, gravel, bricks, tiles, etc. may be procured locally in Mongolia but woods, steel, aluminum, glass, etc. are imported from Russia. The locally made cement is not uniform in quality. Therefore it is necessary to increase the quantity of cement per unit volume of concrete in order to maintain necessary strength of concrete. For local procurement of materials, please refer to Table 4-12.

Table 4-12 The Materials that can be procured locally

Work Division	Equipment & Material	Local Procure-ment	Remark
Building Construction	Main structure		
	Cement	○	Early procurement necessary
	Sand	○	Possible to secure river sand
	Gravel	○	Possible to procure locally.
	Cobblestone	○	Note: largely uneven size
	Reinforcing rods	○	Possible to procure locally
	Mold frame		No local production of veneer
	Brick	○	Can use as partition
	Concrete block	○	Can produce locally
	Terrazzo tile	○	Procure locally because quantity required is small.
	Other tile	○	
	Glass	○	
	Long sheet metal		No local production
	ALC · Sodium silicate plate		ditto
	Wood	○	Because quantity required small, procure locally
	Hardware		Local goods insufficient quality
	Wood fittings		No local production
	Metal fittings		ditto
	Painting	○	Procure locally for maintenance sake
	(Equipment)		
	Ventilation fan		No local production
	Sanitary equipment		Local products are of insufficient quality.
	Pipes		
	Pumps		Joints for piping are hard to get locally.
	Shutter		No local production
Electric Works	Power receiving unit		No local production. Some imported ones available but not enough to meet the demand.
	Distributor		
	Lighting equipment		
	Fire alarm		
	Wiring materials		
Watersupply Sewage Sanitary Equipment	Water pipe		Imported ones can be procured locally.
	Distribution pipe		
	Heat insulation material		
	Meters		

Source: Study mission

Construction workers specially skilled workers are few and concentrated in Ulaanbaatar and can not be employed in remote areas. Whenever there is a large scale construction work in remote area, it will be necessary to send them from Ulaanbaatar.

There is one construction company of Russian Capital (Sovinbesto) and more than ten other companies of Mongol capitals. After the study, it was found out that some of them are not used to the estimate of compound works. These companies are not suitable to participate in the work as sub-contractors for recruiting labours and others.

4-3 Purpose · Object of This Project

The purpose of this project is to reduce losses of wheat, staple food of Mongol in post harvest stage, during storage. Wheat harvested in Mongolia is usually collected by flour mills and stored in the storage facility attached to them. However, the capacity of the storage facility is actually insufficient and therefore, considerable quantity of material wheat for milling is kept piled outdoor for several months every year. In this period, a large loss in quantity and quality occurs, damage by rain and snow, scattering by wind, loss by birds and rodents, etc. Manual works needed for piling in open yard takes many hands and transportation from the site of piling to flour mill is costly. Both are economic burdens of the flour mills. Manual outdoor works in the severe cold season, in which piling take place are prohibitively difficult.

Above-mentioned losses caused by outdoor piling reached several percent in trial estimate of the study mission. The solution to this problem is significant to Mongolia who is suffering from the shortage of food.
This project aims at solution of above-mentioned losses of wheat piled outdoors by constructing storage facility attached to flour mills, located at Harhorin and Undrkhan, both of high priority areas.

4-4 Executing System of This Project

4-4-1 Organisation and Staff

Executing organizations for this project are Economy and Foreign Trade Policy Department of Ministry of Trade and Industry and Crop, Machinery and Irrigation Department of Ministry of Food and Agriculture. Figure 4-01 shows its Organisation.

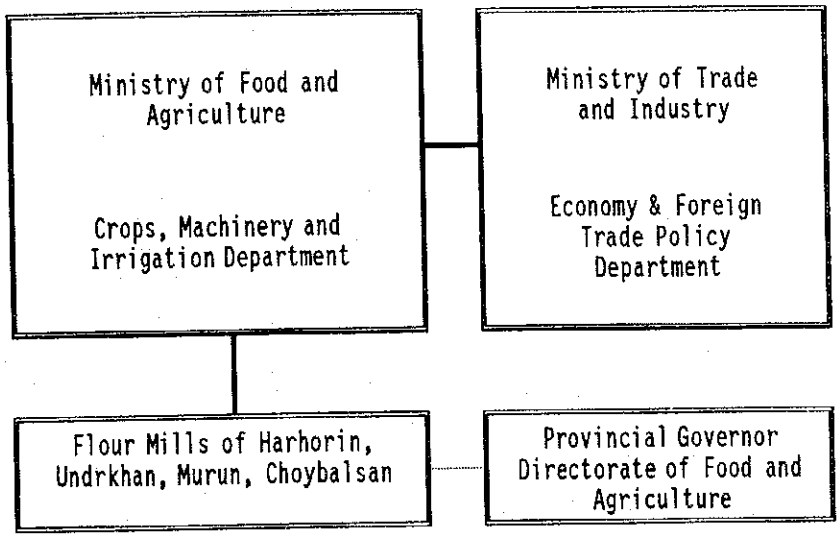
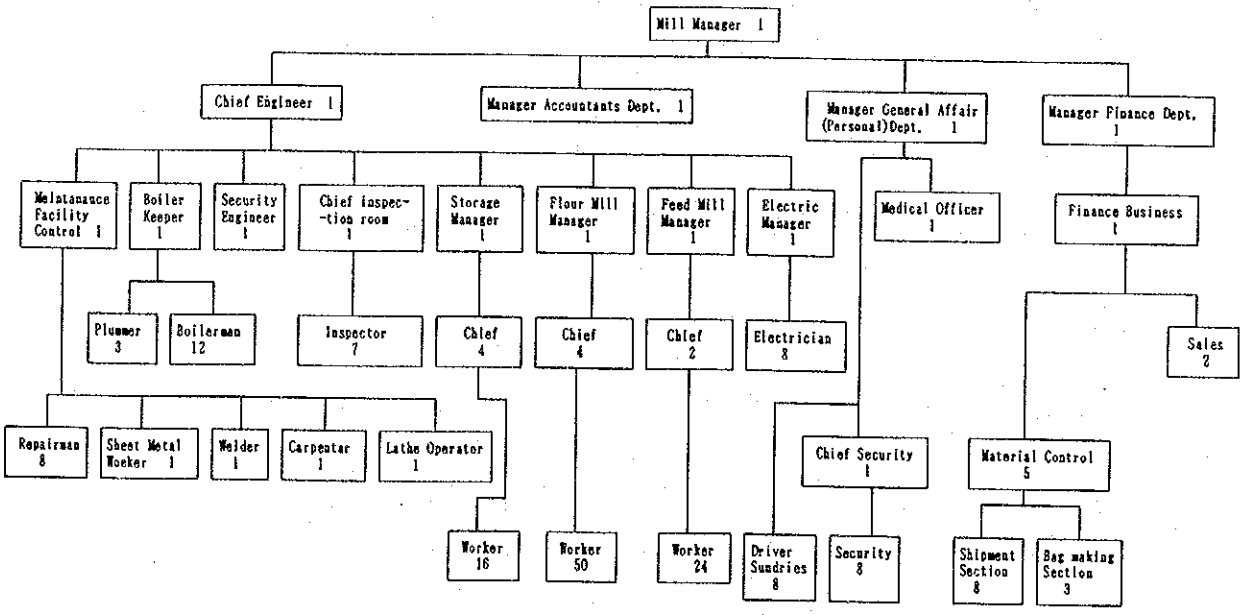


Figure 4-01 Executing Organisation

After market-economy is introduced, the flour mill at each site became an independent organisation. However, more than 50% share is still held by the government. The management of the flour mill always keep close contact with and sometime get instructions from departments concerned in the Ministry of Food and Agriculture and also provincial government. Figure 4-02 shows average management organization and number of staff members in each divisions. At present, they employ about 100 man-month temporary workers chiefly for handling wheat to be piled in open yard at the time of collecting.

Each site owns an existing flour mill and there will be no basic change in present organizational set up even after the new storage facility is constructed. Busiest season for grain storage facility is the time for receiving wheat and subsequent drying works which continues for about four months. However, they should be able to manage with the present mill staff. Therefore, as soon as open-yard piling is discontinued, they will not have to hire temporary workers.



Source: Flour mills

Figure 4-02 Management Setup (Flour Mill)

4-4-2 Budget

Each project site is an independently operating organisation as they do not receive any fund from the Government of Mongolia. Therefore, revenue by sales of flour and feed is all of their operational fund. In Table 4-13, 14, 15 and 16, actual records and plans for income and expenditures of all 4 flour mills are shown.

A largest expenses are procurement costs for buying wheat materials. Its ratio against total expenditure such as personnel cost, lighting and heating expenses, fuel, etc. is on a increasing trend. Compared to the amounts in the settlement of accounts, expenses incurred by handling of wheat for open yard piling is considerably high. Its effect can not be overlooked.

Modification works for existing storage facility in Harhorin was taken into consideration when setting project size (capacity). According to the records and plans for the income and expenditure of Harhorin site, necessary funds are budgeted in their 1994, 1995 budget in the item of "other materials".

Table 4-13 Revenue and Expenditure of Harhorin Site

Item		1990	1991	1992	1993	1994 (Plan)	1994 (Adjusted)	1995 (Expect)
Capital	1,000TG	27,448.2	24,383.9	25,473.9	40,715.9	40,715.9	40,865.2	40,865.2
Staff members		220	225	223	201	216	216	216
(A) Revenue								
Sales of wheat	1,000TG							
Feed	"	24,277.8	47,334.9	117,091.0	306,668.5	1,207,440.0	298,218.4	1,106,340.0
Bran	"							
Bag	"							
Total revenue (A)	"	24,277.8	47,334.9	117,091.0	306,668.5	1,207,440.0	298,218.4	1,106,340.0
(B) Expenditure								
(1) Materials	"							
Raw · Semi-processed materials	"	18,139.8	32,965.7	95,306.2	175,320.4	750,782.4	269,452.8	685,715.0
Sales cost (Transportation)	"	1,706.1	5,038.9	7,684.7				
Electricity	"	498.6	712.5	1,682.9	26,687.9	42,402.0	60,308.4	33,030.4
Fuel	"	286.7	314.9	491.4		23,959.0		
Heating system (Mainly room heating)	"	109.3	119.3	2,162.1	12,588.6	35,000.0		15,593.0
Water Supply	"					715.0	480.0	318.0
Spare parts · Facility	"				2,865.2		1,689.6	
Depreciation of fixed assets	"	1,269.6	1,309.2	1,031.9	7,715.4	1,932.0	1,404.8	1,832.0
Fuels for lorries	"	52.5	201.5	426.7	491.8	4,247.3	14,390.4	5,500.0
Documentation	"							
Communications	"							
Safety management	"							
Other materials	"	240.9	2,254.9	3,828.4	107,682.9	354,473.6	346,516.8	290,198.4
Total (1)	"	22,303.5	42,916.9	112,614.3	333,352.2	1,213,511.3	694,242.8	1,032,186.8
(2) Expenditure other than materials								
Salary	"	1,153.0	1,135.8	1,742.9	6,403.5	14,034.8	20,115.2	29,152.9
Business trip	"	8.9	16.0	12.4	864.5	600.0	255.2	600.0
Others	"				1,089.2	552.0		552.0
Total (2)	"	1,161.9	1,151.8	1,755.3	8,357.2	15,186.8	20,370.4	30,304.9
Total expenditure A = (1) + (2)	"	23,465.4	44,068.7	114,369.6	341,709.4	1,228,698.1	714,613.2	1,062,491.7
Balance (A) - (B)	"	812.4	3,266.2	2,721.4	▲35,040.9	▲21,258.1	▲416,394.8	43,848.3

Source: Harhorin Flour Mill

Table 4-14 Revenue and Expenditure of Undrkhan Site

Item		1990	1991	1992	1993	1994 (Plan)	1994 (Adjusted)	1995 (Expect)
Capital	1,000TG							
Staff members		198	196	194	167	168	168	190
(A) Revenue								
Sales of wheat	1,000TG							
Feed	"	15,536.8	29,674.3	90,211.7	215,832.6		541,593.4	1,036,410.0
Bran	"							
Bag	"							
Total revenue (A)	"	15,536.8	29,674.3	90,211.7	215,832.6		541,593.4	1,036,410.0
(B) Expenditure								
(1) Materials	"							
Raw • Semi-processed materials	"	11,540.7	17,298.1	61,730.7	208,377.3		301,687.7	698,706.0
Sales cost (Transportation)	"							58,828.2
Electricity	"	805.1	1,709.5	11,618.6	39,890.4		54,023.6	54,780.0
Fuel	"			143.0	1,319.3		2,150.0	8,740.0
Heating system (Mainly room heating)	"							
Water Supply	"							
Spare parts • Facility	"			1,641.4	6,619.5		7,136.0	16,607.6
Depreciation of fixed assets	"	224.6	224.8	420.0	3,632.3		4,501.7	4,248.0
Fuels for lorries	"			2,214.1	8,081.2		8,155.6	10,871.0
Documentation	"							
Communications	"							
Safety management	"							
Other materials	"	86.6	141.9	181.2			409.7	2,059.2
Total (1)	"	12,621.0	19,374.3	77,949.0	267,920.0		378,064.3	854,840.0
(2) Expenditure other than materials								
Salary	"	415.1	1,022.5	3,202.9	8,149.7		12,790.2	20,730.0
Business trip	"							
Others	"	39.5	138.0	2,999.5	41,680.2		44,857.2	100,760.1
Total (2)	"	454.6	1,160.5	6,202.4	49,829.9		57,647.4	121,490.1
Total expenditure A = (1) + (2)	"	13,075.6	20,534.8	84,151.4	317,749.9		435,711.7	976,330.1
Balance (A) - (B)	"	2,461.2	9,139.5	6,060.3	▲101,917.3		105,881.7	60,079.9

Source: **Undrkhan Flour Mill**

Table 4-15 Revenue and Expenditure of Murun Site

Item		1990	1991	1992	1993	1994 (Plan)	1994 (Adjusted)	1995 (Expect)
Capital	1,000TG				16,038.2	14,940.0	13,833.3	16,000.0
Staff members					178	168	168	164
(A) Revenue								
Sales of wheat	1,000TG							940,000.0
Feed	"				365,080.3	905,898.7	832,520.9	
Bran	"							67,008.0
Bag	"							
Total revenue (A)	"				365,080.3	905,898.7	832,520.9	1,007,008.0
(B) Expenditure								
(1) Materials	"							
Raw • Semi-processed materials	"				235,112.6	456,327.1		548,220.3
Sales cost (Transportation)	"					62,000.0		67,331.8
Electricity	"				46,924.9	75,811.7		75,855.9
Fuel	"							
Heating system (Mainly room heating)	"					16,174.5		16,174.5
Water Supply	"					40.0		66.2
Spare parts • Facility	"				1,344.7	27,075.9		81,977.6
Depreciation of fixed assets	"				878.6	732.6		811.1
Fuels for lorries	"				4,501.1	82,612.0		8,381.9
Documentation	"				142.5	150.0		170.3
Communications	"				88.0	1,190.0		290.7
Safety management	"				252.5	560.0		2,407.0
Other materials	"				296.1	100.0		1,854.4
Total (1)	"				289,541.0	722,773.8		803,541.7
(2) Expenditure other than materials								
Salary	"				6,835.8	17,707.0		19,000.0
Business trip	"				53.2	2,323.0		3,720.3
Others	"				922.3	134,493.5		134,938.8
Total (2)	"				7,811.3	154,523.5		157,659.1
Total expenditure A = (1) + (2)	"				297,352.3	877,297.3		961,200.8
Balance (A) - (B)	"				67,728.0	28,601.4		45,807.2

Source: Murun Flour Mill

Table 4-16 Revenue and Expenditure of Choybalsan Site

Item		1990	1991	1992	1993	1994 (Plan)	1994 (Adjusted)	1995 (Expect)
Capital	1,000TG				12,249.8	5,544.3	5,544.3	5,544.3
Staff members					121	111	110	99
(A) Revenue								
Sales of wheat	1,000TG							632,700.1
Feed	"				181,947.7	722,500.0	655,100.0	
Bran	"							25,000.0
Bag	"							62,000.0
Total revenue (A)	"				181,947.7	722,500.0	655,100.0	719,700.1
(B) Expenditure								
(1) Materials	"							
Raw • Semi-processed materials	"				92,113.5	444,281.2	441,300.0	468,598.4
Sales cost (Transportation)	"				25,174.8	87,162.8	86,300.0	86,206.3
Electricity	"				8,198.3	30,789.0	35,780.0	25,641.0
Fuel	"							
Heating system (Mainly room heating)	"				3,738.1	5,266.8	5,160.0	4,910.4
Water Supply	"				2,317.5	1,752.0	1,910.0	2,727.9
Spare parts • Facility	"				479.5	23,250.0	21,420.0	15,450.0
Depreciation of fixed assets	"				612.6	697.0	450.0	294.0
Fuels for lorries	"				2,417.0	3,650.0	3,650.0	3,650.0
Documentation	"					40.0	40.0	40.0
Communications	"					360.0	360.0	360.0
Safety management	"					357.5	357.5	1,258.0
Other materials	"				29,082.7	60,959.9	73,772.5	101,281.8
Total (1)	"				164,134.0	658,566.2	670,500.0	710,417.8
(2) Expenditure other than materials								
Salary	"				7,754.9	13,155.2	12,850.0	15,814.6
Business trip	"					25.0	50.0	120.0
Others	"				1,043.0	1,775.9	1,734.7	2,134.9
Total (2)	"				8,797.9	14,956.1	14,634.7	18,069.5
Total expenditure A = (1) + (2)	"				172,931.9	673,522.3	685,134.7	728,487.3
Balance (A) - (B)	"				9,015.8	48,977.7	▲30,034.7	▲8,787.2

Source: Choybalsan Flour Mill

4-4-3 Maintenance Program

(1) System of Maintenance Management

Under this project, the system of maintenance management for grain storage facility is included in the maintenance management system of the flour mill. Budget and necessary staff members for storage facility are also controlled as a part of flour mill. This system is suited to local conditions inasmuch as the interchange of staff members is easy and repair/modification works can be made efficiently.

(2) Cost of Maintenance

Trial calculation was made on annual maintenance cost. Personnel cost, electricity cost, fuel cost, repair cost were separately calculated as follows.

1) Personnel Cost

Based on the local practice, monthly salary is classified by rank and 50-80% was added for bonus and pension. Efficiency in the Table 4-17 means actual working ratio assumed from the annual number of days needed for the operation of the facilities.

Table 4-17 Personnel Cost

Item	Calculation TG/month-Man-Month-Efficiency	Salary/Year(TG)
Mill Manager	45,000 x 1 x 12 x 0.1	54,000
Chief Engineer	40,000 x 1 x 12 x 0.2	96,000
Manager Accountants Dept.	36,000 x 1 x 12 x 0.1	43,200
Manager General Affair (personnel) Dept.	36,000 x 1 x 12 x 0.05	21,600
Manager Finance Dept.	36,000 x 1 x 12 x 0.1	43,200
Storage Manager	32,000 x 1 x 12 x 0.4	153,600
Electric Engineer	32,000 x 1 x 12 x 0.2	76,800
Chief Inspection Room	32,000 x 1 x 12 x 0.2	76,800
Manager Facility	30,000 x 1 x 12 x 0.2	72,000
Boiler worker	30,000 x 1 x 12 x 0.2	72,000
Security Engineer	30,000 x 1 x 12 x 0.1	36,000
Machine Operator	15,000 x 6 x 12 x 0.4	432,000
Electricians	15,000 x 6 x 12 x 0.4	432,000
Inspector	15,000 x 3 x 12 x 0.2	108,000
Repairman	15,000 x 3 x 12 x 0.5	270,000
Boiler man	15,000 x 6 x 12 x 0.25	270,000
Sundry	12,000 x 3 x 12 x 0.4	172,800
Accountant, General Affairs Clerks	20,000 x 3 x 12 x 0.3	216,000
Security guard	12,000 x 6 x 12 x 0.3	259,200
	Total	2,905,200

2) Electricity Cost

a) Actual load

Table 4-18 Actual Load

Item	Harhorin Site			Undrkhan Site		
	Facility Load kw	Utilization Rate %	Actual load kw	Facility Load kw	Utilization Rate %	Actual Load kw
Feeding	125	80	100	120	80	96
Discharging	105	80	84	95	80	76
Drying	85	75	60	80	75	60
Storage	150	30	45	120	30	36
Lighting/receptacles	50	60	30	50	60	30
Total	-	-	319	-	-	298

b) Electricity consumption

Table 4-19 Electricity Consumption

Item	Harhorin Site		Undrkhan Site	
	Calculation of Electric Consumption	Consumption of Electricity kwh	Calculation of Electric Consumption	Consumption of Electricity kwh
Feeding	100kw x 1,440h	144,000	96kw x 1,440h	138,240
Discharging	84 x 950	79,800	76 x 760	57,760
Drying	60 x 1,440	86,400	60 x 1,440	86,400
Storage	45 x 1,200	54,000	45 x 960	43,200
Lighting/receptacles	18 x 3,600	64,800	18 x 3,600	64,800
Total		429,000		390,400

c) Electric charge

The charge is 13TG per 1 kwh for both sites.

Harhorin 429,000 kwh x 13 = 5,577,000 TG

Undrkhan 390,400 kwh x 13 = 5,075,200 TG

3) Fuel Cost

The only fuel used in the grain storage facility is the coal.

a) Harhorin

Annual operation hour of dryer is (60 days x 24hr) = 1440 hr.

Coal consumption per hour is 250kg. The price is 2TG/kg.

Yearly consumption of coal: 250kg/hr x 1440hr = 360,000kg/year

Fuel cost: 360,000kg/year x 2TG/kg = 720,000TG

b) Undrkhan

Consumption of coal is supposed to be about 80% of that for Harhorin: Therefore,

720,000TG x 0.8 = 576,000TG

4) Building and Repairing Expenses

Procurement items such as parts, etc. and cost of works are among building and repairing expenses. Work cost shall be 20% of procurement cost.

Table 4-20 Building & Repairing Expense

Unit: TG/year

Site	Procurement cost	Works cost	Total
Harhorin	1,440,000	288,000	1,728,000
Undrkhan	1,350,000	270,000	1,620,000

As a result of above, yearly maintenance cost (operation cost) for both sites are:

◇ Harhorin ..... 10,930,200 TG (about 2.57 million yen)

◇ Undrkhan ..... 10,176,400 TG (about 2.39 million yen)

(3) Burden of Operational Cost

In order to clarify the burden of such operational costs to the management of flour mill, it is necessary to compare it with "Storage loss, 3-5-2 (4), 2)".

Table 4-21 Comparison of Operation Cost and Economic Loss By Open Yard Piling

Item/Site	Harhorin	Undrkhan
Economic loss by open yard piling=(A)	25,313,000TG	19,728,000TG
Operation cost=(B)	10,930,200TG	10,176,400TG
B/A	43%	52%

If above mentioned losses by open yard piling is prevented by building new storage facility, their operation cost would only be about half of the savings.

It appears that economic savings by building a new storage facility is far greater than the cost of the operation. It leads to reduction of expenditure.

4-5 Optimum Basic Design

4-5-1 Design Policy

(1) Basic Policy

Design works and selection of equipment shall be based on the following stated basic policy considering the conditions in Mongolia such as actual state of proposed project sites, etc.

1) Policy against Natural Condition

a) The design must cope with the climate of Mongolia, short summer and long severe cold season.

b) In designing the foundation, soil resistance shall be estimated after boring tests and the frost depth fully considered and its influence.

c) Handling wheat in the storage facility must be mechanized, as occasion demands in sever cold.

d) Selection of equipment and material shall be made by considering the effect of freezing on rotating parts, rubbing parts, connecting parts, etc. Materials and equipment selected shall not allow errors or mal-functions under freezing conditions.

2) Policy against Social Conditions

Although it is a storage facility for material wheat in the flour mill, function of which is regarded as most important, the design and material of buildings should match with the surroundings.

3) Policy against Local Construction Practice

The local construction situations are not favourable to Japanese constructors. Relative laws and regulations are incomplete, there are few construction companies, both quality and quantity of labour available are insufficient, availability of construction materials are limited, etc.

Therefore, the construction of the facility and the equipment and material that need minimum local process or treatments and can be completed with minimum number of engineers and technicians in the shortest period of time must be selected.

4) Policy against Maintenance Capacity of Local Executing Organization

The facility and equipment to be built under this project shall be covered and maintained by the same maintenance system and program of the flour mill at each site. Therefore, the maintenance must be conducted easily by local maintenance capacity and the facility and equipment must be of low running cost.

5) Policy on Grade and Scope of Supply

To supply minimum material and equipment requirement necessary to construct a facility that can store material wheat procured from farms until it is shipped (maximum about 12 months) according to the needs without the quality deteriorations, rottenness, damages by insects, etc.

6) Policy on Construction Work Period

a) Under this project, construction work is to be executed at Harhorin and Undrkhan in two years time divided into two phases.

b) Work plan shall be made considering the limited time available for local works due to severe natural conditions, insufficient quantity and quality of labours available and not fully developed infrastructure.

c) To strictly observe work periods, organize an executing committee within the Mongol government and clarify the responsibilities for the carrying out of the plan.

(2) Function of Facility and Equipment

The storage facility under this project comprises of a weighing function (the one existing in the site shall be used) to ascertain the quantity of wheat procured, receiving and precleaning function, drying function,

weighing/storage function, shipment function, dust collecting function, operating control and monitoring function and grain quality inspection functions.

Outline of the facility and equipment are explained according to each function as follows:

1) Receiving and Pre-cleaning Function

Material wheat arrives at the flour mill in bulk by trucks, it is then weighed on an existing truck scale. The wheat is then fed to a feeding hopper and is carried to pre-cleaners and impurities larger than wheat (strings, straws, mud balls, stones, etc.) and smaller than wheat (dust, sands, small stones, etc.) are separated. Further, the impurities of a similar size as wheat, but heavier in specific gravity (stones, earth, metals, etc.) are separated by stoners.

2) Drying Function

It is necessary to dry and bring the moisture content of wheat to below 14.5% w.b. in order to allow safe storage for long periods of time. The moisture content of wheat when it arrives at the mill is average 19% w.b. therefore, material wheat cleaned by precleaners is dried by mechanical dryers.

3) Weighing · Storage Function

When cleaned and dried, the wheat is weighed and stored in silos, each grade and quality of wheat stored separately. Whenever the grain temperature rises by sunshine, atmospheric temperature, grains' respiration, aeration or rotation from one silo to another shall be conducted to cool the grain temperature.

4) Shipment Function

Stored material wheat is discharged according to the need, weighed by the weigher for stored grain and conveyed to the milling process by the connecting conveyors.

5) Dust Collection Function

Scattering and dispersing of dust outside is prevented by dust collecting equipment in order to protect the environment, hygienic labour conditions and machinery.

6) Operation and Monitoring Function

The facility receives electricity of 10,000V, 3 phases, 50 Hz (Harhorin) and 6,000V, 3 phases, 50 Hz (Undrkhan) and transforms it to 380V and 220V.
Main machines are operated by remote or automatic control system. Minimum automatic control is incorporated to secure operational safety. A monitoring board is attached to the control room in order that operating conditions may be constantly watched.

4-5-2 Conditions of Equipment

(1) Design Standard

In designing the project, structure and facility, internationally appreciated Japanese standards and standards of Mongolia are both incorporated.

The following laws, regulations and standards shall be used or referred in the design.

1) Relative Laws and Regulations in Mongolia

Building standard act
Standard for environmental pollution
Electrical works standard
Weighment standard
In Mongolia, those standards are based on Russian Models, which are called "Norma".

2) Relative Laws and Standard in Japan

Laws for labour hygiene and safety
Laws on environmental pollution

Building Standards Act
The Fire Services Act
International Standards Organization (ISO)
International Electric Committee (IEC)
Japan Industrial Standards (JIS)
Japan Electric Manufacturers Standard (JEM)
Japan Electric Standard Committee (JEC)

(2) Climate

Temperature: Maximum 32 °C, minimum -28 °C (Harhorin)
Maximum 35 °C, minimum -37 °C (Undrkhan)

Precipitation: 304 mm/year, monthly max. 88 mm (rain) (Harhorin)
(include snow) 258 mm/year, monthly max. 173 mm (rain) (Undrkhan)

Wind Velocity: Max. 21 m/sec. (Harhorin)
Max. 24 m/sec. (Undrkhan)

Earthquake: Horizontal seismic degree 0.1 (Harhorin, Undrkhan)
Note: (According to Mongolian standard, Harhorin is unit 8 and Undrkhan is unknown. However, the relation between the "Unit" and the horizontal seismic degree is not clear. Therefore, in the design of this facility horizontal seismic degree of 0.1 was taken as reasonable value.)

(3) Soil · Ground

Among all four sites, boring tests and study on natural condition were conducted for two sites of Harhorin and Undrkhan, where the construction of grain storage facilities is expected. Foundation design will be made according to the results of tests and studies mentioned above.
According to the result of the study, the seasonal frost depth shall reach 3.7m from surface at Harhorin, 2.6m at Undrkhan. Therefore, preventive measures against underground water and frost depth shall be taken in the design of foundation work.

(4) Physical Properties of Material Wheat

In planning this project and designing equipment, the following mentioned data which are the results of local survey were taken.

Weight to volume: 720 kg/m³

Some of the material wheat is low grade of about 700 kg/m³. But good quality wheat after removing impurities would be about 720-740 kg/m³. For design works, a mean value of 720 kg/m³ was taken.

Moisture content: Max. at time of receiving 24% w.b., average 19% w.b.
Angle of repose: Average 28°
Impurity: At time of receiving, less than 5% by weight

(5) Storage Quality of Wheat at Project Sites Under Severe Cold Season.

The sites in this project are situated at high latitude of 45°N and northward, the site will be under severe cold climatic conditions in winter.

Anxieties for grain storage under such a cold temperature have been expressed by some people.

Generally, agricultural produce including grains tend to deteriorate under high temperature and high moisture. Insects also tend to grow faster in these conditions. The agricultural produce can be stored better under low temperature without quality deterioration and insects growth. Therefore, there is a need for low temperature warehouses and/or refrigerated warehouses.

It is believed in general that wheat storage temperature is the lower the better. According to an article titled "Grain storage, a fundamental knowledge for agricultural facility", written by prof. Maekawa of Tsukuba University and appeared in a bulletin for agricultural civil engineering society (Vol. 59-2, 1991 Feb. issue), "When wheat is stored at a temperature below -20°C, it has the effect of sterilization and insecticide. It is effective for quality preservation. Especially, as there is very little adverse effect by low temperature on, the wheat. This is different from rice".

Minimum outdoor temperature in Mongolia goes down to -40 ˚C but there is no possibility of the wheat being damaged by the low temperature. In northern Europe and Canada, wheat is often stored at about same temperature as that in Mongolia.

The flour mills in Mongolia close for several days at the end of every year. This does not mean holidays only but to exterminate harmful insects within the factory with the cold. When the mill is in operation, it is difficult to change the habitat of harmful insects due to the heating of equipment or by room heaters.

(6) Receiving/Feeding Capacity

1) Quantity Received per Day (Q)

10,000 ton at Harhorin and 8,000 ton at Undrkhan which were set as the appropriate capacity for this project were taken as the quantity received by the flour mills in a year.

Harvesting season of wheat is August to September both for Harhorin and Undrkhan. The peak of the harvesting season is in September. On average, the flour mills receive wheat material from October to December, net two months. In some years they received 90% of annual wheat received in one month time. In other years, they received the wheat in three to four months time. The receiving period varies depending on the time of sowing, climate in the maturing stage, the climate in the harvesting season, which affects the wheat collection, and transportation schedules. Transportation from farms to flour mills is by truck of grain in bulk, which is easily affected by the bad road conditions besides the farms are far away (weighted average distance of about 70km in case of Harhorin site and about 170km for Undrkhan site)

Under these conditions, transportation trucks often wait outside the mill yard for unloading. Therefore, daily receiving quantity depends on the cycle time from the time of truck arrival at the mill to the time unloading work is completed through the work of preparations and procedures. The cycle time of each step of work is as follows:

	Step	Cycle time
a)	From the notice of starting unloading work to the time of weighing by truck scale	180 seconds
b)	Sampling	120 "
c)	Transportation from truck scale to receiving pit	240 "
d)	Exact location of truck	60 "
e)	Tilting of truck and unloading	300 "
f)	Getting back to normal position	180 "
g)	Move to truck scale	240 "
h)	Weighing of tares, notice of completion of work move to outside yard	180 "
	Total	1,500 seconds (25 minutes)

From the above, one cycle of time (from the time truck starts unloading to the time of completion) needs about 25 minutes. Thus, daily receiving quantity (Q) is calculated as follows: one truck is loaded with a 10 ton cargo, receiving work continues for 20 hours a day and a loss ratio at a cycle interval is 62%

$Q = \{10 \times (20 \times 60)/25\} \times 0.62 = 300$ ton/day

2) Receiving Time (T)

Receiving of material wheat at storage facility shall be made in 3 shifts a day.

In deciding, feeding capacity of the facility, effective receiving time (T) was set as 20 hours per day considering the night time operation and outdoor works.

3) Feeding Capacity

Necessary feeding capacity (C) is calculated by below mentioned equation:

$$C = Q \ / \ T \times \xi m \times \xi w$$

where C : Feeding capacity ,(ton/hour)
Q : Daily receiving quantity, (300 ton/day)
T : Daily receiving hours, (20 hr/day)
ξm: Machine efficiency, (80%)
ξw: Work efficiency, (75%)

$$C = 300 / (20 \times 0.8 \times 0.75)$$

Consequently, the feeding capacity shall be 25ton/hour for both site.

(7) Discharging Capacity

In order to use the same conveyors for recirculation between silos and dryer, discharging capacity shall be the same as the feeding capacity.

(8) Capacity of Dryer and Boiler

Wheat procured by flour mills are carried by trucks from farms directly to flour mills. Moisture content of wheat at the time of arriving at flour mills was 19% w.b. in average and maximum 24% w.b. In order to store safely for a long time, moisture content of wheat must be below 14.5% w.b. in average. Therefore, it is necessary to install a dryer which can dry the material wheat to 14.5% w.b.

The dryer's capacity is expressed by quantity of grain dried in a day (ton/day) and drying rate (% w.b.). It can be calculated by an equation,

$$D = Q \times \eta$$

D = Dryer's capacity (ton/day)
Q = Quantity of wheat arriving at flour mill (300 ton)
η = Processing rate = (40%)

It will be D = 300 x 0.4 = 120 ton/day. As a result of this, dryer's capacity shall be 120 ton/day and the drying rate ($\triangle$H) shall be $\triangle$H = 4.5% w.b.

In this case, the necessary heat value of the dryer is as follow:

Condition:		
	Ambient temperature	0℃
	Temperature of grain fed	0℃
	Latent heat of wheat	0.47kcal/kg℃

Average grain temperature inside the drying chamber	24℃
Average grain temperature at discharging	10℃
Air volume	350m³/min
Average temperature of exhaust air	27℃

Heat value consumed for raising grain temperature (0℃→24℃) is:
5,000kg wheat/hr. x 0.47kcal/kg℃ x (24 - 0)℃ = 56,400kcal/hr... ①

Heat value included in the exhaust air (unused heat value) is:
350m3/min x 60min x 1.2 x 0.24kcal/kg℃ x (27 - 0)℃ =
163,296kcal/hr ..... ②

The necessary latent heat for evaporating the moisture in the grain is:
Water in the 5,000kg of wheat with moisture content 19.0%w.b. is 950kg. When the grain is dried to 14.5%w.b., the quantity of water is (5,000 - 950)kg / (1.00 - 0.145) x 0.145 = 687kg
Therefore, the latent heat is
(950 - 687)kg/hr x 580kcal/kg = 152,540kcal/hr ..... ③

The heat value used for cooling the grain temperature is:
5,000kg/hr x 0.47kcal/kg℃ x (24 - 10)℃ = 32,900kcal/hr ..... ④

Therefore, in and out of the heat value inside the dryer is
① + ② + ③ - ④ = 340,000kcal/hr

If the loss of heat value by dryer itself is 14%,
340,000kcal/hr / 0.86 ≒ 395,000kcal/hr would be necessary for a dryer's heated air generating section.

Next, suppose the loss of heat value by the pipe between the boiler and dryer and a radiation heat at the heated air generating section of the dryer is 17%, necessary heat value at the boiler, which is a source of heat generation, shall be:
395,000kcal/hr / 0.83 ≒ 476,300kcal/hr

Therefore, if the boiler's pressure is 3kg/cm² and temperature 132.9℃, the latent heat for evaporation will be about 517kcal/kg and the

necessary amount of steam is:

476,300kcal/hr / 517kal/kg = 920kg/hr ≒ 1,000kg/hr

The boiler of 1,000kg/hr capacity shall be installed at both sites.

(9) Selection of Storage Facility Type

Considering the natural conditions and distribution of wheat in Mongolia, necessary functions for a material wheat storage facility, maintenance difficulty operation cost and construction cost are compared in the following Table 4-22 for silo and existing warehouse attached to the flour mills in Mongolia.

Table 4-22 Comparison of Main Functions

Item of Comparison	Existing Storage Facility		Silo
	Flat Warehouse	Mechanised Flat Warehouse	
Suitability of bulk handling	×	○	○
Long time storage	×	○	○
Separate storage of 1000 ton unit	×	△	○
Rotation work	×	△	○
First-in and first-out	×	○	○
Quantity control of grain	×	△	○
Construction cost	S	L S	RC ..... L Steel .. S
Maintenance	○	△	

Note: 1. ○ = good or easy, × = bad or difficult, △ = medium
S = Small, L = Large

2. Mechanised flat warehouse is an underground type with an upper and a lower conveyers for charging and discharging.

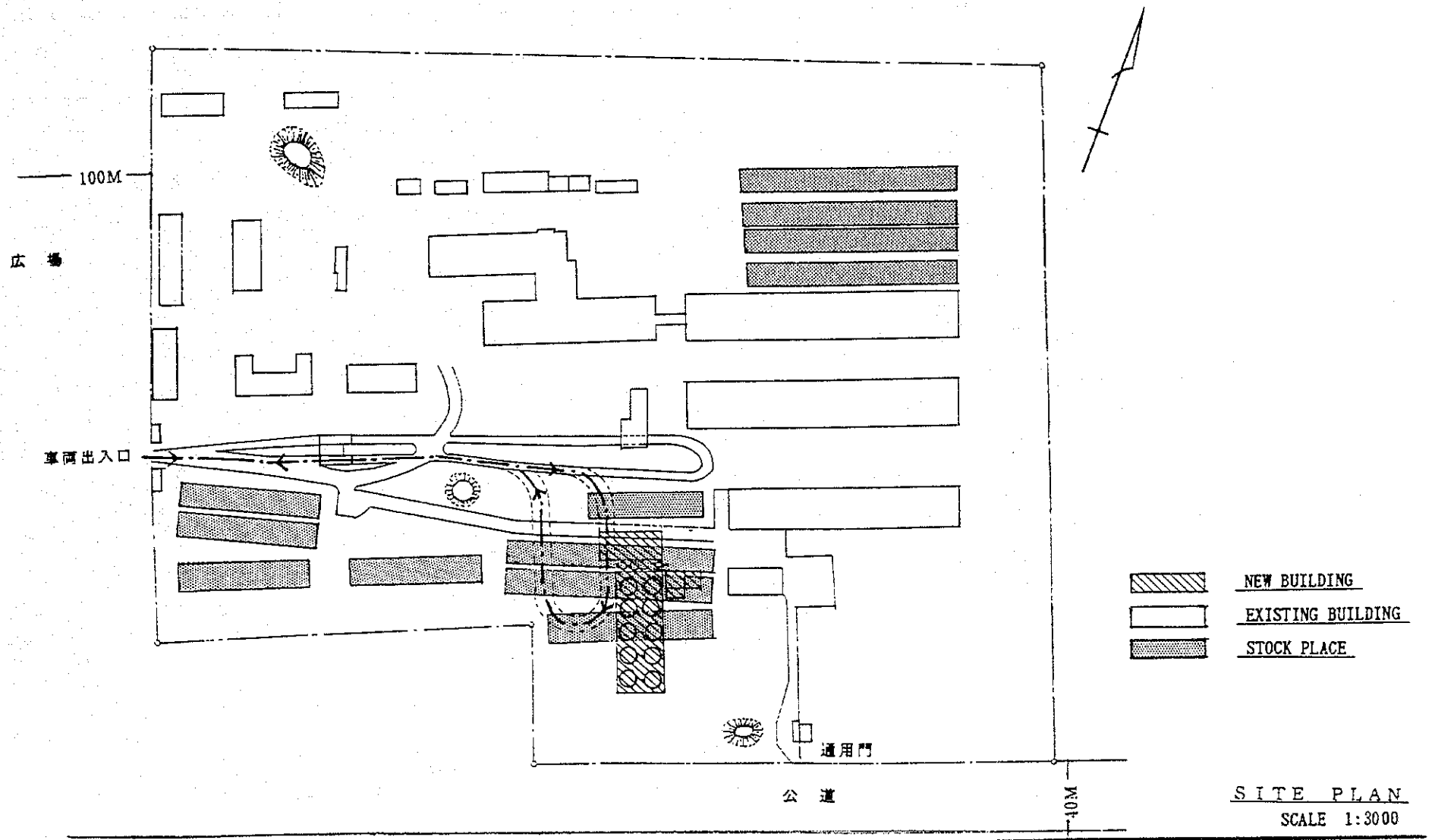
3. RC = Reinforced concrete silo, Steel = Corrugated steel plate silo of "assembling at the site" type.

Comparison of silo specifications for the corrugated steel plate of local production and reinforced concrete form was made and the results are shown in Table 4-23.

Table 4-23 Comparison of Silo Specification

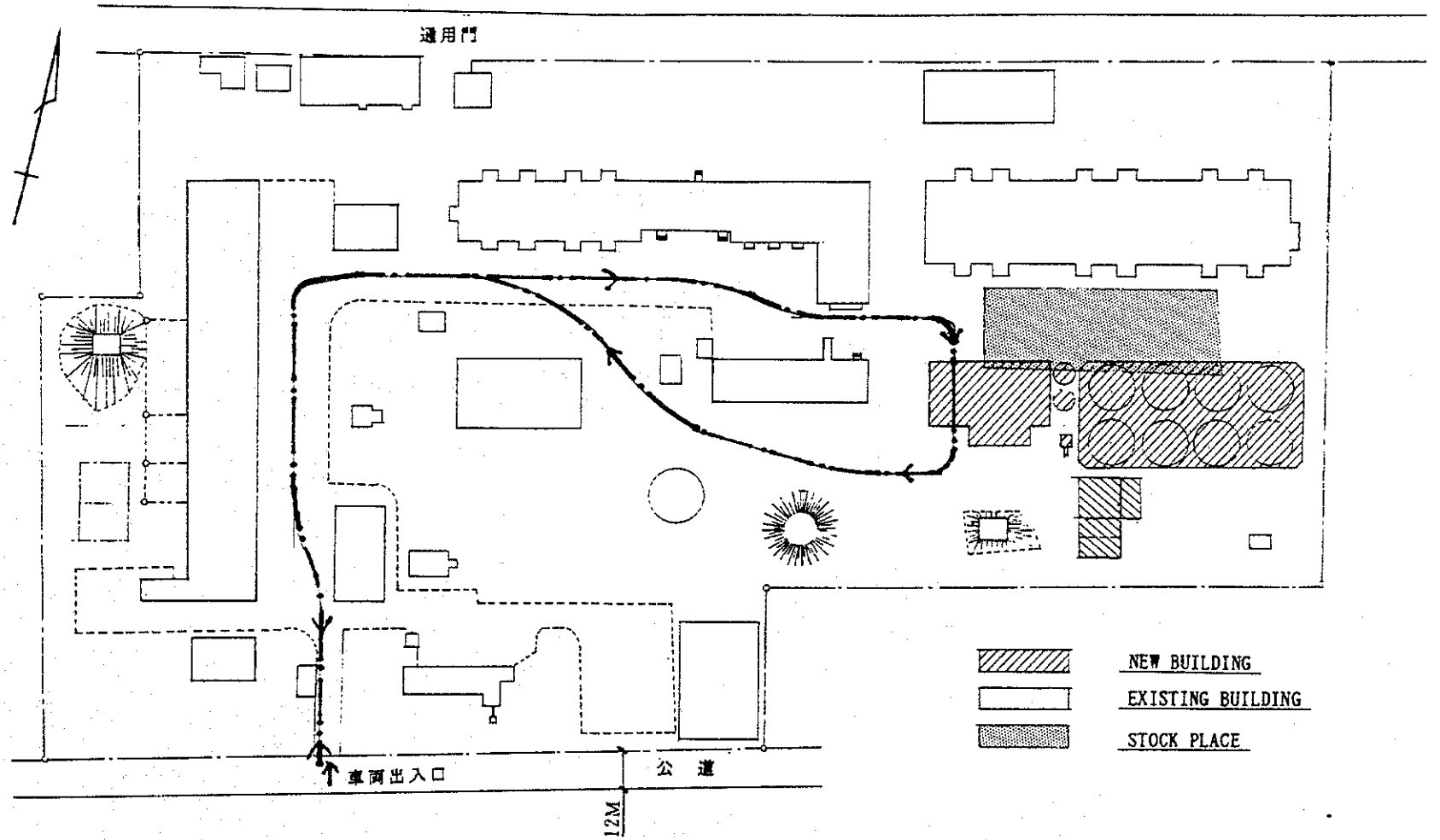
Item of Comparison	Local Fabrication of Corrugated Steel Silo	Reinforced Concrete Molding Frame (Local Work)
Type	Flat bottom, round shape with discharger	Same as left
Main material	Corrugated steel plate surface treated	Reinforced concrete
Storage performance	Extreme cold: Excellent Summer: Good	Extreme cold: Good Summer: Good
Material procured from	Japan	Mongolia. Difficult to secure quantity in time stably.
Construction machines materials	Procure in Mongolia and nearby countries	Machines from Japan Material like frame from Mongolia
Construction technology	After some guidance, local labourers (unskilled labour) can assemble.	Chiefly by Japanese skilled workers with assistance by local labourers.
Construction time	Construction work is possible in winter except foundation work	Work is difficult in winter, Nov. to March (below 5°C)
Work period	About 6-7 months including foundation work which is simple due to light weight.	About 12 months including foundation work
Quality control	Easy	Difficult
Construction cost	Relatively low	Relatively high
Durability	About 25 - 30 years	About 20 - 40 years
Maintenance	Easy	Easy
Others	· Many such type are used in wheat producing countries (Canada, U.S.A.) and developing countries. · Uniform quality designed for fabrication by unspecialized staff.	· Mostly large scale installed at key station of marketing. · Uneven quality due to quality of concrete mixing, work of concrete frame, material and work of reinforcing rods. Durability and maintenance are largely dependent on above.

As a result of all these, "local fabrication of corrugated steel silo" was selected for this project as most suitable type.



SITE PLAN
SCALE 1:3000

HARHORIN (カラコルム)



SITE PLAN　SCALE 1:1500

UNDORKHAAN（ウンドゥルハーン）

4-5-3 Basic Design

(1) Plot layout plan

1) Plot Plan

In this project, plot plans for both construction sites of Harhorin and Undrkhan must be made with due consideration in the relation with the existing facilities so that the whole flour mill functions as a system.

a) Harhorin Site

When entering from the gate for cars that faces the square, there are two truck scales, one on your left, the other on your right side. The one on your right side shall be used for this project. The one on your left side shall be used for conventional warehouse.

b) Undrkhan Site

A truck enters from 12 m width road and pass through the existing truck scale and then unload or load the cargo, then again come back to the truck scale to go out. This is the route that should be followed by the incoming and outgoing trucks.

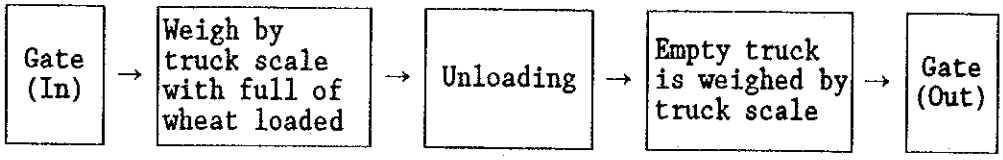
2) Path of Flow Planning

<u>On the present path of flow</u>

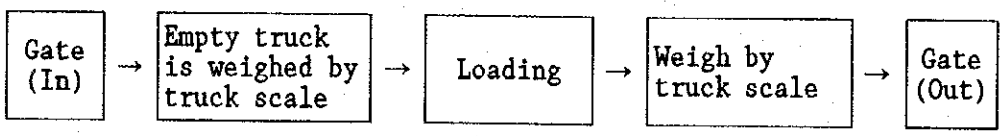
The path of flow planning is very important in the grain storage. It is necessary that the routes of incoming and outgoing trucks should not cross each other. Figure 4-03, 04 shows the path of flow in the plan for each site.

Feeding inlet of material wheat for the grain storage facility should be installed on the present path of flow or on its extension line of the existing flour mill and at closest position to the existing flour mill. The movement of trucks in this project is schematized as follows.

a) The path of flow for arriving trucks



b) The path of flow for shipping trucks



The shipment of dried and precleaned wheat shall be made by installing a bulk shipment line and a carriage porch in the front of the machine building.

Figure 4-05 shows a flow of each process in the design of grain storage facility, arrival → storage → shipment.

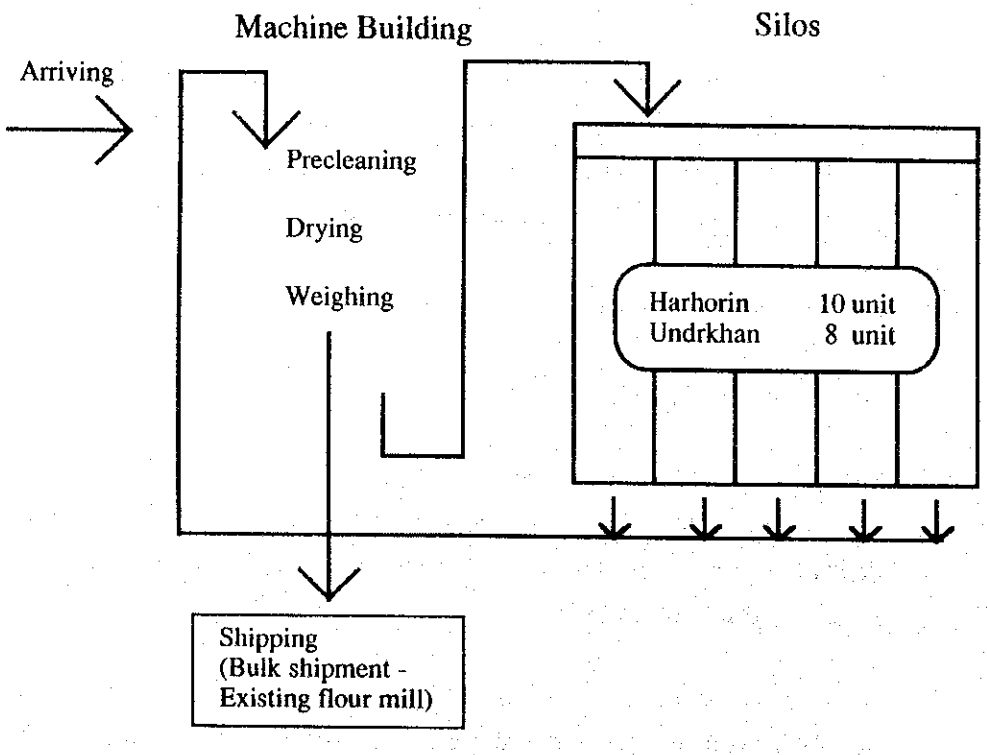


Figure 4-05 Grain Flow in the Storage Facility under this project

Adding to the above silos, machine building and boiler house exclusive for dryer are the main buildings to be built. Design concepts are as follows:

- To make efficient facility functions.
- Consider local climate, local features, geographic conditions, type of facility, method of utilizations, etc.
- To procure as much material as possible in Mongolia so that maintenance work shall be made easy.
- Consider safety and security of each facility.

3) Function Layout Plan

The facility in each site shall be as shown in Figure 4-06 Function Layout.

Trucks shall be weighed by a truck scale installed near the gate (entrance or exit). Then, goes to a receiving section as shown by the path of flow. The material wheat is thrown into a receiving hopper installed at semi-underground section of a receiving section, through conveyors (chain conveyors, bucket elevator) goes to and cleaned by pre-cleaner. High moisture wheat will be dried up to 14.5% w.b., suitable for storage, by the drying process and already dried wheat will directly go to the weighing process, where grains are continuously being weighed. The wheat will then be the sent to the silos and stored. Processed wheat will be discharged from silo, according to the need, and sent to the flour mill through conveyors and weigher.

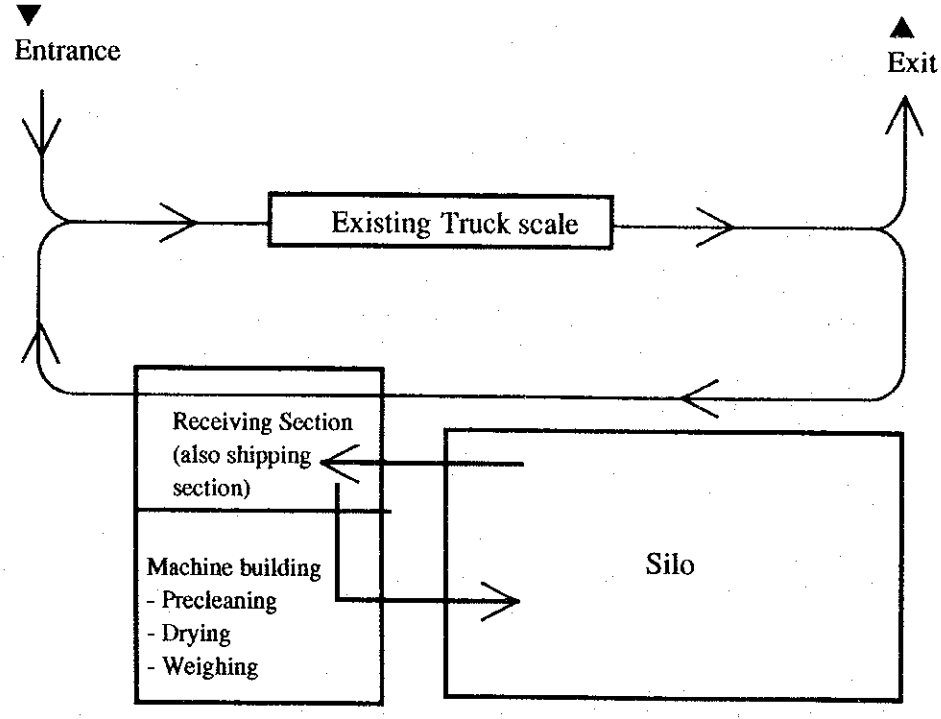


Figure 4-06 Function Layout

4) Attention in Equipment Layout

Attention is required in the planning of the equipment layout on the following points.

- In order to maintain the performance and durability of each piece of equipment, pre-cleaning and weighing processes, also electrical equipment shall be placed indoors.

- Maintain ample space for workers to make inspection and maintenance works. Especially, pre-cleaning equipment and lower part of elevators requires frequent cleaning. Consider for the efficient cleaning works. Also place pit covers, and handrails at stands for inspection of higher places for the safety of workers.

- Dust collection equipment should be installed so that dust is concentrically collected for efficient dust disposal and noise control.

5) Silo Layout Plan

a) Receiving/Shipping Equipment and Silo Position

Draw a layout plan for a grain receiving unit, feeding, discharging and shipping equipment, considering the path of flow plan of incoming trucks with loaded wheat, inside the existing flour mill. Further, after securing necessary space for operation such as control room, inspection room, etc., decide a floor plan and plane dimensions of machine building, which is about 26m x 16m. According to this, a side of silo foundation will be 26m width. Arrangement of silos shall be two rows in order to place receiving and discharging units economically and rationally.

b) Soil Condition and Silo base

From the result of soil survey and boring tests conducted as a part of the study on natural conditions, necessary ground area for silo base (foundation) should be obtained. Allowable load for the weight of silo and inside grains without the weight of silo foundation itself per unit space of silo base was calculated to be approximately 15 ton/m² for Harhorin site and approximately 7 ton/m² for Undrkhan site. Therefore, the necessary area will be about 740m² for Harhorin site and for Undrkhan site, it will be about 1,300m². If a side (width) of silo foundation is 26m, the required length will be about 30m and 50m each.

c) Shape of Silo

When wheat is discharged from the silo, movement of grains differs by the shape of silo. If H/D ratio (Height of silo's cylindrical portion / Diameter of silo) is below 1.5, there will be no vertical load exerted on the side wall of silo and no need of evaluating the resistance (strength) of silo wall. This has been proved by pulverulent engineering. In this project,

corrugated steel plates are used as wall material of silo, therefore diameter of a silo needs to be more than 2/3 of the silo height.

Considering the factors mentioned in above a)-c), economical dimensions of corrugated steel silo was obtained to be 10-12m in diameter and 15-18m in height.

d) Number of Silos Necessary to Store Each Grade Separately

Quality standard of material wheat in Mongolia is divided into six classes, namely grade 1st to grade 6th by weight, foreign matter, impurity, broken grain and damaged grain. In the present open-piling, the wheat is not always placed separately according to its grade. But in silo storage, it is necessary to store each grade separately. A necessary number of silos is therefore minimum six (6). Next, during the storage, grains must be kept alive but other insects and microorganisms must be exterminated or suppressed. For this purpose, it is necessary that the moisture content of grains may be adjusted, heating of grain temperature can be prevented and fumigation to exterminate insects and microorganisms can easily be conducted. In order to conduct this, at least one spare silo is necessary for the rotation of the grain from one silo to another.
Considering the storage by grade, rotation for quality control of grains, easiness of operation, etc., necessary number of silo is more than over six (6).

Considering all above conditions, optimum layout plan has been studied on the site reserved for construction. As a result, it was found out that ten (10) silos in two rows (5 silos x 2 rows), 1,000 ton capacity for Harhorin site and eight (8) silos of 1,000 ton capacity each in two rows (4 silos x 2 rows) for Undrkhan site will have necessary functions mentioned so far.

(2) Responsibility of Each Party

In the implementation of this project, the range of words that falls under the responsibility of each party shall be as follows.

Table 4-24 Work Divisions

Item	Mongolia	Japan
Basic design & detailed design	Presentation of design conditions	Design work
Civil, Construction work	Ground leveling & Disposal of hard standings at construction site. Disposal of abandoned flat warehouse for temporary store of construction material (Harhorin). Modification of existing building & equipment. (11,000t warehouse)	Procurement and installation works, necessary for foundation · pits, machine building and boiler house. Make an opening at existing building for a new conveyor feeding grains to flour mill.
Machinery		Procurement and installation work for all necessary machinery and equipment from receiving to conveyor for carrying grains to flour mill.
Electric works	Secure necessary electricity for this project and the works. And bring high voltage trunk wires into the yard.	Works to bring in the high voltage trunk line to this facility. Procurement of materials and works necessary to supply electricity to all necessary parts of this facility.
Water supply	Secure necessary quantity of water and hot water and diverging work to bring pipelines from the adjacent building.	Plumbing work to bring pipe line from existing ramification point to the facility in this project. Procurement of material and works necessary to supply water and hot water.

Adjustments and Running test	Procurement of grains and fuels necessary for trial operation	Execute adjustments and trial operations. Making manuals and training of local operators
Maintenance and operation management	Maintenance, operation management for the machinery and equipment in this facility provided by the project.	Making and presentation of a list of machinery and equipment and manuals for maintenance and inspection.
Others	Observe the memorandum dated October 14, 1994 (Appendix 4. Memorandum)	

(3) Machinery and Equipment Plan

1) Purpose and Function of Each Process

This project is to construct grain (wheat) storage facilities for the purpose of preventing and reducing losses and damages in quantity and quality caused by open-yard piling. The equipment plan shall be made by considering the above purpose and the prevailing conditions of Mongolia. The results are shown in Table 4-25.

Table 4-25 The Purpose and Functions of Each Process

Process	Purpose	Type - Functions
Receiving	To receive wheat weighed by existing truck scale, first step before storage.	Construction allows efficient receiving of bulk wheat arrived by trucks. Can accommodate forwarding trucks as well as backward moving trucks.
Precleaning	To remove impurities (earth, small stones, sand, glass, metal, straws, leather, other grains) in the wheat received before drying, weighing, and storage processes as this enhances the functions of these three processes.	Separation mechanism differs by the kind and size of impurities. Sieve oscillation, wind, etc. are incorporated in each machine according to each purpose. A separate machine is used for removing stones of same size as wheat grains.

Drying	To dry the wheat received with high moisture content to store at a certain low moisture level.	To perform efficient drying of wheat, equip tempering bins which act also as receiving bins. Coal is used as a heat source for dryer, which is requested by executing organization.
Storage	To store wheat in severe cold season and discharge easily along with the progress of milling work.	Corrugated steel silos which can accommodate a large quantity of grains are employed.
Weighing	To accurately record the quantity of stored wheat and reflect in accurate inventory and management of the facility.	Mechanical type weigher that can work out aggregate sum.
Others	1) Conveyors To carry wheat from one process to another, connecting all processes. 2) Dust collection To remove dust inside the factory to improve working environment. 3) Operation control Operation of all facility can be made by centralized control system.	· Consideration paid so that dust will not leak to outside the equipment. Chain type conveyors are used. · Receiving, precleaning and weighing processes, where dust generate most will be objects of dust collection. · Automatic control is not employed. Basically each machine and equipment are operated through remote control system.

2) Basic Conditions for Selection of Machinery and Equipment

Basic conditions for selection of machinery and equipment are shown below.

- To select machines and equipment which strengthen the management of the facility that suites actual conditions, and also actual operation in the grain storage facility are efficiently and correctly performed.

- Select machines and equipment which will be relatively easy for Mongol labour to handle and maintain in future.

- Operation cost and maintenance cost should not largely exceed the losses suffered by the flour mills in the past and also the reduced value of wheat caused by quality deterioration.

- Machinery and equipment should be selected properly so that each work under the responsibility of each party and shall be done easily. Selection of machines and equipment should be made keeping close reference with each work as it affects the height, floor area and size of underground portion of the room.

- Pay attention to the border line of work with the existing flour mill and feed mill.

- Select the machines and equipment whose function will not be blocked by the severe coldest climate in Mongolia.

3) Functions and Design Specifications of Each Equipment

a) Receiving Process

To receive wheat arriving from farms continuously and to convey to following process of precleaning and drying. In this process, a lot of dust is generated at the time wheat is dumped into the feeding pit. This process shall be partitioned from control room and other machines.

- Dumping Equipment

When trucks arrive at the flour mill and wheat is dumped into a receiving hopper, a first process in the facility, the truck itself is tilted to unload the wheat in order to save manpower and energy. This equipment is used in the existing facility at Harhorin.

In Mongolia, Russian made trucks are used. Generally trailers are used for the transportation of the wheat. Both trucks and trailers are not equipped with a tilting device, their platforms are fixed. Therefore, without this dumping equipment, the wheat has to be unloaded manually. This dumping equipment is necessary in order to unload a large quantity of wheat quickly.

Specification: To tilt up to 30° the truck of projected dimensions in mm; L7,500 x W2,500, (trailer L4,500 x W2,500) and maximum load; approx. 13 ton including carrying load wheat by hydraulic pressure and to discharge wheat automatically.
Since the hydraulic system is placed underground below the platform that supports the truck, care must be taken to prevent dust and to facilitate cleaning works.

- Receiving Hopper

This is a first process of the storage facility receiving the wheat thrown by truck with a dumping equipment. In Mongolia, wheat growing farms are far away from the project sites and it is difficult to plan the collection of material wheat systematically.
There is a fluctuation in the quantity of wheat that arrives at the site. Therefore, it is even more important to collect, clean and dry the high moisture wheat quickly.
Trucks loaded with wheat must not wait for a long period of time.
A function of carrying one lot (brought by one truck and a trailer) of about 10 ton of wheat to next processes continuously after throwing is necessary.

Specifications: Hopper capacity; Wheat 10 ton (about 14m³)
Upper part of the hopper is grating. The grating needs to be strong enough to stand the weight of the truck loaded with wheat (13 ton), as the truck passes on the grating. Discharging capacity is more than 25 ton/hr.

b) Pre-cleaning Process

The wheat discharged from the feeding hopper is conveyed to the pre-cleaning process. If straws, rachis branches, stones, sands, mud, dust, metal pieces, etc. are included in the wheat, fluidity of grains would be poor and it affects the performance of conveyors, dryers, storage, etc.

The pre-cleaning process is equipped with a separation function

of minimum requirement to remove such a variety of impurities so that the following processes may be performed smoothly. In order to achieve better separation efficiency, a separator specially designed for wheat shall be used.

- Scalper

  Although a special machine is used depending on the size and kind of impurities, as a first process, large size straws, grains with rachis branches, strings, stones, papers, wooden pieces and dust are separated from wheat grains by a scalper in order to enhance the performance of the following cleaning machines.

  Specifications: In order to clean a large quantity of wheat with a small size machine, a cylindrical shape screen is rotated. The dust outlet is equipped to discharge dust, which will be collected by a dust collector. Feeding rate will be over 25 ton/hr.

- Oscillating Screen Separator

  Impurities larger than the wheat length and smaller than the width of wheat grain, such as pebbles, sand and dust are separated and removed from the wheat.

  Specifications: Double layer screens are oscillating latitudinally or longitudinally against the direction of grain flow to separate impurities. Light impurities such as small straws or ear pieces shall be separated by wind force and the wind is connected to dust collecting system. Feeding capacity is over 25 ton/hr.

- Specific Gravity Separator

  Impurities that were not separated with the machines previously stated small stones, metal pieces, glass of about same size as wheat grains are separated by the difference in specific gravity.

Specifications: Impurities heavier in specific gravity are separated from wheat flowing on a oscillating screen by utilizing wind pressure. Feeding rate shall be over 25 ton/hr.

- Magnetic Separator

In order to protect processing machines, metals such as iron powder, nails, bolts and nuts, etc. are separated to prevent mixing with the product.
The magnetic separators are installed not only in the pre-cleaning process but also before shipping and before conveyance to the flour mill. A large machine like metal detector shall not be used because of its difficult maintenance work.

Specifications: Permanent magnet that can be placed or equipped in the chute pipes or inlet or outlet of each machine.
The magnet itself or a part to which the magnet is fixed shall be easily dismantled so that replacement of magnet and removal of metals attached to the magnet may be made very easily. Since daily inspections will become necessary, the magnet shall not be placed at very high position. Feeding rate shall be 25 ton/hr.

c) Drying Process

After precleaning process, the wheat is sent to drying process. In the quality test such as moisture measurement in the receiving stage, if the moisture content was 14.5% w.b., standard moisture content for storage in Mongolia or below, the wheat is sent to weighing and storage process without passing through the drying process. The wheat with higher moisture content is sent to tempering tanks, also serve as receiving bins, until drying process starts. The wheat is then dried with a continuous flow drying process until the moisture content is brought down to standard level for storage. Depending on the initial moisture content of the grain, drying rate per one pass is adjusted by the temperature of heated air and the time it takes for the grains to

pass through the dryer.
If one pass through the dryer is not enough, the wheat is sent to tempering tanks and allow the moisture to equalize within each grain in several hours. Then repeat the drying. As soon as the moisture content reaches 14.5% w.b., the grains are cooled and put to storage.

- Tempering Tanks

  The wheat after precleaning stage is fed to tempering tanks, which also serve as receiving bins, until the quantity reaches to a level enough to fill the dryer. The received quantity is about 200 ton per day in average (about 40% is of low moisture content and may be stored in the silo directly). This tank is used for tempering of the grain being dried. Therefore, two tanks of 150 ton capacity each shall be installed.

  Specifications: Total capacity is 300 ton (150ton tank x 2).
  Corrugated steel plate with steel legs.
  Diameter is 5~6 m, height is about 13 m.

- Dryer

  Material wheat needs to be dried for storage from average moisture content of 19.0% w.b. to the standard moisture content for storage, 14.5% w.b. The drying capacity is 120 ton/day at least 5 ton/hr is necessary. The dried grains will be put to storage after the cooling treatment.

  Specifications: Through put capacity is about 5 ton/hr. The drying rate per one pass shall be 4.5% w.b. Air volume is about 350m³/min. Approximate outer dimensions are L3,000 x W3,000 x H8,000. For heating air, the radiator using the steam is used. The steam is taken from a boiler with a coal furnace. Heat value of 350,000kcal/hr is required for the radiator.

- Boiler

The boiler generates saturated steam to be used as a heat source for the dryer. The coal mined in Mongolia in abundance shall be used as fuel. Sufficiently high chimney shall be erected in order to control the content of smoke dust.

Specifications: Calorific value of the coal is 4,000-5,000 kcal/kg. Its size is 2-50mm. The combustion section is a stoker type furnace with a coal feeding device. Necessary evaporative capacity converted from the above calorific value is 1,000 kg/hr. at normal use (rated capacity 1,200 kg/hr.). Approximate dimension of main body and the furnace shall be ⌐2,000 x ⌐2,100 x ⌐4,300. Other necessary equipment are for ash disposal, water supply, water softening, condensation, dust collection, pressure regulator, etc. Approximate chimney dimensions are diameter 500 mm and height more than 17 m. To cope with the cold climate, sufficient heat insulation is necessary.

d) Weighing Process

The material wheat after drying is weighed before feeding into silos. It will be weighed again whenever sent to existing flour mill for milling or whenever shipped out without milling so that stock control is accurately conducted.

- Weigher

These weighers are for stock control. Two weighers shall be able to weigh feeding wheat and discharging wheat simultaneously.

Specifications: One batch of 250kg can be weighed. Hourly capacity shall be over 25 ton/hr. Electric weigher is not used. All mechanical constructions.

e) Storage Process

The material wheat after drying and weighing will be put to

storage in silos. Cable type thermometers are used for grain temperature monitoring during storage. For the discharging of the wheat, movable auger shall be used lest grains should not remain on the bottom floor of the silos.

- Silo

  To put the material wheat inside in order to protect from rain, snow, wind, birds, rats the grains otherwise stored piled in open yard. Storage period shall be one year or less.

  Specifications: Corrugated steel plate is zinc coated (over 350g/m² ; JIS HDZ35) finish. Roof pitch is 30° for high efficiency of wheat storage. Approximate silo dimensions are diameter 11 m and height 15 m.

- Tank for Shipment

  When the wheat is shipped out of the silo without going through the milling process, the wheat shall not be loaded on to trucks directly from the conveyors but it shall be accumulated in the tank until the quantity reaches to a unit of shipment. In this way, the discharging rate from this tank may be adjusted freely and independent of the conveyor's capacity. The tank will be installed at the receiving section.

  Specifications: Made of steel plate. Capacity is over 10ton wheat (effective cubic volume 15m³). Approximate dimensions shall be ℄2,500 x ⌀4,500 x ⌀5,000.

f) Conveyors

The conveyors are used to carry the material wheat from one process to another. There are three kinds, namely bucket elevators to lift the grains, chain conveyors to move the grain horizontally and auger to discharge the grains from the silos. For the operation of switch valves and shutters attached to conveyors, compressed air shall not be used as the air might freeze in the cold atmosphere. They shall be operated by electric

motors instead.

g) Inspection Equipment

• Grain prove	2 pcs	Double tube ㄴ1,500mm
• Sample divider	1 pc	Manual, hopper capacity 1kg
• Sieve separator	1 "	3 sieve layers to separate impurities
• Grain dockage sieve	1 set	5 screen meshes, a lid and bottom (round hole)
• Grain dockage sieve	1 "	7 screen meshes, a lid and bottom (long hole) pan
• Portable moisture meter	5 pcs	Electric resistance type, Range 10~25% w.b., battery operated
• Table moisture meter	1 pc	Electric resistance type, Range 10~25% w.b.
• Infrared moisture meter	1 "	Measuring range 0~100%
• Grain counter	2 pcs	100 grain
• Triple beam balance	2 "	Capacity 2600g
• Weight per volume tester	1 pc	Max. Capacity 1kg
• Grain shape tester	1 "	measuring range 0~20mm
• Magnifier, 3x	2 pcs	20W lamp, lens dia. 130mm
• Sample pan (square)	30 "	100mmx100mm
• Sample pan (round)	30 "	Diameter 100mm
• Sample container, Medium	100 "	Capacity 120cc
• Sample container, Large	100 "	Capacity 200cc
• Test mill	1 set	220W, Capa. 200 mℓ, Check gluten contents

(4) Facility · Building Plan

Based on the equipment plan, facility · building plan shall be made.

1) Layout Plan

Machine building is a facility to receive, weigh, inspect, clean (separation of impurities), dry, store, again weigh and ship out the wheat. Following rooms mentioned in table 4-26 are needed. The

control room, inspection room and outfit/rest room are heated and therefore provided with ancillary rooms as buffers to outdoor cold temperature.

Table 4-26 Room Partition List

Room	Works	Nos of Worker	Area
Platform	Receiving (unloading from and loading onto 10 ton truck)	1~2 persons	Width 10m Length 16m 160 m²
Control room	Control on Receiving weighing and shipping. Double doors to maintain temperature.	1~2 persons	5x5 25 m² (ancillary room) (3 m²) 25m²
Inspection room	Inspection of insects and moisture content of wheat. Double doors to maintain temperature.	1~2 persons	5x5 25 m² (ancillary room) (3 m²) 25m²
Outfit/rest room for workers	Necessary because 3 shifts works in harvest season. Double doors to maintain temperature.	4~8 persons	5x5 25 m² (ancillary room) (3 m²) 25m²
Spare parts room	Store the necessary spare parts		5x4 20m²
Machine room	Precleaning and weight measurement of wheat	4~8 persons	8x20 160 m²
Repair cars entrance	Entrance for machine maintenance		40 m²
Passage	A passage for internal works		36 m²
Electricity room	Install cubicle for transformer	1 person	30
Dust collection room	Collection and disposal of separated dust	1 person	50 M²
Boiler room	To supply hot water for grain dryer	1 person	100 M²
Coal store yard (open yard)	Adjacent to boiler room. Make wall (0.5m height) on a side		100 M²
Coal ashes yard (open yard)	Adjacent to boiler room. Make wall (0.5m height) on a side.		50 M²

2) Cross Section Plan

Because of very little rain and snow, the first floor's surface shall be +200mm on the existing ground level. Installation floor for weighing process in the machine building shall be separate from the building and precleaning process so that the weighing performance shall not be influenced by vibrations of other machines and equipment.

A penthouse roof of a pitch 3/10 shall be adopted, considering the layout of the machines.

3) Structure Plan

a) Design Standard and Norm

Design standard and load shall be based on the following standards. The value equals to or is in excess shall be used. For silo portion, a powder pressure generated by wheat shall be calculated and referred to each of the standard.

Design standard

Reinforced concrete:	Japanese standard
Steel structural frame:	Japanese standard
Silo:	Japanese standard

b) Wind Load

The facility to be built on an exposed site: a Japanese standard shall be referred to.

c) Foundation Structure

Both sites are on flat areas and according to the boring test, there is a sand layer including conglomerate. A mat foundation supported by this ground shall be employed as a foundation structure. For the machine building, concrete casting on the spot shall be used to make a foundation as there are pits construction works.

Supporting ground shall be set at a depth of over 30 cm deeper than the depth of frost as Mongolia is in a cold district.

d) Main Frame Structure

Considering the construction situation in Mongolia, steel frame structure shall be adopted to cope with earthquakes, whose coefficient force is judged to be K=0.1 from the past examples. It is very important that the buildings and other structural bodies in Mongolia should be quake resistant and highly durable structures as the magnitude of earthquakes is large and epicenters are directly under.

In Mongolia, such construction method as assembling the precast made structures and erect the buildings is well developed.

Structures are processed in factories in winter time and assembling in place is made in summer, April to October.

Precast concretes are made only by casting concrete into the steel made mold frame, in which reinforcing rods are placed. Centrifugal force or stress relief treatments are not applied in the manufacturing stage. Therefore, in the structural planning for the country where earthquakes occur, elaborate the planning by making comparison list such as the one shown in Table 4-27:

Table 4-27 Comparison of Structural Materials
(Locally made precast concretes and steel structures)

Item of Comparison	Locally made precast concretes	Steel structures
Compression force	180~210 kg/cm²	1,600 kg/cm²
Tensile force	Weak	Strong
Weight of a certain cross section (outer dimension)	147 kg/m (350x175)	49.6 kg/m (H form steel structure: 350x175x7x11)
Joint	Welding of reinforcing rod and spot-casting or by bolts	High tension bolts
Transportation	Heavy, tend to crack in a long distance transportation with horizontal piling	Weight is about 1/3 of concretes. Does not break during transportation.
Vertical load (column)	Strong	Strong
Vertical load (beam)	Weak	Strong
Horizontal load (column · beam)	Some problems in the joints	Joints are strong
Price	Low because locally produced	High because they are imported.
Transportation cost for same distance	Heavy and cost high	Low because weight is 1/3.
Durability of Joints	Weak to earthquakes	Strong against earthquakes
Work period	Takes time (abt 9 months) from manufacturing to construction	Construction takes less time (about 7 months)

According to the above table, precast concrete, compared to steel frame construction, is:

- Joint part tends to break in case of earthquake because it is either welded reinforcing rods or tightened bolts casted in the concrete (pin-connected construction, pin joint).
- Columns and beams are 8-9 m long. In case they are cracked by the vibration in the transportation of long distance, it takes considerable time to make them again if it would be happened.
- It takes long period of time from the start of manufacturing to the start of assembling.

- The height of machinery in this facility would be about 15m. Therefore, the precast concrete roof would be too heavy and would be vulnerable to horizontal force by earthquakes.

Due to all above, steel frame construction (steel structure), which has no such problems, was selected as most suitable.

- Machine building

Main structure	:	Steel frame
Floor	:	Slabs of reinforced concrete
Outer wall	:	Folded Steel plate with heat insulation material pasted
Ceiling	:	Foamy concrete plate (+50 m/m) covered with insulated material

- Boiler house

Main structure	:	Steel frame
Floor	:	Slabs of reinforced concrete
Outer wall	:	Partially bricks, upper part is folded steel plate with heat insulation material pasted.
Roof	:	Foamy concrete (t:50 m/m) covered with insulated material

e) Structure Material

Main structural materials are as mentioned below:

- Concrete

Foundation	:	210 kg/cm²
Floor slabs	:	210 kg/cm²
Leveling concrete	:	135 kg/cm²

- Cement : Portland cement
- Reinforcing rods : Use products of MONGOLIMPEX corporation
- Steel frame : Use H shaped bar of Japanese standard

(5) Equipment Plan

1) Electric Equipment

Electric load capacity was calculated from the machines and equipment in the machine building, boiler house and operating conditions of those equipments as shown in Table 4-28.

Table 4-28 Electric Load

		Harhorin Site		Undrkhan Site	
Item	Conditions of Calculation	Load calculation Area x Unit load x Operation rate	Load Capacity (kw)	Load Calculation	Load Capacity (kw)
Feeding	According to equipment and material plan	Equipment capacity 125 kw Operation rate 80%	100	120 kw 80%	96
Discharging	"	Equipment capacity 105 kw Operation rate 80%	84	95 kw 80%	76
Drying	"	Equipment capacity 80 kw Operation rate 75%	60	80 kw 75%	60
Storage	"	Equipment capacity 150 kw Operation rate 30%	45	120 kw 30%	36
Machine room Lighting · Receptacles	10w/m²	510m² x 10w/m² x 80%	4.08	505m² x 10 x 80%	4.04
Control room Inspection room Outfit room Lighting · Receptacles	30w/m²	50 x 30 x 80	1.20	50 x 30 x 80%	1.20
Boiler house Lighting · Receptacles	10w/m²	40 x 10 x 80	0.32	40 x 10 x 80%	0.32
Outdoor lamps & others			15		12
Total			309.60		285.56

A power transmission line of 6,000V x 3φ4w x 50HZ shall be pulled to the site by the Mongolians. Bringing high tension trunk lines from there to the facility and power receiving and transmission units shall be the responsibility of the Japanese.

Same power receiving and transmission units for both sites shall be adopted as the electric consumption rates of both sites are same.

- Type of transmission station : Indoor type
- Receiving type : Single circuit power receiving type
- Cable setting : Elevated cable setting
- Electric type : Primary 3 phase 4 wires
  10,000V x 50HZ(Harhorin)
  6,000V x 50hz(Undrkhan)
  Secondary 3 phase 4 wires
  380/220V x 50HZ
- Maximum contract electricity : 350kw
- Capacity of power receiving unit : 500KVA

For Murun and Choybalsan sites, where only the wheat quality inspection equipment are supplied, there will be no large difference in electric consumption. Therefore, existing power receiving units shall be used.

For lighting of rooms, luminous intensity of each section was planned as follows:

Table 4-29 Luminous Intensity

Place	Luminous Intensity (Lx)
• Receiving/Discharging room	100
• Operation, Control and Inspection room	300
• Outfit/ Rest room	100
• Spare parts room	100
• Power receiving and transmission room, Cyclone room	100
• Machine room	100
• Boiler room	100

Considering fluorescent and incandescent lamps, suitable ones for each section, shall be selected. Considerations should also be paid to easiness of maintenance works. Receptacles should be arranged with considerations for future changes in equipment layout.

2) Lightening Arrester

On top of the buildings and the silos, lightning rods shall be fixed in order to prevent accidents by strikes of lightning. They should be led to earth plates in order not to affect control panels.

3) Communication Equipment

An interphone system shall be installed for communications within the facility. Wiring works shall be made at the control and inspection room. An emergency bell shall be attached in the control room so that the bell will ring whenever there is a disorder in machines and equipment.

4) Water Supply Equipment

Water supply necessary for the operation of the facility is taken from the existing diverging point and a service pipe connected to it. The water is necessary for the boiler for drying, for the disposing of coal ash, for quality inspection of grains and for workers living purposes. Quantity needed for each purpose are planned as shown in Table 4-30.

Table 4-30 Necessary Water

Item	Calculation of Necessary Quantity	Necessary Water (ℓ/h)
Boiler	1,000 ℓ/h x 30%	300
Ashes disposal	250 kg x 20% x 1 ℓ/kg	50
Quality inspections	10 ℓ/h	10
Workers use	8 persons x 90 ℓ/day x 1/24h	30
For sprinkling and others	10 ℓ/h	10
	Total	400

5) Drainage

For drainage, miscellaneous waste water shall be drained in one line pipe. For freeze prevention purpose, it is to be wrapped with heat insulation materials and be buried at a depth of 2.7m and connect to existing sewage waterway.

6) Room Heating (Hot Water Supply) Equipment

Object of heating in this facility will be control room, inspection room, outfit/ rest room and boiler room. Heating is made by hot water supplied by the heat station. Heating area is 25 m^2 each.

7) Sanitary Facility

Washing stands and sinks shall be attached to inspection room and outfit/rest room.

8) Fire Extinguisher

Sprinklers may freeze in severe cold season. Therefore, small fire extinguisher shall be installed.

(6) Construction Material Plan

Based on the items of basic designs, materials and method of construction are compiled in Table 4-31.

Table 4-31 Comparison of Materials · Construction Method

Item	Common Local Practice	Construction Method Expected to adopt	Reason for Adoption
Foundation in General	1. Footing must be below seasonal frost ground. 2. Place precast concrete plates on the excavated bottom on which foundation pillars are erected. 3. Cannot expect strength of monolithic construction.	1. Same as left 2. Broken stone foundation on excavated bottom. Then, lean concrete on which base concrete beam shall be cast.	1. Suitable measures to seasonal frost ground. 2. Monolithic foundation to stand horizontal load.
Foundation for Silos	1. Supported from under seasonal frost ground. 2. At both edges and in the center, three rows concrete footings shall be made in the length direction of silo installation area. Cover with 200mm thick concrete slabs.	1. Same as left 2. Excavate all area deeper than frost depth. Circumference shall be wedge shape concrete legs. Central part shall be broken stones or cast plain concrete, covered with Horizontal slabs of 900mm thickness and monolithic with the wedge shaped legs.	1. Suitable for frost ground. 2. Extended area supporting the weight of silo and the contents contributes to stable foundation.
Pillars & Beams	Assembling the pillars and beams of precast concrete by welding reinforcing rods or bolt tightening. Welded portions are cast with concrete on the spot.	Use H shape steel bars. Joints are by high tension bolts.	1. Local practice of welding is not gas pressed welding and welded portion of reinforcing rods wear out and original strength of reinforcing rods will not last long. 2. On the spot, concrete casting is of uneven quality and not reliable.

Flooring/ Structure Finish	Reinforced concrete Machine building t:150 Boiler house t:150 Silos t:200 Mortar with metal trowel	Reinforced concrete Machine building t:150 Boiler house t:150 Silo t:900 Plain concrete and plain concrete with Mortar applied by metal trowel.	Thickness of concrete for each floor seem adequate. Silo floor thickness 900mm was taken to distribute the vertical loads of silo.
Wall	Precast concrete slabs with bolted joints. Lysin spray.	Inner surface fixed with painted folded steel plate fitted with heat insulating material.	Because of the height, folded steel plates fitted with heat insulating materials were employed to reduce weight.
Roofing	Precast concrete plates fixed with bolts. Three layers of waterproof asphalt finish.	Painted and folded steel plate with heat insulating construction method.	Heat insulation by steel plate was taken into consideration.
Ceiling	Precast concrete plates, t120 painted.	Soundproof board	Light weight was taken into consideration.
Inner Wall	Brick piling Mortar finish. OP Painting.	Folded plates	Shorter time of construction was counted.
Fittings & Others	Fixed double glass with wooden frame, OP painted.	Steel sash with fixed double glass · Double sliding windows in two layers.	Better fitting with outer wall.

(7) Basic Design Drawing

1) Size of Facility (Building Area)

		Harhorin site	Undrkhan site
a)	Machine building	560 m²	555 m²
	Annex building	150 m²	150 m²
	Boiler house	100 m²	100 m²
	Sub-total:	810 m²	805 m²
b)	Silo	1,772 m²	1,440 m²
	Total:	2,582 m²	2,245 m²