MALAYSIA

PADDY DRYING AND STORAGE COMPLEXES

— MUDA IRRIGATION SCHEME —

DESIGN REPORT

NOVEMBER 1970

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

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PREFACE

The Government of Japan, in response to the request of the Government of Malaysia, decided to render assistance in the survey for the Paddy Drying and Storage Complexes, Muda Irrigation Scheme, and entrusted the Overseas Technical Cooperation Agency with the implementation of the survey.

The Overseas Technical Cooperation Agency on its part organized a survey team comprising six members, headed by Mr. Kotaro Nagai, Institute of Tropical Agriculture, Ministry of Agriculture and Forestry, and dispatched the team to Malaysia for about one month since May 18, 1970.

The survey was made on the requirments for the design of paddy drying and storage complexes in the Muda Scheme area.

After returning to Japan, the survey team reviewed the results of the survey on the basis of various data collected during the survey, arranged for the standard design of complexes and prepared a report for presentation to the Government of Malaysia.

It is hoped that the report will be helpful for the development of the Muda Irrigation Scheme and will contribute to the promotion of friendly relations between Malaysia and Japan.

Finally, I express my sincere gratitude and appreciation to the Government of Malaysia and other organizations for their unlimited support and cooperation extended to the team during the survey.

November 1970

Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

REPORT ON PADDY DRYING AND STORAGE COMPLEXES
MUDA IRRIGATION SCHEME IN MALAYSIA

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SUMMARY & RECOMMENDATION

Requirements for the design of paddy drying and storage complex

1. As it is very likely that the harvesting of crops is made in the ill-drained field, sun drying of paddy as a means of pre-drying can not be expected in many cases. Generally, the moisture content of paddy immediately after threshing is around 23%. However, it is anticipated that the paddy having a moisture content of 28% or more, raised in the year of unfavorable climate and in the area of disadvantageous condition may be brought into the complex in considerably a large quantity. It is important, therefore, that plans are worked out so as to be able to meet any situations in the future. As the moisture content of paddy fluctuates greatly depending on the weather condition and the state of paddy field at time of harvesting, drying must be made after sorting out paddy according to moisture contents.
2. The quality of paddy also varies depending on the conditions at time of harvesting and subsequent storage method. To ensure proper drying to obtain paddy of good quality, it is necessary to handle paddy of varying qualities separately. As the paddy immediately after threshing often contains foreign matters, it is necessary to provide facilities to grade the paddy prior to feeding to the dryer hopper.

3. As the collected paddy has various moisture contents and qualities, batch dryer must be used so that the paddy may be handled in lot. The capacity of one complex was determined by assuming the loading capacity of a lorry to be about 5 tons.

4. Harvesting of paddy will be made in July and August and the period of paddy collection is estimated to be six weeks. As a greater fluctuation in the quantity of daily collection of paddy results in the decrease in the total quantity of dried paddy in the scheduled period and lowering the economy of the complex, adjustment must be made on the daily collection based on paddy collection plan so that balanced quantity may be collected during the operating period. As the collection will be made mostly during daytime and the drying operation will continue all day long, a facility for temporary storage of paddy must be provided.

5. To prevent deterioration of quality of paddy, the paddy after drying must be cooled down to the ambient temperature before storage.

6. The capacity of each complex is generally determined by such factors as the area of paddy collection, acre-yield and the intensity of utilization of complex by farmers. However, for the prevention of deterioration of quality and realization of speedy handling of paddy, it is desirable provide relatively small complexes in various locations. With the batch system, the capacity of each complex can be adjusted by changing the number of dryers per unit or increase of the number of units. For the detailed design, however, an unit of 2,000 tons/6 weeks was used as a standard capacity.

7. Storage facilities were divided into blocks, each having a holding capacity of 100 tons in consideration of the need for separating paddy of different qualities and for the prevention of damage to the whole paddy in storage. The height of pile in the storage facilities was limited to 7 meters in view of weak land bearing capacity. The storage facilities were designed on the assumption that 1/2 of the

total quantity of dried paddy requires storage, though the quantity may vary depending on the receiving and shipping policy.

Design and cost of the unit complex

8. Based on the above mentioned conditions, Designs A, B and C were newly developed and details of these designs are shown in specifications table, design calculation, and drawings 1-16.

The basic differences among the three designs are shown in the following table.

Design	Moisture extraction	No. of dryers per unit	Daily capacity per unit
A	23 - 14%	6 (Used twice a day)	54 tons
B	Same as the above	12 (Used once a day)	54
C	28 - 14%	12 (")	57

9. An estimate on the cost of construction for one unit is shown in the table below, summarized from Table 10. Since this estimate is based on the prevailing prices in Japan, and the revised rough estimate calculated with the supposed local prices in Malaysia is shown under the column Revised Total (Unit: M$).

Description	Design A	Design B	Design C
Machinery	450, 260	575, 710	621, 790
Building	580, 598	614, 957	614, 957
Others	163, 250	194, 880	203, 410
Total	1, 194, 108	1, 385, 547	1, 440, 159
Revised Total	998, 000	1, 176, 000	1, 226, 000

Arrangement of complexes in the Muda Scheme area

10. Assuming that the area of double cropping under the Muda Scheme is 260, 000 acres and the acre-yield is 5, 000 gantangs, the total production of paddy in the whole project area will be 325, 000 tons. Under the scheme, a half of the total production is to be brought in for artificial drying, therefore the facilities capable of handling 160, 000 tons of paddy will be required. In view of the fact that the project is divided into 27 localities and each locality serves as the sphere of activities of Farmers' Association, it is advisable to provide at least one complex in each locality at the final stage. In this case, the capacity of each complex may be determined according to the production capacity of each locality and the assumed capacity will be in the range from 3, 000 tons to 9, 000 tons, average 5, 500 tons. (Table 15)

11. The degree of utilization of the complexes by farmers will be another major factor in determining the capacity of each complex. It will be safe to establish complexes a moderate size initially and plan for gradual expansion of their capacity in the future. For this reason, the conservative estimate on acre-yield is taken in the report.

12. From the standpoint of convenience for FAMA or MADA, which will be directly responsible for the operation of complexes for the time being after their establishment, it is desirable to expand the capacity of each complex and limit the number of complexes (15 to 16 complexes) but there seem to be a limit in the minimum number of complexes, judging from the following reasons.

13. With the expansion of the size of one complex, the area of paddy collection will also expand correspondingly, and the need for the improvement of paddy collection method is keenly felt. To realize smooth operation of a complex, it is necessary to secure fixed quantity of paddy brought in to the complex daily under the scheduled collection program which also regulates cultivation of paddy. To achieve this purpose, however, there must be improved field canals and field roads, strengthened farm road (road along distributary) and new or improved public roads.

14. For the improvement of paddy collection method, there is much to owe the activities of farmers' organizations. However, the cost of end works such as setting up of field roads will have to be burdened by farmers and therefore, the implementation of the end works will be difficult without the understanding and cooperation of farmers, which can only be obtained after they gained enough experiences on the off-season cropping.

15. When the large centralized complex system is adopted, the number of units (2,000 ton/6 weeks) described in paragraph 8 should be increased, however, the centralization of units will not make a significant comtribution to the reduction of the overall cost. To provide a large complex of 10,000 tons capacity, it is recommeded to use 4 units instead of 5 units, since the design of the unit allows for reserve capacity to a considerable extent. The 4-unit complex can adequately handle 10,000 tons per 47 days (requiring 5 extra days). Land area required is 9,570m^2 = 2.36 acre.

16. In view of the fact that the off-season cropping is scheduled to start in almost the whole area of North Region in 1971 with very little time left and that decisions have already been made on the construction of five complexes, each having a capacity of 10,000 tons, under Project First Phase of FAMA, it is considered more realistic to provide a total of eight complexes by adding three more of similar capacity to the proposed five complexes.

17. For South Region, the total quantity of paddy to be handled by the complexes is estimated at 16,000 tons in 1971, 32,000 tons in 1972 and 31,000 tons in 1973, a total of 79,000 tons during a three year period. For the arrangement of complexes for the year after 1972, a decision will probably made as to which system - the centralized or dispersed system - is to be adopted by taking into account the road improvement project, the intensity of FA's activities and from the experiences gained in the North Region.

18. When the capacity of a complex is assumed to be 10,000 tons, with 4,000 tons storage capacity, the cost under Design A will be approximately M$4,370,000 (costs of 5 acres of land and civil work are to be the same as under FAMA's plan but the expenses for the despatch of engineers are not included). If 11 complexes are to be constructed in the project area (5 complexes planned by FAMA are not included), the total cost will be M$48,066,000, M$21,848,000 for 1971 and M$13,109,000 for 1972 and 1973 respectively. In this estimate, however, the price reductions, which may be expected for a large order, are not considered.

19. Though the present project for the establishment of complexes has a strong color of stopgap measures for the encouragement and stability of double cropping, there will be a growing demand for the improvement of rice quality, not only the promotion of production as the country moves on toward the achievement of self-sufficiency in the supply of rice. To meet this demand, it is important to give consideration to the overall development of rural communities from a long-range point of view.

20. As the estimated acre-yield and the increase in the paddy production may vary with each locality, it will be necessary to revise the capacity of each complex and the number of complexes in the future. As the drying facility with the batch system may be broken down into units and each unit may be moved to other locations, reasonable arrangement of complexes will be possible as the double cropping is settled in the whole area.

INTRODUCTION

It is indeed a matter for congratulation that the double-cropping of rice is now to begin in Kedah Plain, the so-called Rice Bowl of Malaysia, as a result of smooth progress of the Muda Irrigation Scheme.

This report contains the results of the survey for the construction of artificial drying and storage facilities for off-season paddy crops, conducted at the request of the Government of Malaysia and gives outlines of standard designs for these facilities.

The survey team comprised the following members:

Team Leader	Kotaro NAGAI	Tropical Agricultural Research Center, MAF
Member	Ritsuya YAMASHITA	Faculty of Agriculture, Kyoto University
"	Toshiaki ASHIZAWA	Extension & Education Section Agricultural Administration Bureau, MAF
"	Masaharu MAYUMI	Agricultural Production Section Agricultural Administration Bureau, MAF
"	Katsuhiro MARUYAMA	Agricultural Administration Division, Nagano Prefectural Government
"	Hidetoshi YAOI	Ibaragi International Agricultural Training Center, OTCA

The survey team remained in Malaysia from May 19 to June 20, 1970 (one member remained until May 27) and was engaged in the survey to grasp a true picture of the existing conditions, the study on all aspects of the scheme and in the collection of necessary data and materials. The survey team also had discussions with officials concerned in Kuala Lumpur and Alor Star during this period.

Detailed engineering and computation of estimated construction costs of drying and storage facilities were provided by the Country Elevator Association in Japan on the basis of the survey results.

Construction of artificial drying and storage facilities requires a considerable amount of investment regardless of their design. For the effective and smooth operation of these facilities, there must be a well planned and improved paddy collection setup such as coordinated harvesting time and improved field roads. It is also conceivable that the scheme will face some difficulties which may not be solved in a day.

Though the double-cropping of paddy in the tropics may be a short cut for the increase of rice production, difficulties in harvesting in the rainy season will also be felt in the tropics.

It is the sincere desire of the survey team that the establishment of the

Complex will serve as a turning-point for the promotion of balanced and modernized rural community in Malaysia and that the Muda Scheme, as a pioneer, will set a good example, taking the lead in the project of this type.

The survey team extends its sincere gratitude and appreciation to the officials of EPU, FAMA and MADA for their unlimited cooperation and support extended to the team during its stay in Malaysia. The team fears that the efforts of the survey team may have fallen short of the expectations of these officials.

EPU :	Economic Planning Unit
FAMA:	Federal Agricultural Marketing Authority
MADA:	Muda Agricultural Development Authority
MAF:	Ministry of Agriculture and Forestry, Government of Japan
OTCA :	Overseas Technical Cooperation Agency

Design of Paddy Drying and Storage Complex

1. Requirements for the Design of Paddy Drying and Storage Complex

Drying and storage of paddy are greatly influenced by weather conditions such as air temperatures, relative humidity, rainfall and also by paddy conditions such as harvesting period and method and the moisture content of the grains.

(1) Weather Conditions

i) Air Temperatures

The air temperature is closely related to paddy storability, heating requirement for drying and the cooling effect after drying. Table 1 shows monthly mean, maximum and minimum air temperatures during a 5-year period from 1965 to 1969. It is known from the Table that the annual average temperature is about 27°C and that the monthly fluctuation is within the range of ± 1°C and the air temperature is almost constant throughout the year. The range between maximum and minimum temperatures in a day is 9°C on the annual average, which is regarded rather small.

Table 2 shows the daily mean, maximum and minimum temperatures and mean temperature of daytime and nighttime in relation to paddy harvest during off-season, from July to August. Fig. 1 illustrates the frequency distribution of the air temperature. According to the graph, the maximum is 31 - 33°C, the minimum 23 - 24°C and the mean 27 - 28°C, showing a comparatively small variation.

As the air temperature is high and the range between maximum and minimum temperature is small, special care must be exercised when storing paddy of high moisture content in the temporary storage tank immediately after harvesting.

Assuming that the air temperature of dryer must be kept at 45°C, it is necessary to heat the open air to 13 - 15°C in daytime and 21 - 22°C at night, on the average of 17 - 18°C.

If the open air is to be used for cooling of paddy after drying, it is possible only during daytime because of the high humidity of the air at night. In view of the mean temperature of daytime shown in Table 2, the minimum temperature to which the paddy may be cooled is 30 - 32°C. From Table 2 and Fig. 1 it is evident that the air temperature in July is slightly higher than in August though slight variations are seen in each year.

ii) Relative Humidity

Relative humidity also influences paddy drying, moisture absorbability and paddy storability. Table 3 and Fig. 2 indicate the monthly mean, maximum and minimum humidity for the 5 year period from 1965 to 1969. (mean humidity only for '68 - '69). While the monthly variation of the maximum relative humidity is small, the mean and minimum relative humidity decrease during the dry season from December to March, by about 10%. Fig. 3 shows the range and the frequency distribution of minimum and mean relative humidity in July and August (off-season) of 1969.

Table 1 Monthly air temperature, 1965 - 1969

Alor Star

Year / Month	1965				1966				1967				1968				1969			
	Mean	Max	Min	Range	Mean	Max	Min	Range	Mean	Max	Min	Range	Mean	Max	Min	Range	Mean	Max	Min	Range
Jan	25.6	32.4	19.6	12.8	26.5	31.9	22.2	9.7	25.8	31.0	21.9	9.1	26.5	33.0	21.5	11.5	26.8	33.1	22.3	10.8
Feb	27.3	34.0	22.2	11.8	27.6	34.0	22.4	11.6	26.8	32.9	21.8	11.1	27.6	34.9	21.0	13.9	27.5	34.2	22.2	12.0
Mar	27.5	34.0	22.8	11.2	27.7	33.7	23.1	10.6	27.9	34.8	22.1	12.7	28.0	34.8	22.8	12.0	28.0	35.4	22.8	12.6
Apr	27.4	33.1	23.6	9.5	28.2	33.9	24.2	9.7	27.4	33.8	23.2	10.6	27.9	34.3	23.4	10.9	28.4	34.7	23.8	10.9
May	27.6	32.1	24.0	8.1	27.5	31.7	24.2	7.5	27.6	32.6	24.2	8.4	27.5	32.6	24.0	8.6	28.3	33.4	24.6	8.8
Jun	27.5	32.0	24.0	8.0	27.5	32.1	23.9	8.2	27.1	31.5	23.8	7.7	27.4	32.2	24.0	8.2	27.2	31.8	24.1	7.7
Jul	26.9	31.5	23.3	8.2	27.0	31.3	23.5	7.8	27.0	31.5	23.7	7.8	27.2	31.2	24.0	7.2	27.3	31.9	23.9	8.0
Aug	26.7	31.2	23.3	7.9	27.2	31.5	23.7	7.8	27.1	31.2	23.8	7.4	26.5	31.1	23.2	7.9	27.0	31.8	23.6	7.8
Sep	26.5	30.9	23.3	7.6	26.8	31.4	23.3	8.1	26.9	31.1	23.6	7.5	26.7	30.8	23.4	7.4	27.1	31.2	23.9	7.3
Oct	26.3	31.3	23.2	8.1	26.5	31.2	23.3	7.9	26.1	30.7	23.1	7.6	26.4	31.2	23.3	7.9	26.3	31.3	23.3	8.0
Nov	26.3	31.3	23.1	8.2	26.1	31.3	22.8	8.5	26.3	31.5	22.9	8.6	26.9	33.2	22.2	11.0	25.8	30.2	23.3	6.9
Dec	25.9	30.7	22.6	8.1	26.1	31.1	22.8	8.3	26.1	31.3	21.7	9.6	26.5	32.2	22.6	9.6	26.3	31.8	22.4	9.4
Mean	26.8	32.0	22.9	9.1	27.1	32.1	23.3	8.8	26.9	32.0	23.0	9.0	27.1	32.6	23.0	9.7	27.2	32.6	23.4	9.2

Note : Each figure is the arithmetic mean of daily temperature

Table 2 Daily air temperature in July & August, 1969

Alor Star

Day	July							August						
	Mean	Max	Min	Range	Mean Temp. Daytime	Mean Temp. Night	Range	Mean	Max	Min	Range	Mean Temp. Daytime	Mean Temp. Night	Range
1	27.3	31.6	23.4	8.2	29.9	24.7	5.2	28.1	329	23.9	90	31.8	25.0	6.8
2	26.7	30.1	23.4	6.7	29.0	24.8	4.2	26.3	30.4	24.2	6.2	282	24.8	3.4
3	28.2	32.8	24.4	8.4	31.6	25.0	6.6	27.6	32.4	23.3	9.1	31.7	256	6.1
4	27.0	30.8	24.6	6.2	292	25.3	39	266	30.7	23.4	7.3	29.1	243	4.8
5	26.1	29.0	239	5.1	27.2	24.6	2.6	27.3	32.0	23.3	87	30.6	24.2	64
6	26.2	31.7	23.3	8.4	29.3	239	5.4	282	32.7	24.0	8.7	31.3	25.0	6.3
7	27.3	32.5	230	9.5	30.9	238	7.1	27.5	32.4	24.1	83	31.0	248	6.2
8	28.3	32.2	24.4	7.8	31.4	25.4	60	27.2	329	24.3	8.6	31.2	24.8	6.4
9	27.5	31.3	23.5	7.8	310	24.7	6.3	27.0	31.8	235	8.3	30.2	242	60
10	27.9	33.2	234	98	31.8	24.4	7.4	27.6	32.1	23.3	8.8	31.2	24.4	6.8
11	26.2	29.5	24.4	5.1	27.0	24.8	22	28.1	32.7	24.0	8.7	31.4	25.1	6.3
12	27.5	323	23.2	9.1	296	24.0	5.6	27.9	332	239	9.3	31.4	251	6.3
13	28.8	33.8	24.0	98	32.2	24.9	7.3	26.3	32.0	239	8.1	30.0	24.3	5.7
14	28.3	32.4	23.9	8.5	31.3	252	61	25.4	32.6	232	9.4	29.2	23.6	56
15	28.7	331	24.6	85	320	254	6.6	27.0	324	228	9.6	305	23.7	6.8
16	28.0	31.7	25.0	67	308	25.9	4.9	27.1	32.3	24.1	82	30.7	24.7	6.0
17	27.9	32.8	24.3	8.5	30.7	252	55	267	31.7	23.1	8.6	300	24.1	5.9
18	25.9	29.1	24.2	4.9	27.9	25.0	2.9	26.6	31.2	23.7	7.5	298	24.0	58
19	24.8	307	22.6	8.1	277	23.3	4.4	254	306	22.8	7.8	28.9	23.2	5.7
20	25.9	31.2	22.4	8.8	28.5	230	5.5	268	30.7	23.0	7.7	296	23.7	59
21	25.9	33.2	239	9.3	28.1	24.3	3.8	27.1	30.7	24.5	6.2	29.7	25.1	46
22	27.3	33.5	236	9.9	30.7	243	6.4	27.2	31.3	23.8	7.5	30.2	24.4	5.8
23	27.7	31.9	240	7.9	31.0	24.9	6.1	26.2	31.8	24.3	7.5	295	25.0	4.5
24	27.9	32.6	24.0	8.6	31.8	24.5	7.3	267	32.1	223	9.8	30.2	23.4	6.8
25	27.9	32.5	23.7	88	31.7	24.4	7.3	27.2	31.8	24.4	7.4	29.9	250	4.9
26	28.0	32.9	23.9	9.0	320	24.6	7.4	27.1	31.2	24.1	7.1	29.8	24.5	53
27	28.1	32.6	24.0	8.6	31.7	24.6	7.1	26.7	30.2	23.3	6.9	29.0	23.5	55
28	28.1	33.1	24.1	9.0	30.5	24.3	62	26.7	30.2	24.5	5.7	28.3	25.3	30
29	27.9	31.8	24.4	7.4	30.7	25.3	5.4	27.2	31.3	235	7.8	30.4	24.7	5.7
30	28.2	32.5	24.3	8.2	30.7	25.4	5.3	265	31.3	22.9	8.4	29.1	24.3	4.8
31	27.2	32.1	23.0	9.1	30.5	24.0	65	27.0	31.4	230	8.4	300	24.0	6.0
Mean	27.4	32.0	23.8	8.2	30.3	24.6	5.7	27.0	31.7	23.6	8.1	30.1	24.4	5.7

Note : Mean temperature during 10:00 - 17:00 and 0:00 - 7:00 were used for daytime and right, as the temperatures in these time zone were considered to be static.

Table 3 Monthly relative humidity, 1965 - 1969

Alor Star

Year / Month	1965				1966				1967				1968	1969	Mean			
	Mean	Max	Min	Range	Mean	Max	Min	Range	Mean	Max	Min	Range	Mean	Mean	Mean	Max	Min	Range
Jan	69.6	94.3	41.1	53.2	77.6	96.0	52.9	43.1	79.8	96.4	55.9	40.5	70.3	79.0	75.3	95.6	50.0	45.6
Feb	72.0	93.8	41.7	52.1	73.7	95.4	45.6	49.8	70.9	92.5	44.7	47.8	66.3	73.9	71.4	93.9	44.0	49.9
Mar	74.0	94.0	43.6	50.4	78.3	96.5	49.2	47.3	71.0	95.1	39.3	55.9	70.6	75.6	73.9	95.2	44.0	51.2
Apr	81.6	95.7	54.9	40.8	81.1	97.0	54.6	42.4	81.0	97.9	50.8	47.1	78.2	77.1	79.8	96.9	53.4	43.4
May	82.9	96.3	61.5	34.8	85.2	97.8	65.5	32.3	83.6	97.9	59.9	38.0	83.2	82.3	83.4	97.3	62.3	35.0
Jun	82.4	96.5	60.6	35.9	82.6	97.8	60.6	37.2	84.6	98.3	62.3	36.0	83.0	85.3	83.6	97.5	61.2	36.4
Jul	83.0	97.4	61.6	36.3	83.7	97.4	63.0	34.4	83.3	97.8	61.2	36.7	83.6	82.8	83.3	97.5	61.9	35.8
Aug	84.8	97.2	63.5	33.7	83.5	97.2	63.0	34.2	83.2	97.6	62.4	35.2	86.0	83.9	84.3	97.3	63.0	34.4
Sep	86.2	97.0	65.3	31.7	85.2	97.4	63.8	33.6	84.1	98.2	62.0	36.1	85.9	84.6	85.2	97.5	63.7	33.8
Oct	87.4	97.6	63.9	33.8	86.7	97.6	64.5	33.1	87.1	97.5	63.9	33.6	86.3	87.5	87.0	97.6	64.1	33.5
Nov	86.4	97.5	62.6	34.9	86.5	97.6	61.7	36.1	83.9	97.5	58.6	38.9	80.2	88.2	85.0	97.5	61.0	36.6
Dec	84.8	97.7	63.1	34.6	85.3	97.8	60.2	37.8	74.9	94.2	52.5	41.7	79.3	79.2	80.7	96.6	58.6	38.0
Mean	81.3	96.3	56.9	39.3	82.5	97.1	58.7	38.4	80.6	96.7	56.1	40.6	79.4	81.6	81.1	96.7	57.3	39.4

Note : Each figure is the arithmetic mean of daily relative humidity

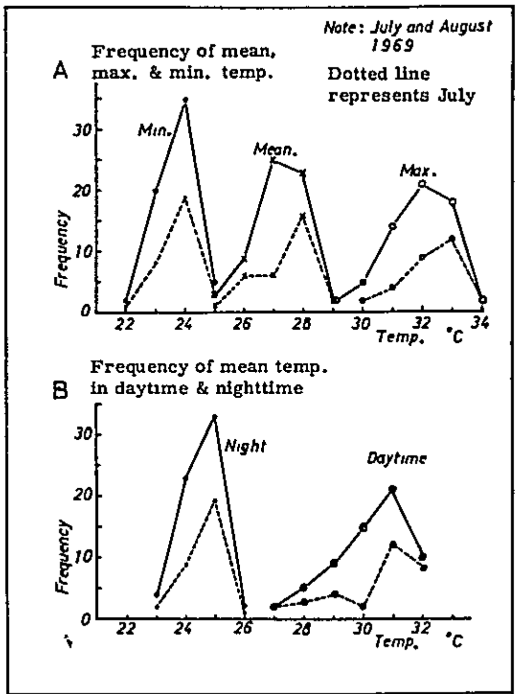


Fig. 1 Frequency distribution of daily air temperature in July & August

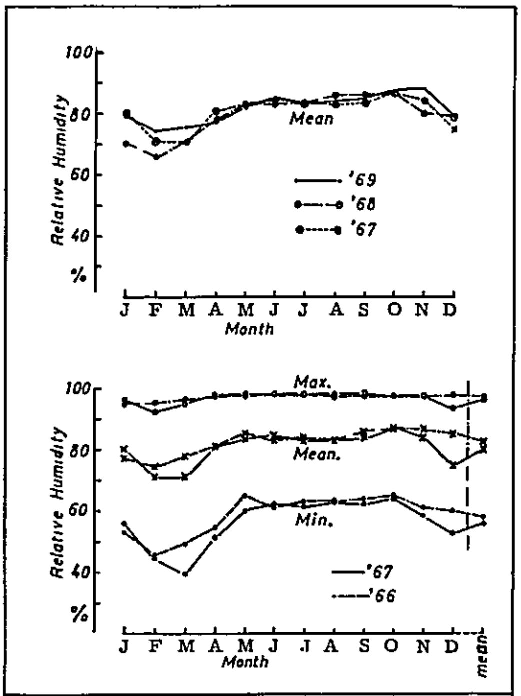


Fig. 2 Monthly values of relative humidity, 1966 - 1967

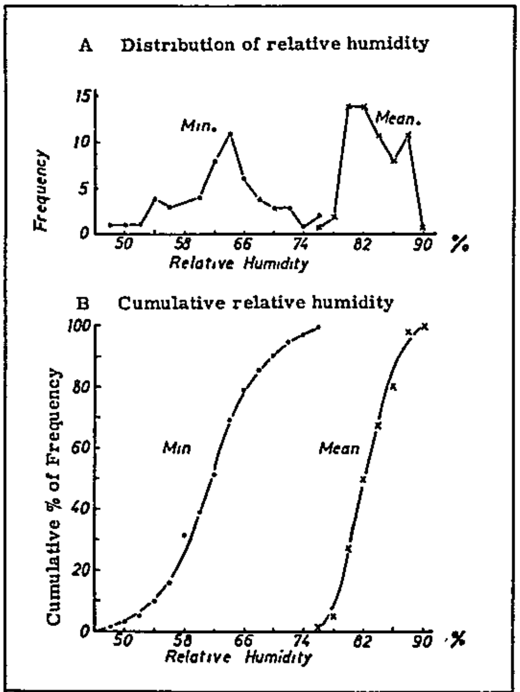


Fig. 3 Frequency distribution of relative humidity in July & August, 1969

While the mean humidity has a very small variation ranging from 80% to 88%, the minimum humidity has a wide variation ranging from 48% to 76%. This illustrates the fact that the climatic change is quite conspicuous. (See Fig. 3-B).

Assuming that the air temperature after heating is 45°C, the humidity in the dryer is estimated at about 30% when the mean temperature and humidity in July and August are taken into consideration.

When warm paddy just taken out of the dryer is cooled down by the open air containing high humidity, the paddy quickly absorbs moisture. Therefore appropriate time zone of low relative humidity must be chosen for cooling. From Fig. 4 it is known that the maximum relative humidity at which the paddy with 14% of moisture content stops absorbing moisture is about 75%. The available time zone in a day on the basis of this standard is shown in Fig. 5. Fig. 6 shows the available time zone in the drying operation period in July and August. According to the diagram, the available time zone for cooling is from 10:00 to 18:00, approximately 7 hours on the average of two-months. If slight absorption of moisture is allowed and the humidity limit is raised to 80%, available time zone for cooling operation expands to 9 hours on the average of two months as shown in Fig. 7.

In order to operate the dryer continuously, a certain period of time must be secured everyday for cooling. But the necessary period of time is not always available owing to the changes in the weather conditions. Fig. 8 shows the hours of each day in which relative humidity is less than 75% or 80% and their frequency distribution for 1969. If the maximum allowable humidity is to be 75%, the operation of dryer must be suspended in 2 days during a month. The number of days in which operation is disturbed varies depending on the specified maximum allowable humidity and the number of hours to be maintained in a day as the minimum cooling time. Assuming that at least 3.5 hours are to be maintained in a day and the maximum allowable humidity is 75%, a total of 10 days are disturbed during July and August. But when the limit is raised to 80%, the whole period is available for operation. However, consideration must be given to the fact that the relative humidity differs from year to year.

iii) Rainfall

Time and the amount of rainfall affect harvesting and drying operation, as well as the moisture content of paddy. Table 4 and Fig. 9 show monthly precipitations in the period from 1965 to 1969. Fig. 10 which has been used as the standard chart of double cropping for the Muda Irrigation Scheme, shows less rainfall in the dry season than in Table 4.

Fig. 9 shows precipitations during a five year period in a cumulative bar graph in an effort to obtain clear idea on annual variations. It is not appropriate to make any judgement from normal rainfall, only.

The changes of precipitation in July and August at Alor Star in a 5 year period and Telok Chengai in a 21 year period, are tabulated in Table 5, which reveals a wide variation between maximum and minimum rainfall ranging from 66 mm to 352 mm in the former and from 66 mm to 474 mm in the latter, though the average precipitations are 217 mm and 231 mm respectively.

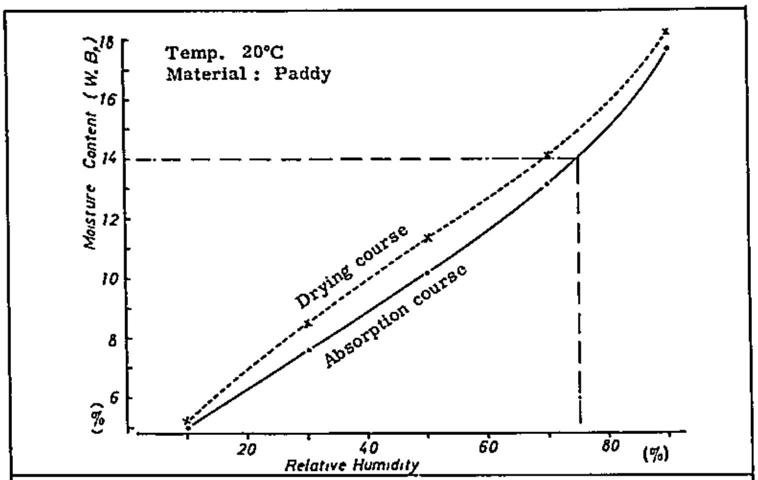


Fig. 4 Equilibrium between relative humidity and grain moisture

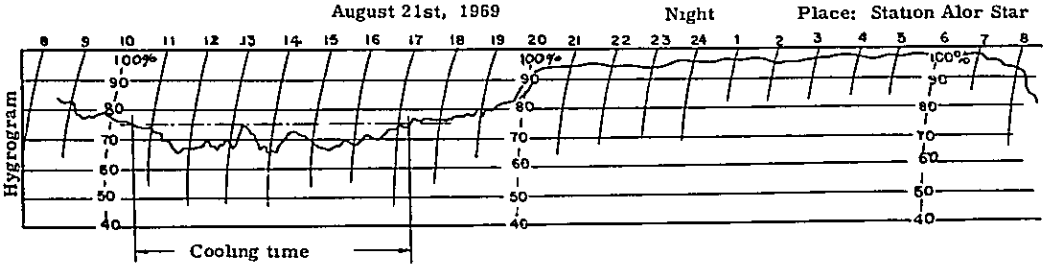


Fig. 5 Typical example of hygrogram

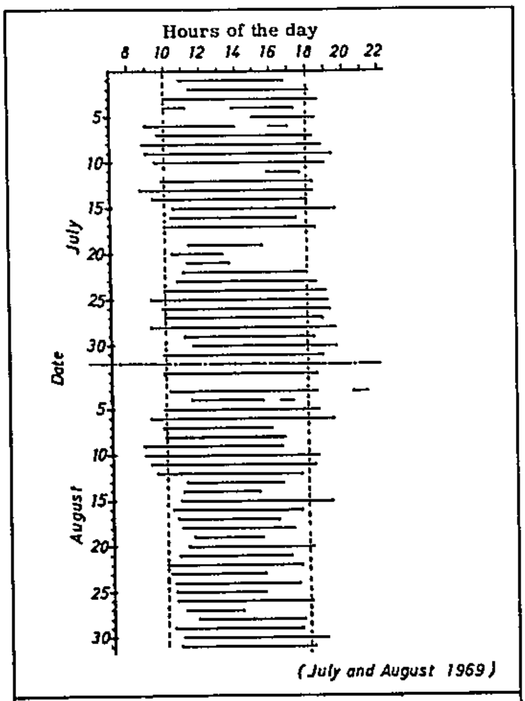


Fig. 6 Time-zone while relative humidity is below 75%

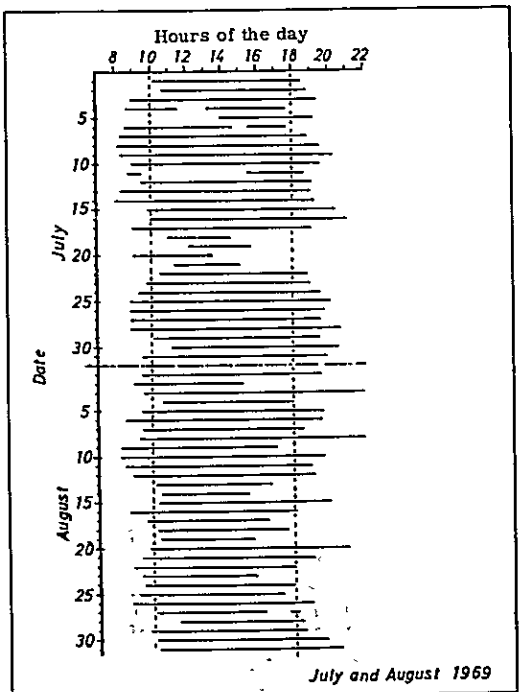


Fig. 7 Time-zone while relative humidity is below 80%

Table 4 Monthly precipitation, 1965 - 1969

Alor Star

Year / Month	1965	1966	1967	1968	1969	Mean
Jan	0	58.9	124.7	0	258.3	88.4
Feb	41.4	141.5	4.8	33.8	37.1	51.7
Mar	182.4	193.5	60.5	96.0	109.5	128.4
Apr	335.8	128.5	239.8	116.8	143.5	192.9
May	157.5	312.7	333.5	217.7	164.1	237.1
Jun	106.2	247.9	366.0	200.7	303.0	244.8
Jul	211.3	186.7	154.9	250.4	66.5	174.0
Aug	244.9	246.4	220.7	237.7	352.3	260.4
Sep	288.3	212.6	220.5	301.0	153.2	235.1
Oct	385.6	254.3	393.4	227.4	401.1	332.4
Nov	196.6	141.0	134.4	43.9	328.7	168.9
Dec	254.8	193.5	11.7	89.7	13.7	112.7
Mean	200.4	193.1	188.7	151.3	194.3	185.6

Unit : mm

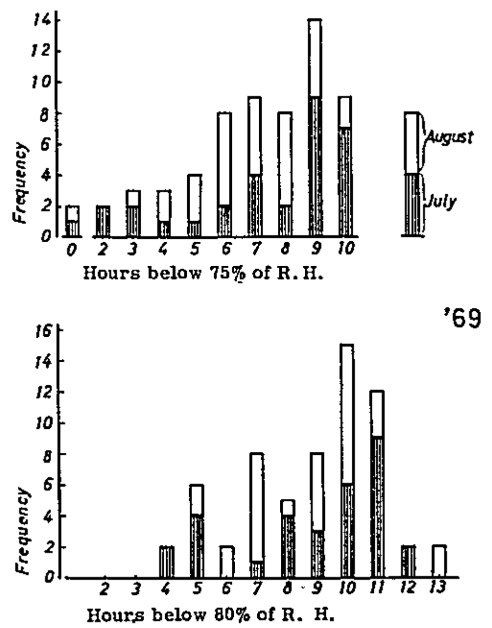


Fig. 8 Frequency distribution of hours below 75% or 80% of relative humidity

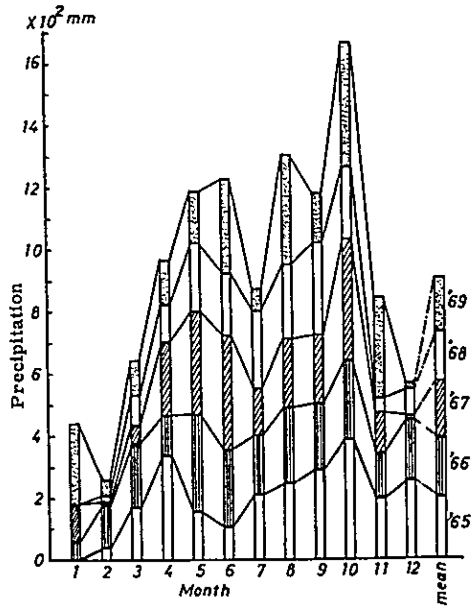


Fig. 9 Precipitation in 1965 - 1969 (Cumulative)

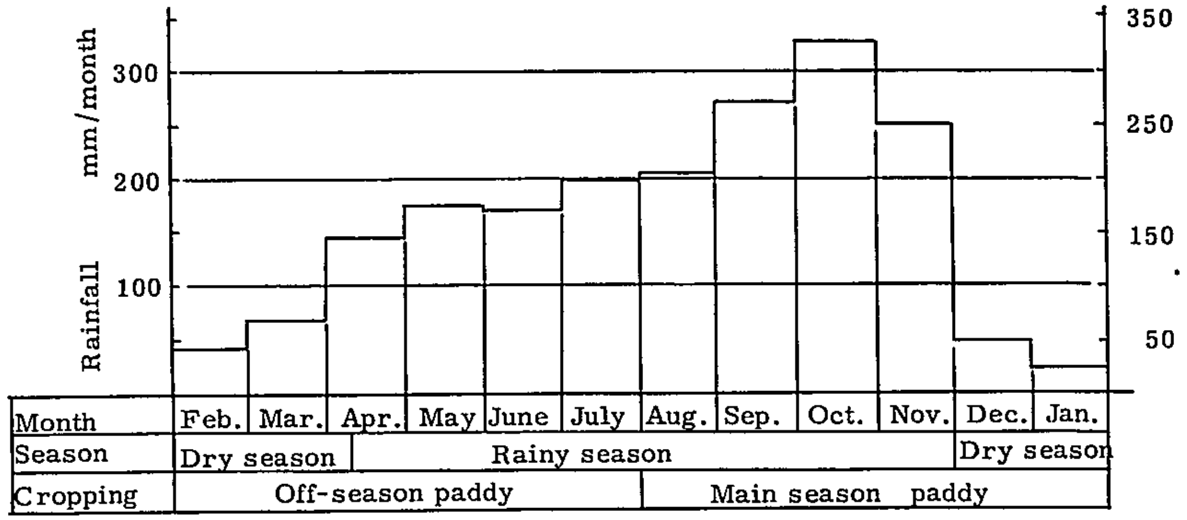


Fig. 10 Standard chart of double cropping for the Muda Irrigation Scheme

Table 5 Frequency distribution of monthly precipitation in July & August

Precipitation / Place, Year	51 – 100	101 – 150	151— 200	201 – 250	251 – 300	301 – 350	351 – 400	401 – 450	451 – 500	Mean	Max	Min
										mm	mm	mm
Alor Star 1965–1969	1	0	2	5	1	0	1	0	0	217	352	66
Telok Chengai 1948–1968	4	3	10	8	10	3	2	1	1	231	474	66

Table 6 Moisture extraction tests on paddy by sun-drying (1970)

	Conditions		Moisture content		Drying hours	Drying speed	Refference
	Time	Weather	Raw	Dried			
A	10:30–15:30	fair	20.0%	8.0%	5.0 hr.	2.40%/hr	
			19.3	9.0	5.0	2.06	Harvested
	13:00–16:30		21.0	11.0	3.5	3.25	in early June
B	9:00–17:00	slighly cloudy	19.7	12.2	8.0	0.94	On concrete floor
			19.6	12.8	8.0	0.85	On jute mats laid on lawn
C	10:00–14:00	fair	23.8	14.0	4.0	2.45	Harvested
			14.0	10.0	4.0	1.00	in early July
D	9:30–15:30		25.4	19.4	6.0	1.00	Harvested in late Aug..

(From Fig 13 & 14)

As the rainfall at time of harvesting has a great influence on farm operation and sun-drying, it is imprtant to know the rainfall time zone. Fig. 11 shows the rainfall time zone in July and August of 1969. Assuming that the harvesting and sun-drying time is mainly from 10:00 to 16:00, the number of days in which it rains in this particular time zone is 8 days (total rain day; 14) in July and 1 day (total rain day; 19) in August. Insignificant rainfall was excluded from the calculation.

Rainfall in this region has a tendency to concentrate in the time zone from 4 p.m. to early morning of the next day. Though there may be some variations with each year, the local people point out this tendency quite affirmatively. Therefore, the time zone from 10:00 to 16:00 may be secured as operation time.

Fig. 12 shows the total precipitation of a day corresponding to Fig. 11. Duration of rainfall averages 2 - 3 hours per one time and the amount of rainfall averages about 10 mm, but heavy rains are seen sometimes. As it clears up after the rain, the relative humidity decreases to about 60% and the paddy which get wet in the rain may also be dried.

(2) Sun-drying and Temporary Storage

i) Sun-drying

Since the weather in the day time is comparatively fair even in the rainy season of July and August, as mentioned above, sun-drying may be employed as the preliminary drying when appropriate spaces are available. The results of the experiment conducted at the Telok Chengai Paddy Experiment Station on the paddy harvested at Penang in early June are shown in Fig. 13. It shows that drying under a good weather condition is very rapid. The reason for this good result which seems to be better than actual drying speed is that in the experiment the paddy was spread on the concrete floor, 50 cm x 50 cm in area in a layer of slightly less than 2 cm in thickness.

The customary paddy drying method used by the farmers is to spread paddy on jute mats laid along the farm roads. The comparison of this drying method with that using a concrete floor is shown in Fig. 14-B, from which it is evident that drying on the concrete floor is faster than the other method by 1%. The weather condition at time of this drying experiment was slightly cloudy and accordingly, the paddy temperature did not exceed 40°C and the drying speed was nearly a half of the speed in the experiment shown in Fig. 13. The results of sun-drying of paddy harvested in Kedah State in early July and late August, obtained by Mr. Takatsugu Horiuchi, a Japanese student in Malaysia are shown in Table 6 and Fig. 14-C. As the drying speed varies depending on the air temperature and the rate of rise in paddy temperature, the results obtained are similar to those for the paddy harvested in Penang in early June.

Sun-drying method is very effective if spaces for drying are provided. But under the existing circumstances that a farm road is provided very sparsely, it is extremely difficult to secure open upland spaces for sun-drying. Therefore the need for paddy drying complexes is keenly felt. As annual fluctuation of rainfall is quite conspicuous, as shown in Fig. 9, it is essential to prepare for the worst.

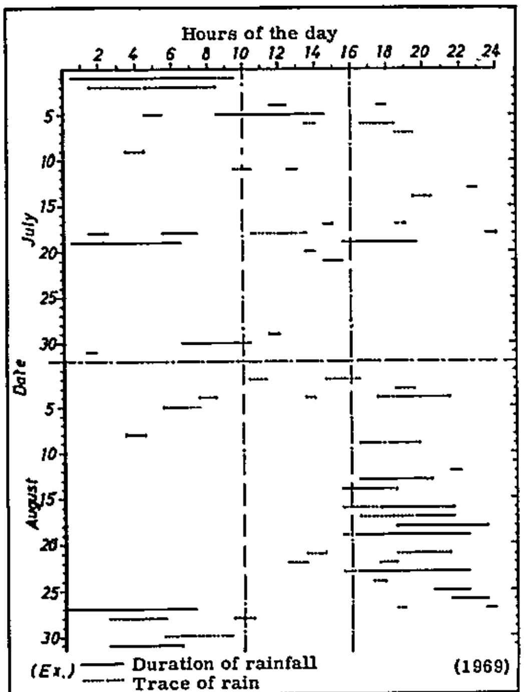


Fig. 11 Duration of daily rainfall in July & August

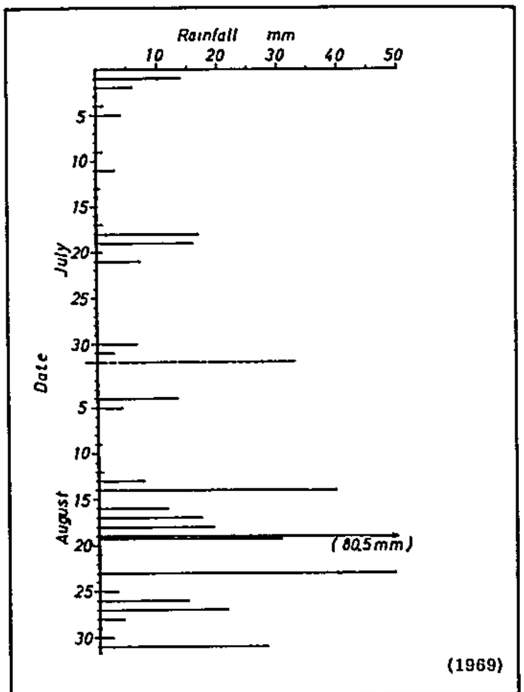


Fig. 12 Distribution of daily rainfall in July & August

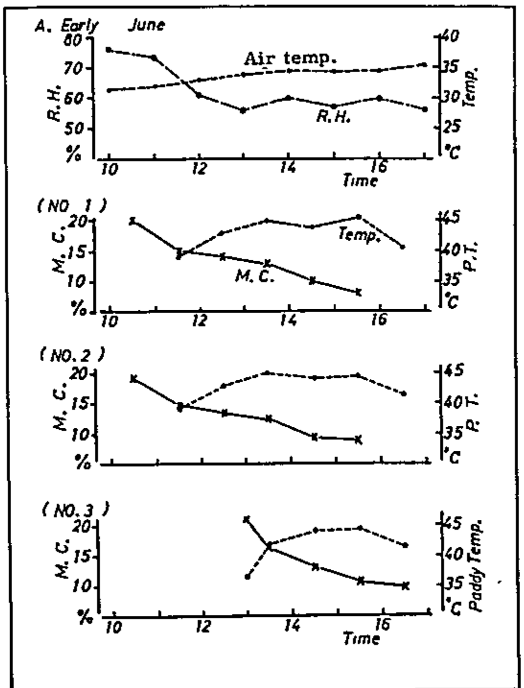


Fig. 13 Results of the test on paddy sun-drying (1)

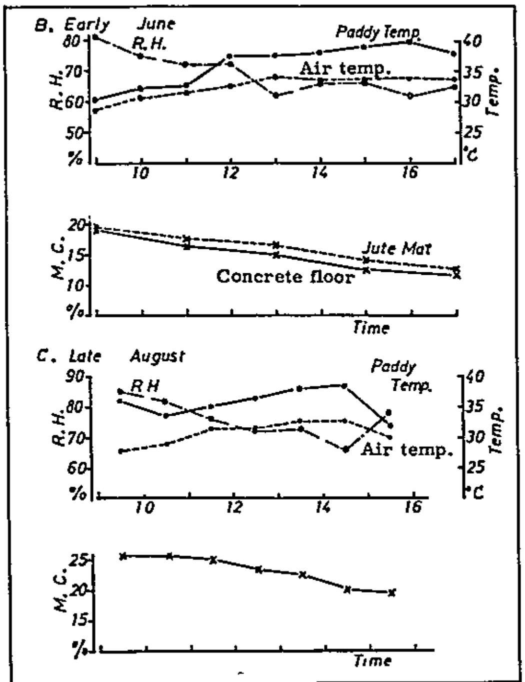


Fig. 14 Results of the test on paddy sun-drying (2)

ii) Temporary Storage

After threshing, the raw paddy is packed in gunny bags for the convenience of transportation. It is conceivable, however, that the raw paddy in bags is left for 2 or 3 days before they are carried in to the complexes. Paddy with high moisture content packed in bags must be dried as soon as possible, because the quality of paddy deteriorates by fermentation or germination, if kept in the bag for a long period of time. Fig. 15 shows the paddy temperature in gunny bags which were exposed direct to the sun. It shows that the temperature of 36 - 37°C, which is higher than the air temperature, is always maintained in paddy bags. Therefore, care must be taken to prevent deterioration of paddy by avoiding storage of paddy under these conditions.

(3) Harvest Season and the Quantity of Transported Paddy

i) Harvest Season

Because of delays in the implementation of the initial plan in 1970, the harvest season seemed to have been from July to September. Smooth progress of the Muda Irrigation Scheme, however, will make it possible to harvest in July and August with a six-week net harvesting time. Consequently, the design of paddy drying and storage complexes must be based on this assumption.

ii) Daily Fluctuation of Quantity of Transported Paddy

In order to increase the total production of complexes, it is highly desirable that the uniform quantity of paddy is transported to the complexes daily. For this purpose, it is necessary to plan scheduled planting and harvesting which enables daily assembling of uniform quantity of paddy for 6 weeks. However, even when planting is carried out on schedule, it is anticipated that the weather and other factors may cause fluctuation of the quantity of transported paddy. Thus, by estimating the fluctuation in the quantity of daily transportation, the maximum quantity of daily drying operation may be determined.

Fig. 16 shows two cases (A_1, B_1) of fluctuation in the quantity of paddy transported. With the paddy drying complex, capacity of which is increased by 50% of the average production of the complex during the season, there is room even at the peak period with A_1 type, but the transported paddy have to be stored for about 10 day before drying with B_1 type. This is the reason scheduled planting, harvesting and assembling are so important.

iii) Hourly Fluctuations in the Transportation

It is presumed that the paddy will be purchased at the farmhouse and transported to the drying complexes by agents. As the purchase of paddy by the agents will take place mainly in the afternoon and the paddy will be transported to the complexes during the hours of 8:00 - 18:00 everyday, fluctuation in the quantity of transported paddy is anticipated as shown in Fig. 17. There are two peaks shown by the curve, one in the morning and the other in the afternoon. The former is for the paddy purchased late on the day before, the latter for the same purchased during the hours of 15:00 - 16:00 on that day. Since the drying operation will be carried out continously, but the transportation of paddy is limited to daytime, temporary storing yard or tanks must be provided.

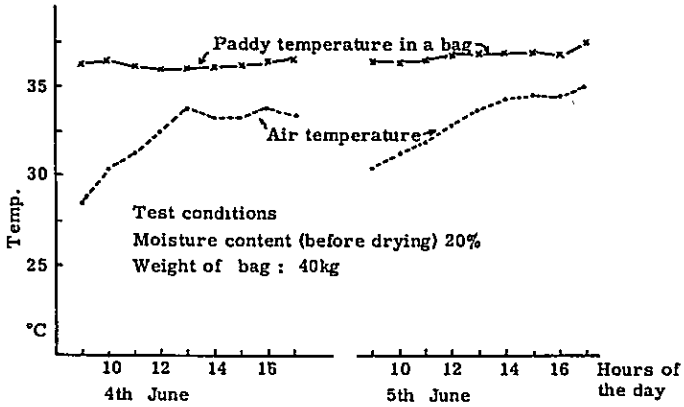


Fig. 15 Change of paddy temperature in gunny bag

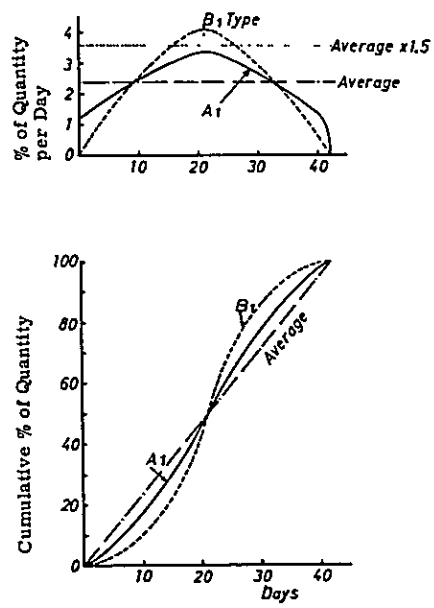


Fig. 16 Daily fluctuation in the quantity of paddy assembled

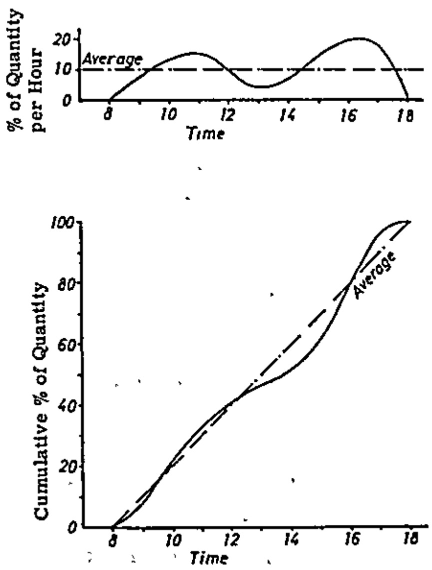


Fig. 17 Hourly fluctuation in the quantity of paddy assembled per day

(4) Requirements for the Paddy Transported to the Complexes

i) High Moisture Content

It is highly likely that wet paddy harvested in the fields, which has not been completely drained in off season, is transported to the complexes. Moisture content of the grains from standing hills in the harvest season is 22 - 23% as indicated in Table 7. There may be cases, however, in which the moisture content of the grains from lodged hills whose panicles were submerged in the water, rises to 28%. It must be anticipated, therefore, that the paddy with unfavorable moisture condition is brought into the complexes, which are designed originally to handle paddy with the moisture content of 22 - 23%.

ii) Differences in Moisture content

The degree of moisture content of the paddy transported to the complexes varies considerably depending on the weather and field conditions, harvest methods, etc. Where sun-drying is possible, preliminary drying may be given prior to the transportation. In another case, the paddy may get wet in the rain during transportation. Thus, the variation in the moisture content may be quite great and for this reason it is important to select the type of dryer which can treat paddy of varied moisture contents.

iii) Variation in Grain Quality

Grain quality varies each other depending on the paddy variety or cultivating method in general, however, deterioration of quality is likely to occur during temporary storage immediately after harvesting, when the moisture content of paddy is still high. Particularly in the field where each lot has a total area of more than 1,000 acres special care must be exercised, for it takes a quite long time to carry the paddy from the center of the ill-drained lot to the farm road.

Rice raised in Kedah has excellent quality and is only next to Thai rice. When Malaysia becomes self-sufficiency, Malaysia should secure rice having better quality than Thai rice. In order to achieve this objective, it is necessary to separate the paddy of good quality from that of poor quality before drying operation.

iv) Mixture of Straw and Immatured Paddy

Threshing is done mainly by beating method in the farm. After sun-drying, foreign matters are removed with the aid of a flat tray of plaited bamboo and natural wind. During off-season period, however, the paddy is not sun-dried thoroughly and it may contain a lot of broken straw and immatured paddy after threshing, thus causing mechanical failures of dryers. It is necessary, therefore, to equip the complexes with pre-cleaners.

2. Basic Requirements for Designing

For detailed design of the complex, it is necessary to clarify basic requirements. For this reason, the following criteria have been established in relation to machines and buildings.

(1) Machines

i) Size of Dryer and Storage House

The size of a complex is determined by the area of harvest, acre-yield, the degree of utilization of the complex by farmers, etc. In view of the traditional assembling and transportation methods employed in this region, complexes of large size but limited in number may cause deterioration of quality because of the time required to transport the paddy over a long way. In order to secure fast treatment of paddy, complexes with the smaller capacity are to be provided in dispersed locations as the first step. But they are so designed that the capacity may be increased as the utilization of the complexes by farmers increases. In this respect, the specification of the complex has been determined to be 2000 tons/6 weeks, as an unit.

The holding capacity of storage house is determined by the expected quantity of the paddy to be treated and by the shipping plan. It may vary depending on each planning: for instance, with the daily fluctuation with type A_2 shown in Fig. 18, the holding capacity must be 50% of the total quantity of the paddy received. And with type B_2, the holding capacity must be 70% of the same.

For this particular design the holding capacity has been specified to be a half of the total production of the complex, following the design of type A_2.

ii) Type and Holding Capacity of Dryer

The paddy transported to the complex is expected to have considerably different moisture content and quality.

If various kinds of paddy are treated in a continuous flow-dryer, they will be finished with different moisture content because of the difference in the initial moisture content and moreover, the paddy of poor quality may be mixed with that of good quality, thus making the whole quality inferior. For this reason, the Batch Type Dryer has been adopted, which can treat the paddy of different moisture content and different variety separately. The dryer of this type has advantages in that it may be operative with the feeding of a comparatively small amount of paddy but a number of dryers must be installed, requiring a large area for their installation.

The capacity of the dryer is to be determined on the basis of the loading capacity of a lorry. Assuming that the loading capacity of a lorry is 3 or 6 tons, the holding capacity of a dryer should be 5 tons, because the paddy may be of different moisture content or quality.

iii) Cooling Facility

Paddy temperature immediately after drying is presumed to be in the neighborhood of 40°C. The high temperature of paddy stored in a tank immediately after drying will not go down easily and will cause deterioration of the quality of paddy. It is important to send the paddy to the tank after cooling it down to about the same degree as the air temperature.

Two cooling methods are conceivable: One is to equip a special cooler and the other is to switch the dryer to a cooling bin by shutting off the burner. When the open air is introduced for cooling in any event, the operation

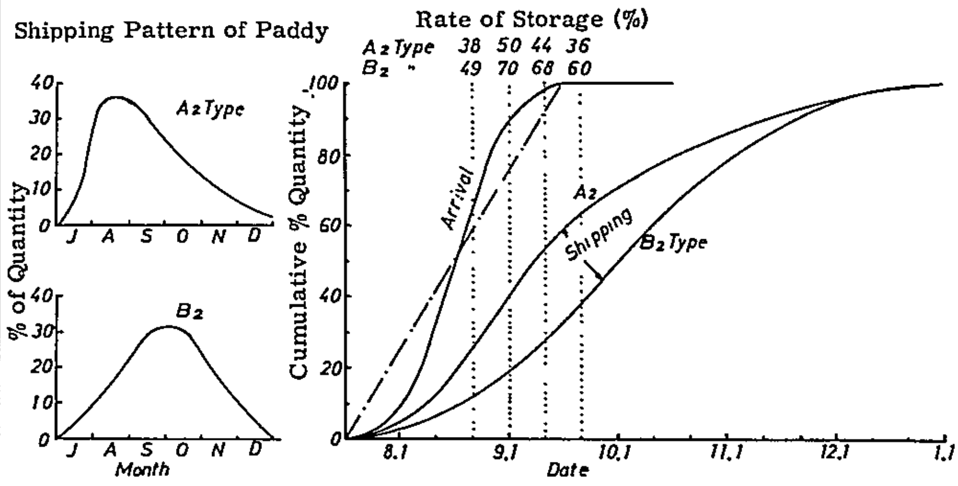


Fig. 18 Requirement of storage capacity of paddy, based on shipping pattern

Table 7 Examples of moisture content of paddy harvested in Kedah (1970)

No.	Harvest season and reference		Variety	Moisture content
1	Middle July		Ria Secondary	22.0%
2	- do -		C-4-63	23.8
3	Late July	(Top of panicle)	C-4-63	21.2
		(Middle of panicle)	C-4-63	21.4
		(Bottom of panicle)	C-4-63	22.0
4	- do -	(In gunny bag)	Mahsuri X IRS	20.4
5	Early August	(Standing hills)	Bahagia	19.6
		(Lodged hills)	Bahagia	21.8
6	Middle August	(Standing hills)	Bahagia	21.4
		(Lodged hills)	Bahagia	28.2
		(Bending hills)	Bahagia	22.8
7	Late August	(Kept in gunny bag for 3 days)	Bahagia	25.4

Note: Measurement was repeated 2 - 3 times on the same material. Measured by the infrared type (Kett F-1A) moisture content tester, by Mr. Takatsugu Horiuchi.

is restricted to daytime only as explained in Fig. 6-7. Therefore a well planned running schedule (mentioned later) must be established. Under this plan, both cases, are taken into consideration.

iv) Sorting Facility

As the transported paddy may contain foreign matters such as broken straw, immatured paddy and it is almost impossible for the agents to sort the paddy at time of purchasing under present conditions, pre-cleaners must be installed in the complexes. It is designed that all the transported paddy goes through pre-cleaners before it is fed into storage bin or dryer. On shipping paddy is sorted again by aspirators, because pre-cleaners are not sufficient to get rid of all the foreign matters. Dried paddy is easy to sort and this method is effective to maintain good quality.

v) Storage Unit and Handling of Paddy

Paddy is stored in the unit of 100 tons in order to prevent troubles or accidents and a mixture of paddy of different quality. Heaping height of paddy is restricted to 6 - 7 m in consideration of land bearing capacity.

For the handling of paddy, bulk handling is more advantageous from the stand point of economy in storage and transportation. However, the sales of paddy in bulk may cause inconvenience under the present system, and therefore sewing machines have been provided in the complex so that the paddy may be bagged for shipping.

vi) Distinction of Design

The moisture content of the most of transported paddy is considered to be around 23%, but a considerably large amount of paddy with the higher moisture content is also expected depending on the year and region. In addition, the facility of the complex varies greatly depending on whether special cooling bins are installed or the dryers are used as cooling bin.

A comparative study on 3 designs was made, each of which is to meet different moisture content, and different cooling method. (Table 8) As the only difference in these design is the number of dryers and pre-cleaners, and whether feeding bin and cooling bin are provided and the rest is more or less the same, the explanation is focused on the Design A.

(2) Buildings

i) Land Bearing Capacity

Land bearing capacity, though not studied well, presumed to be around 5.0 ton/m^2 on the basis of the results of some investigations. Since a high building increases the load per unit area and requires a considerable amount of investment for the work to strengthen land bearing capacity, the building was designed on a rather spacious plot.

ii) Underground Water

As the paddy field is water-logged in the rainy season and the level of underground water becomes very high in the area of the complex, careful measures must be taken to prevent the gushing of underground water in construct-

Table 8 Major differences among three designs

Description	Design A	Design B	Design C
1 Receiving Facility			
Receiving Hopper	2	4	4
Receiving Scale	2	4	4
Feeding Bin (with fun)	6(5.5 tons)	-	-
2 Drying Facility			
Standard speed of drying	1.10%/hr	0.53%/hr	0.90%/hr
Dryer	6	12	12
Spec. of fan			
Wind volume	$240m^3$/min	$150m^3$/min	$240m^3$/min
Static pressure	110mmAq	70mmAq	110mmAq
Power of motor	7.5 Kw	3.7 Kw	7.5 Kw
Cooling bin (with fun)	6 (5.5 tons)	-	-
Furnace	6	12	12
Max calorific value	150,000 Kcal/hr	90,000 Kcal/hr	150,000 Kcal/hr

Note: Differences on the related conveying facility are omitted.

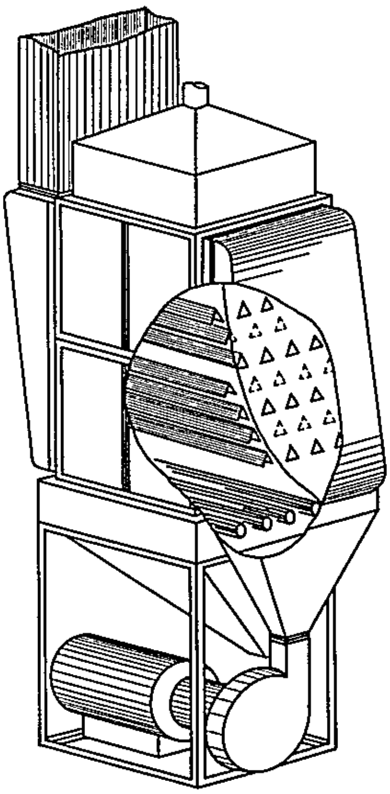


Fig. 19 Dryer

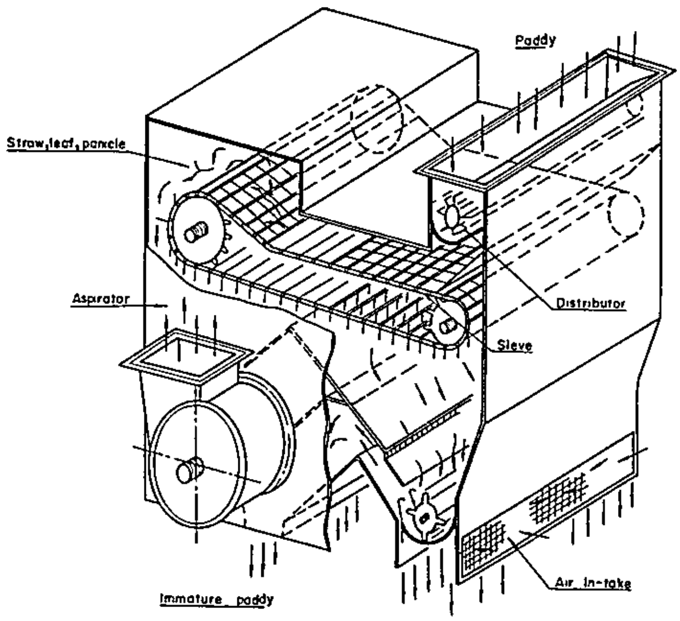


Fig. 20 Precleaner

ing the pit of elevators and feeding bin. In order to avoid the possible underground water, all the facilities in this report are designed not to go down more than 50 cm from the setting level of machines. In this context, a screw conveyor is employed for receiving the paddy and two-stage system is employed for belt conveyors.

iii) Requirements for Buildings

As any construction regurations were not given in Malaysia, the plan followed the Japanese standards by taking into consideration of the following conditions.

a) Maximum wind velocity is to be less than 30 m/sec.
b) No earthquake is to be expected.
c) Building is to be of open type as much as possible, for the drying facility causes a lot of dust.
d) Warehouse must be of the design which prevents rodents from coming in.

3. Design

(1) Flow Chart
See Figure 21 - 22

(2) Running Schedule
See Figure 23 - 25

(3) Description of Drying Facilities
i) Specifications table of the unit compex
See Table 9

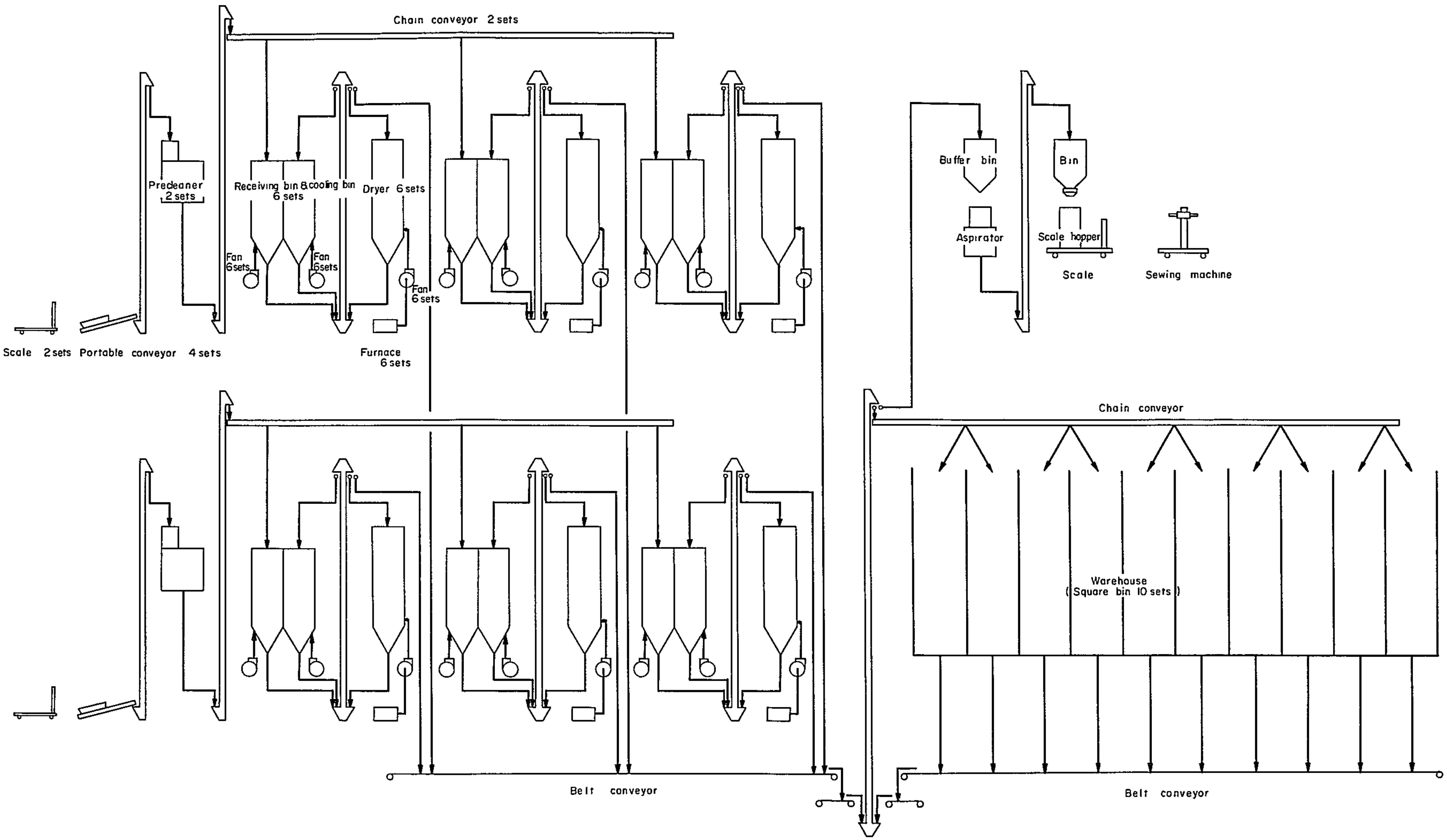


Fig. 21 Flow chart (Design - A)

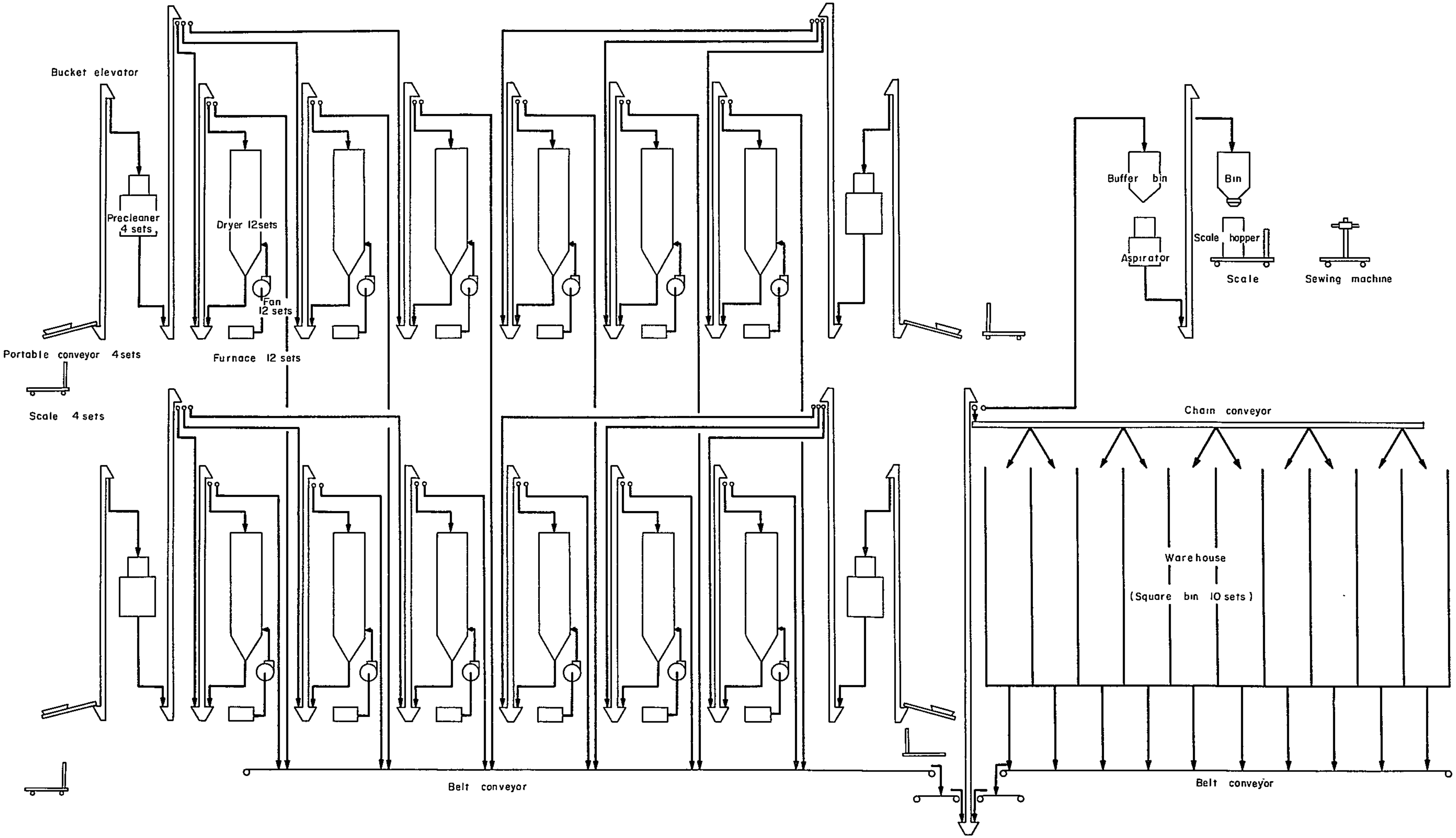


Fig. 22 Flow chart (Design – B & C)

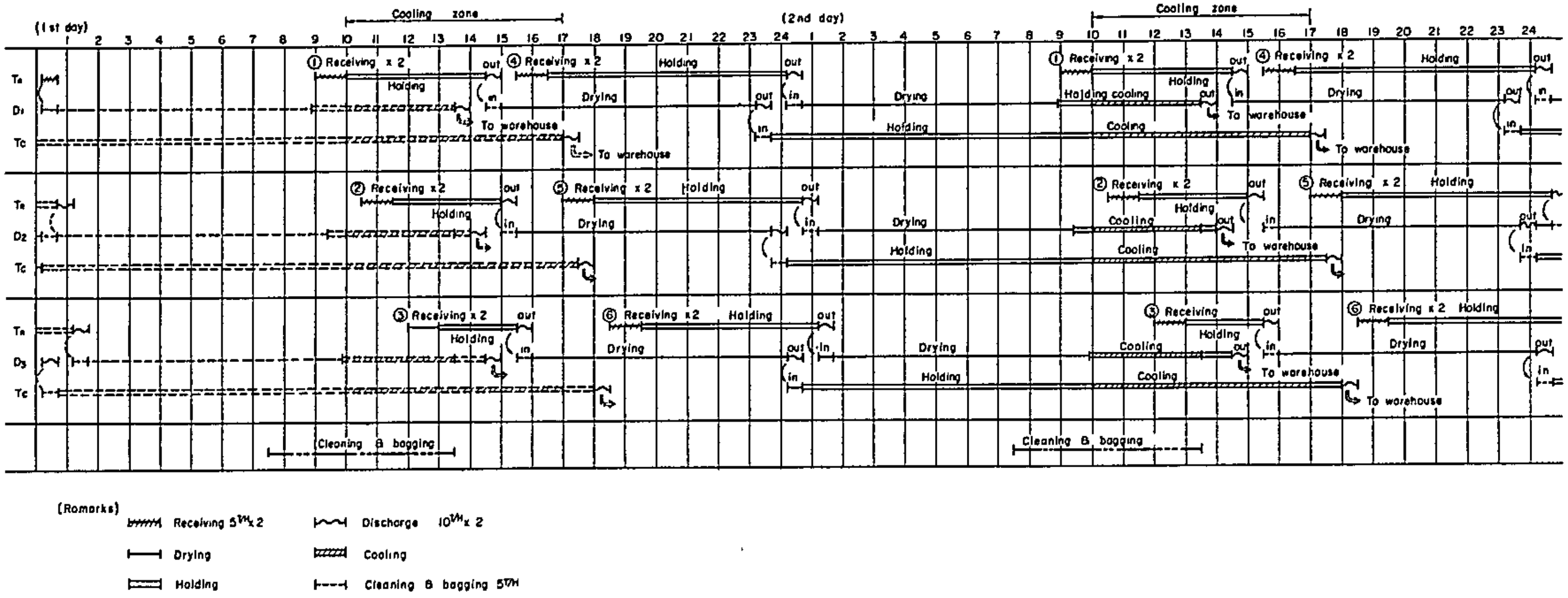


Fig. 23 Running schedule Design A (5^{TON} dryer x 6sets, 2rounds running)

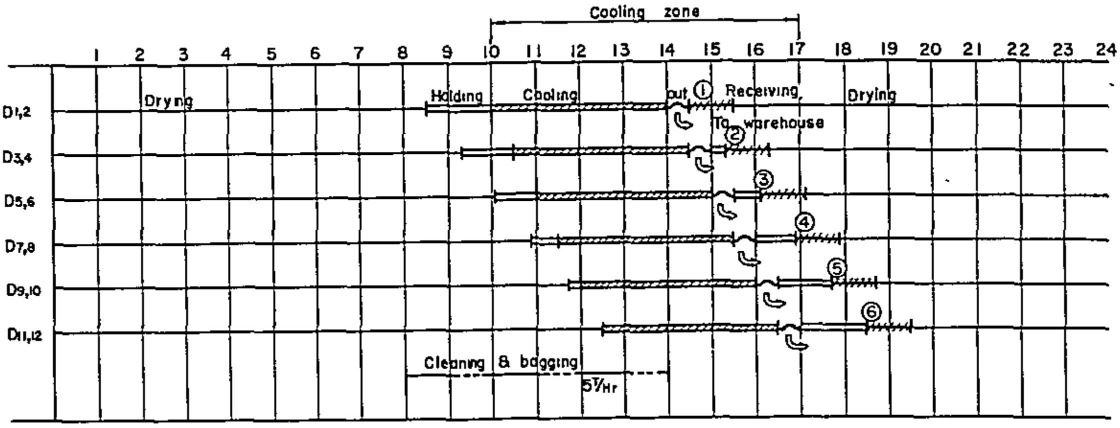


Fig 24 Running schedule Design B (5^{TON}dryer x 12 sets)

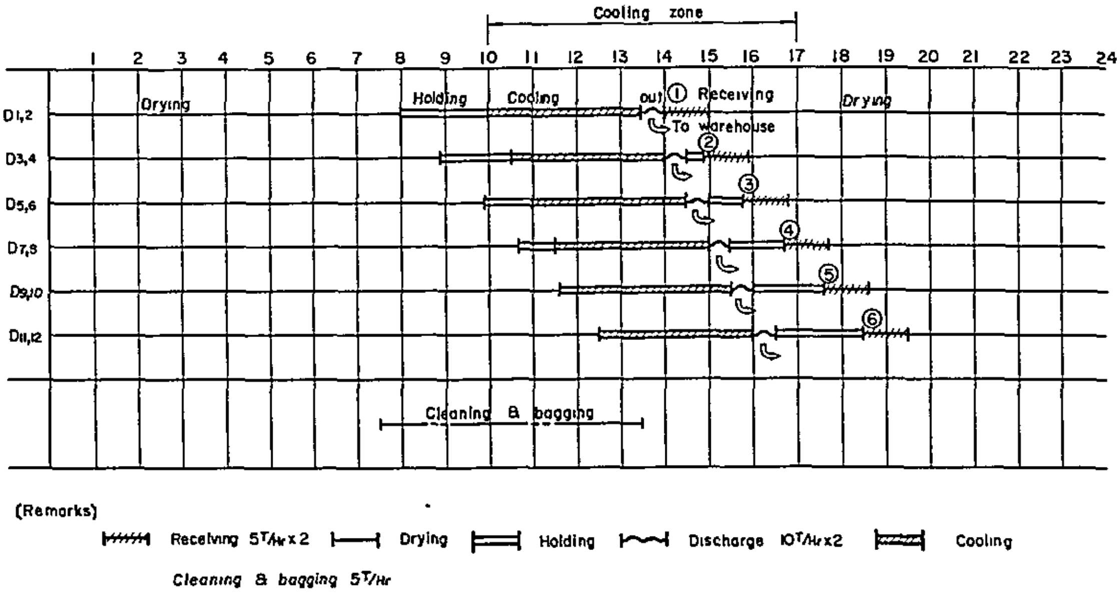


Fig. 25 Running schedule C (5^{TON}dryer x 12 sets)

Table 9 Specifications table of the unit complex

Item	Design A	Design B	Design C
1. Receiving Facility			
(1) Receiving Hopper			
Type	Steel made portable type	Same as A	Same as A
Capacity & number	$0.2m^3$ x 2	$0.2m^3$ x 4	$0.2m^3$ x 4
(2) Receiving Scale			
Type	Dial type platform scale	- do -	- do -
Weighing	500 kg	- do -	- do -
Accuracy	±1/1,000	- do -	- do -
Number	2	4	4
(3) Precleaner			
Type	Automatic turn-overed screen type (with winnower)	- do -	- do -
Performance	5 tons/hr.	- do -	- do -
Number	2	4	4
(4) Feeding Bin			
Type	Steel made angled square bottle	-	-
Capacity	5.5 tons	-	-
Number	6	-	-
Fan		-	-
Type	turbo-fan	-	-
Volume	$3.3m^3$/min.	-	-
Static pressure	120 mmAq	-	-
Motor	0.75 kw	-	-
Number	6	-	-
2 Drying Facility			
(1) Dryer			
Type	Vertical flow circulation type Hot air forced drying type (LSU type)	Same as A	Same as A
Capacity	5 tons	- do -	- do -
Moisture Extraction Rate	1.1%/hr	0.53%/hr	0.9%/h4
Number	6	12	12
Discharge Device	Rotary feeder, 10 tons/hr	Same as A	Same as A
Fan			
Type	Turbo-fan, #4,	Turbo-fan, #3 1.2	Turbo-fan, #4
Volume	240m /min.	150m /min.	240m /min.
Static pressure	110mmAq	70mmAg	110mmAg
Motor	7.5 kw	3.7 kw	7.5 kw
Number	6	12	12
(2) Cooling Bin			
Type	Steel made angled square bottle	-	-
Capacity	5.5 tons	-	-
Number	6	-	-
Fan			
Type	Turbo-fan	-	-
Volume	16.5 m	-	-
Static pressure	200mmAq	-	-
Motor	2.2 kw	-	-
Number	6	-	-
(3) Furnace			
Type	Holizontal direct burning (Kerosene)	Same as A	Same as A
Calorific Value	150,000kcal/hr. (Max.)	90,000kcal/hr. (Max.)	150,000kcal/hr. (Max.)
Number	6	12	12

(4) Oil Tank			
Capacity	30 Kl	Same as A	Same as A
Number	1	- do -	- do -
3. Storage Facility			
(1) Warehouse			
Type	Flat floor	Same as A	Same as A
Capacity & number	100 ton x 10	- do -	- do -
Dimension	11,500mm(W) x 40,000mm(L) x 7,000mm(H)	- do -	- do -
Other Devices			
Movable chute pipe	6	6	6
Discharge gate	30	30	30
Portable chute	1	1	1
Portable ladder	2	2	2
Operation passage	up-passage and down-passage	Same as A	Same as A
4. Final Process Facility			
(1) Aspirator			
Type	Automatic turn-overed screen type (with winnower)	Same as A	Same as A
Performance	5 tons/hr	- do -	- do -
Number	1	1	1
Accessories	Buffer tank	- do -	- do -
(2) Dried paddy scale			
Type	Auto-shatter	- do -	- do -
Scale Hopper	60 kg	60 kg	60 kg
Platform Scale	150 kg	150 kg	150 kg
Accessories	Clean paddy tank	- do -	- do -
(3) Sewing Machine			
Type	B - DS- 2D	- do -	- do -
Performance	200 - 300 bags (60kg)/hr.	- do -	- do -
5. Inspection Equipment			
(1) Moisture content meter			
Wet paddy Moisture meter			
Type and number	Infrared ray type x 4	- do -	- do -
Dried paddy Moisture meter			
Type and number	Electric resistance type x 4	- do -	- do -
6. Conveying facility			
(1) Screw conveyor			
Type	U-shaped traf	Same as A	Same as A
Diameter	200 mm	- do -	- do -
Pitch	200 mm	- do -	- do -
Revolution	60 rpm	- do -	- do -
Material	Steel Plate	- do -	- do -
Name	Performance Total Length No.	Performance Total Length No.	Performance Total length No.
Receiving Portable Conveyor	6 tons/hr. 2,000mm 2	6tons/hr. 2,000mm 4	6 tons/hr. 2,000mm 4
(2) Belt Conveyor			
Type	Rubber belt, carrier roller 2 phase type	Same as A	Same as A
Belt width	400 mm	- do -	- do -
Belt speed	45 m/min.	- do -	- do -

Name	Performance	Total L.	No.	Performance	Total L.	No.	Performance	Total L.	No.
Conv. to Warehouse (1)	24 tons/hr.	14,000 mm	1	24 tons/hr.	29,500 mm	1	24 tons/hr.	29,500 mm	1
Conv. to Warehouse (2)	24 "	2,600 mm	1	24 "	2,600 mm	1	24 "	2,600 mm	1
Conv. from Warehouse (1)	6 "	33,600 mm	1	6 "	33,600 mm	1	6 "	33,600 mm	1
Conv. from Warehouse (2)	6 "	8,600 mm	1	6 "	8,600 mm	1	6 "	8,600 mm	1

(3) Bucket Elevator			
Type	Centrifugal force dump and horizontal belt type	Same as A	Same as A
Bucket Size	200 mm (conveyors of receiving, bin, dryer, and relay)	200 mm (conveyors of receiving, and dryer)	200 mm (conveyors of receiving, and dryer)
	400 mm (conveyors of out and in or warehouse)	Same as A	Same as A
Belt speed	80 m/min. (on receiving, bin, dryer and relay)	80 m/min. (on receiving and dryer)	80 m/min. (on receiving and dryer)
	100 m/min. (conveyors for in and out of warehouse)	Same as A	Same as A
Materials	Belt: Rubber, Frame: Steel plate	- do -	- do -

Name	Performance	Total L.	No.	Performance	Total L.	No.	Performance	Total L.	No.
Receiving Conv.	6 tons/hr	8,200 mm	2	6 tons/hr.	8,000 mm	4	6 tons/hr.	8,000 mm	4
Relay Conv.	-	-	-	6 "	8,000 mm	4	6 "	8,000 mm	4
Feeding bin conv.	6 tons/hr.	10,000 mm	2	-	-	-	-	-	-
Dryer Conv.	12 "	12,500 mm	6	12 tons/hr.	12,500 mm	12	12 tons/hr.	12,500 mm	12
Warehouse Conv.	24 "	15,000 mm	1	24 "	15,000 mm	1	24 "	15,000 mm	1
Relay Conv.	6 "	8,100 mm	1	6 "	8,100 mm	1	6 "	8,100 mm	1

(4) Chain Conveyor			
Type	Truf-flow	Same as A	Same as A
Chain speed	25 m/min.	- do -	- do -
Materials	Hard steel chain, and Steel plate body	- do -	- do -

Name	Performance	Total L.	No.	Performance	Total L.	No.	Performance	Total L.	No.
Feeding bin chain conv.	6 tons/hr.	15,200 mm	2	-	-	-	-	-	-
Warehouse chain conv.	24 tons/hr.	40,000 mm	1	24 tons/hr.	40,000 mm	1	24 tons/hr.	40,000 mm	1

7. Electricial Facility			
(1) Generating Facility			
Generator Type	Pertable diesel engine generator	Same as A	Same as A
Output	175KVA(50Hz)/1,500rpm	- do -	- do -
	200KVA(60Hz)/1,800rpm	- do -	- do -
Number	1	- do -	- do -
Fuel Comsumption	57 ℓ/hr. Max. (light oil)	- do -	- do -
Oil Tank	10 Kℓ x 1 (Steel made)	- do -	- do -
(2) Distributing Panel			
Type	Wall hang	- do -	- do -
(3) Operation Panel			
Type	Semi-graphic	- do -	- do -
(4) Power wiring tube and equipments			
(5) Lighting Equipments			
8. Total Output of Motors	105.75Kw	110.95Kw	156.55Kw
9. Total Weight of machines and equipment	79.5 tons	111.6 tons	112.8 tons
10. Building			
(1) Machine House			
Type	Steel frame	Same as A	Same as A
	Roof: colored corrugated iron plate	- do -	- do -
	Wall: open	- do -	- do -
	Floor: trowel finished concrete	- do -	- do -
	$420m^2$	$525m^2$	$525m^2$
(2) Warehouse			
Type	Steel frame	Same as A	Same as A
	Roof: colored corrugated iron plate	- do -	- do -
	Wall and floor: lauan board	- do -	- do --
	$460m^2$:	- do -	- do -

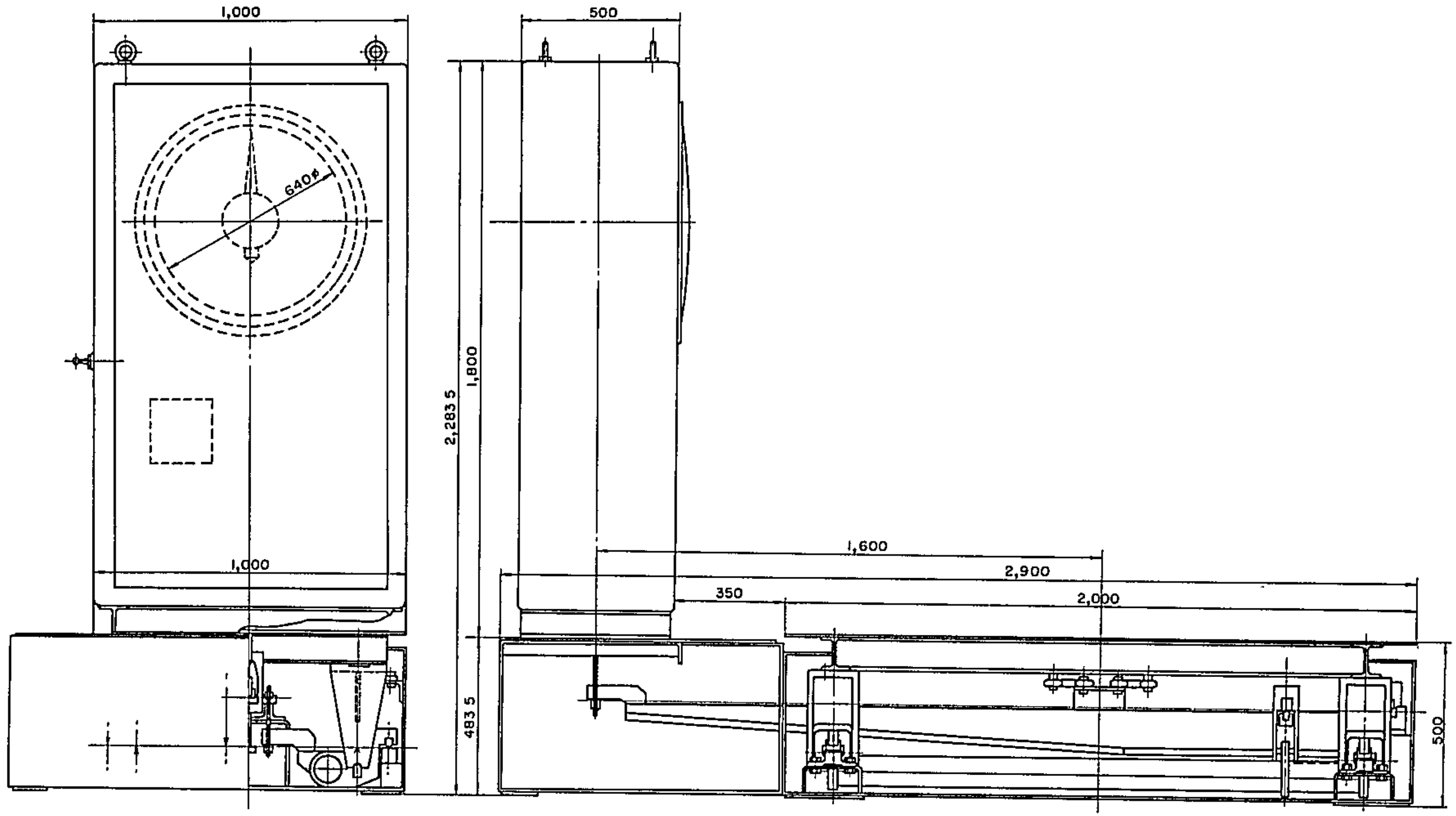
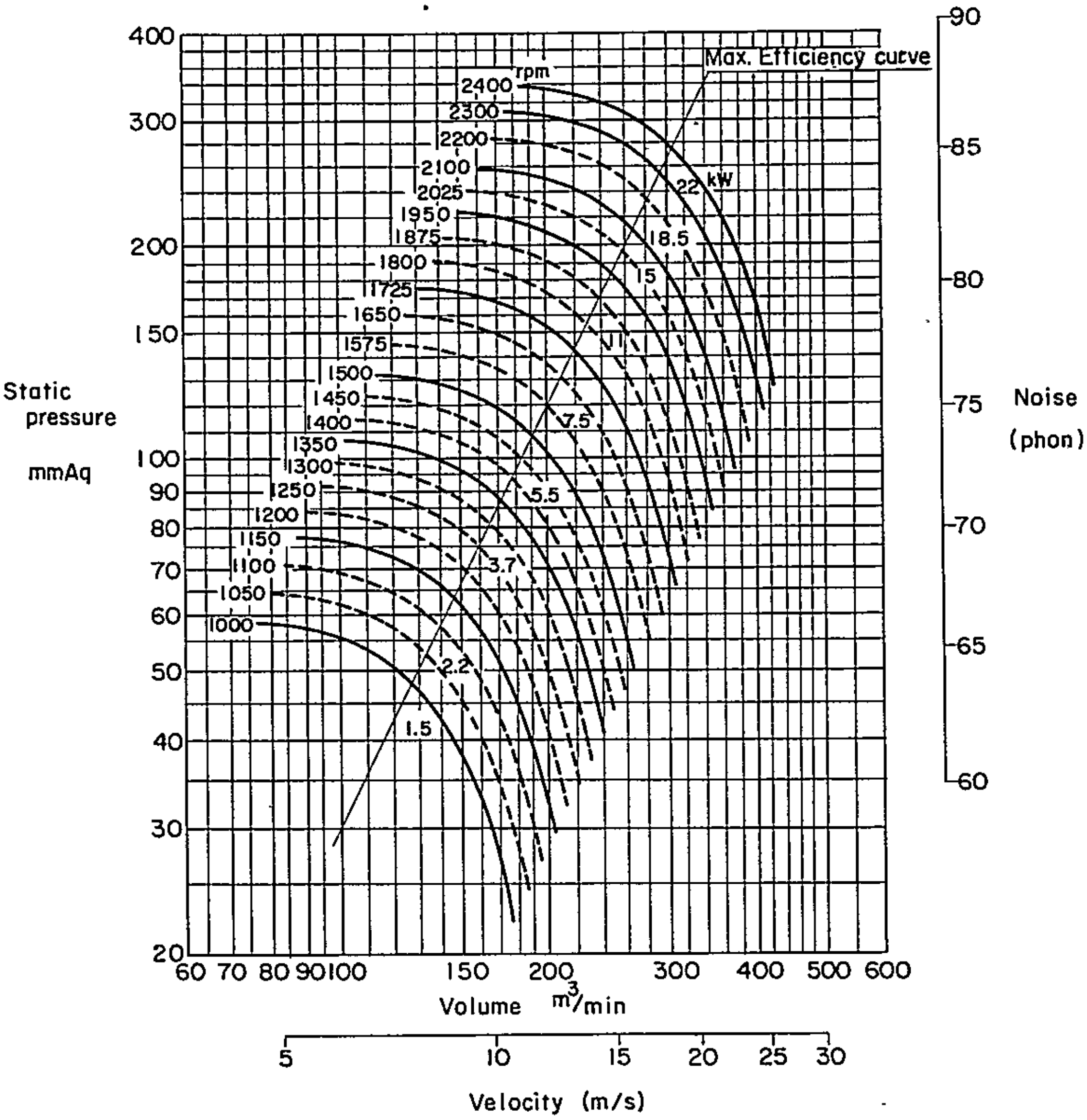


Fig. 26 Receiving Scale


Max. Efficiency curve
rpm
2400
2300
2200
2100
2025
1950
1875
1800
1725
1650
1575
1500
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
22 kW
18.5
15
11
7.5
5.5
3.7
2.2
1.5
Static pressure mmAq
Noise (phon)
Volume m³/min
Velocity (m/s)

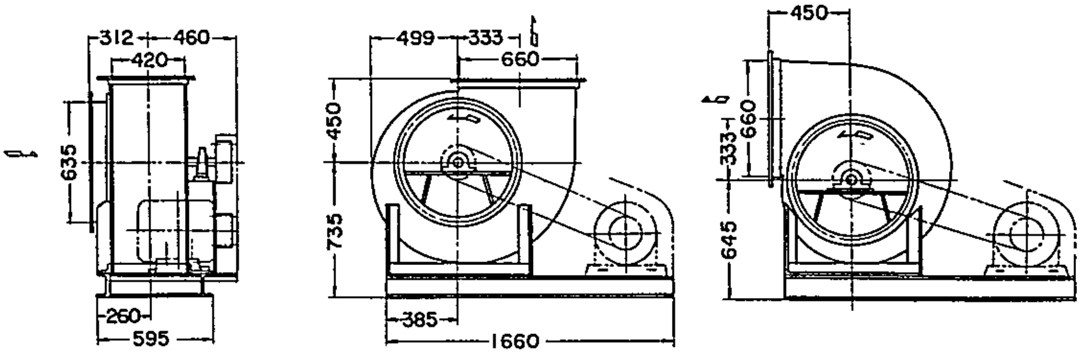

312
460
420
635
260
595
499
333
660
450
735
385
1660
450
660
333
645

Fig. 27 Fan

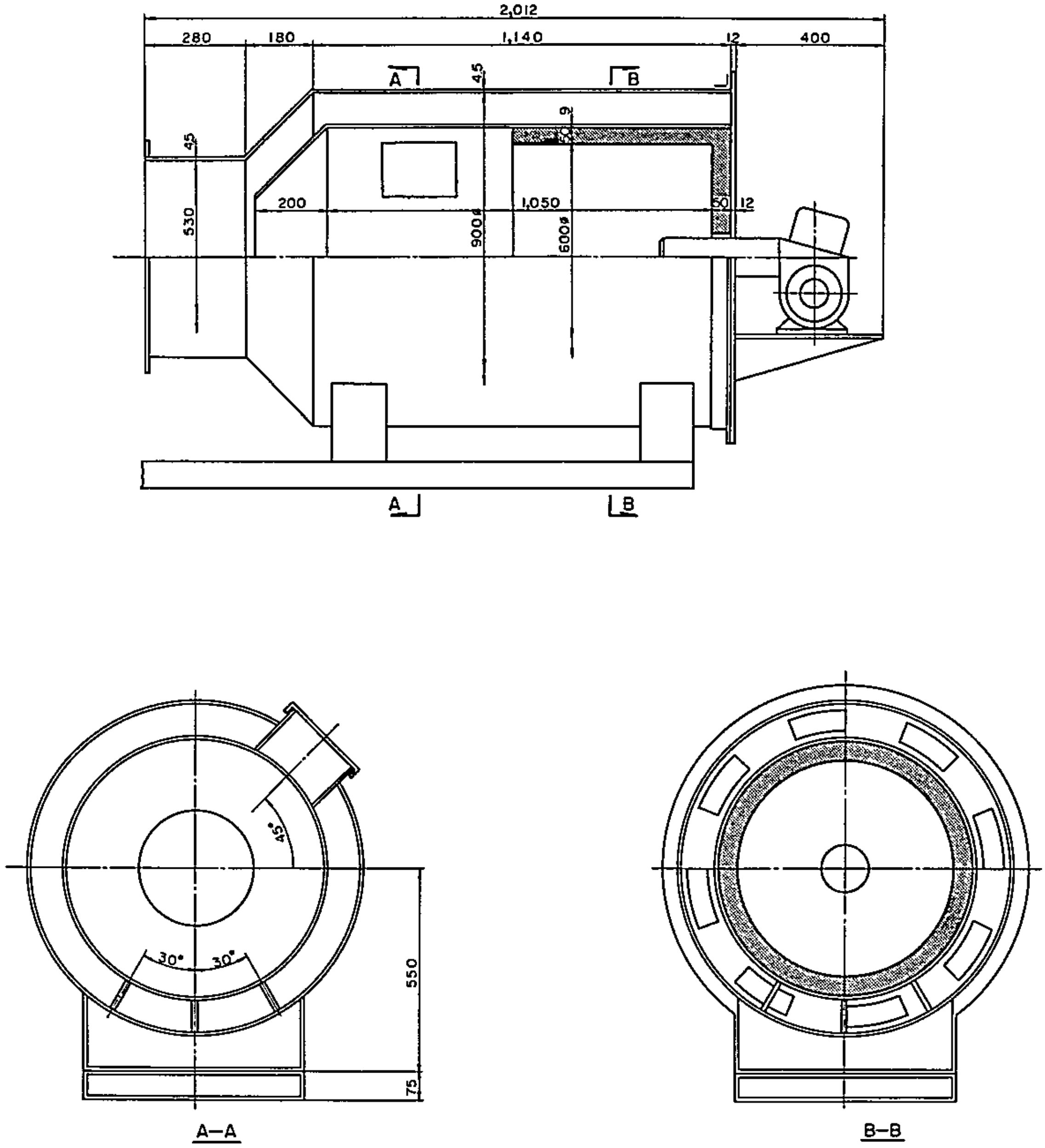
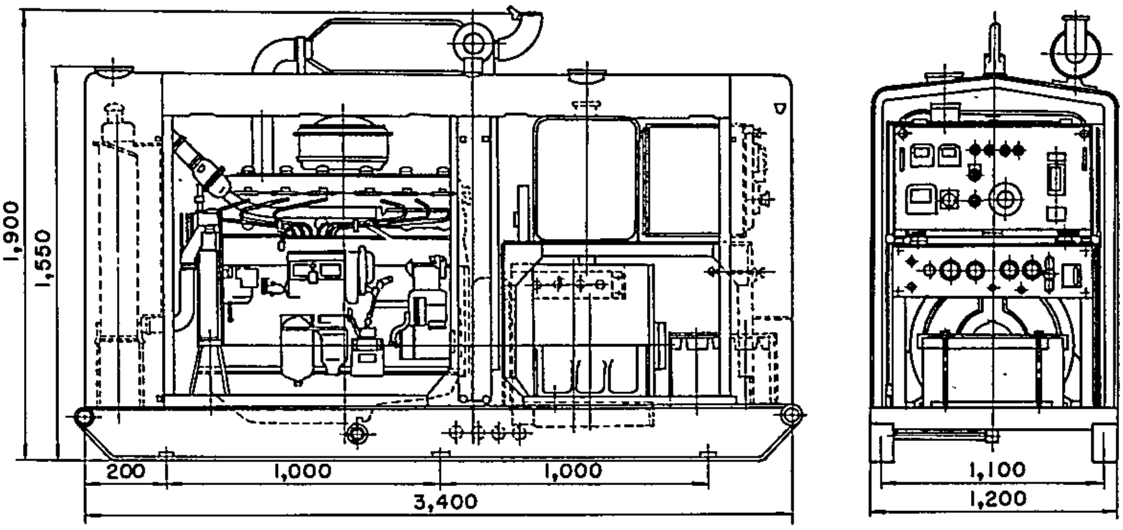


Fig. 28 Furnace



Specifications

Frequency	50 Hz
Continuous rating output	175 KVA 140 KW
Voltage	220/400 V
Current	505/253 A
Revolution	1,500 r.p.m
No. of Pole	4
Power Factor	80%
Net weiget	4,600 Kg

Fig. 29 Generator

ii) Design Calculation for Dryer (Design A)

A. Outline of sheme

1. Capacity per unit complex — 2,000 tons (dried paddy)
2. Harvesting period — six (6) weeks (42 days)
3. Initial moisture — 23% (W. B.)
4. Final moistrure — 14% (W. B.)

   (Paddy is to be dried to a moisture content of 14% in 24 hours.)
5. Drying capacity per day — 54 tons/day (wet paddy)

   2,000/42 = 48 tons (dried paddy) ÷ 54 tons/day (wet paddy)
6. Number of dryers

   The capacity of the dryer is assumed to be 5 tons and the dryer is to run twice a day.

   54 tons/ 5 tons/ 2 times = 5.4 dryers

   A total of six dryers are required.

B. Calculation of dryer operation

1. Moisture extruction rate — 1.1%/hour
2. Drying hour — 16.5 hours

   from A-3 and A-4,

   (23% - 14%)/1.1% x 2 times ÷ 16.5
3. Cooling hour — 3.5 hours
4. Feeding — 1.0 hour
5. Discharging — 1.0 hour

Total 22.0 hours

Holding capacity of dryer .... 5 tons

The dryer consists of two 2-ton sections and one 1-ton section. Hot air is to be blown into the two ton sections only and the one-ton section is to be maintained as a non-air blow bin.

Assuming that the unit air volume per tonage (q) is 0.8 m^3/sec/ton, to get 1.1%/h of moisture extruction rate the total air delivery (Q') will be:

$$Q' = q \times 5 \text{ tons} = 0.8 \times 5 = 4.0 m^3/sec = 240 m^3/min. \quad \text{.......... (1)}$$

The air delivery per section on the blast side (Q) will be:

$$Q = \frac{4.0 m^3/sec}{2 \text{ sections}} = 2.0 m^3/sec = 120 m^3/min.$$

When a louver shape is arranged as shown in as Fig. A:

$$\text{Area } S_1 = 0.23 \times 0.199 \times 1/2 = 0.0229 \ m^2$$

$$\text{Area } S_2 = 0.23 \times 0.066 \times 1/2 = 0.0076 \ m^2$$

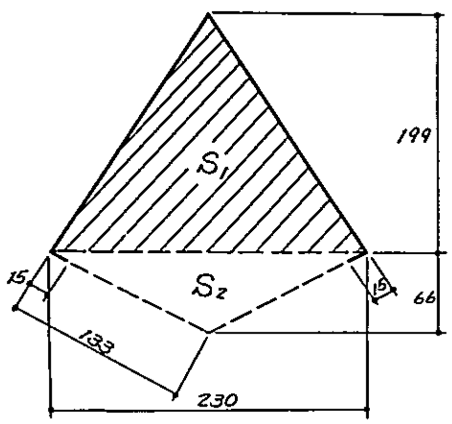


Fig. A

Assuming that the paddy floating speed is 7.4 m/sec, the required sectional area (A) may be calculated from the division of the air volume ($2m^3/sec$) by the paddy floating speed.

$$A = \frac{2.0m^3/sec}{7.4m/sec} = 0.27m^2$$

The number of louvers may be obtained from formula $\frac{A}{S}$

$$\frac{0.27}{0.0229} = 11.8 \ldots\ldots. \text{ 15 louvers,}$$

(5 rows x 3 stages)

The total sectional area of louvers will be:

$$0.0229m^2 \times 15 = 0.3435m^2$$

Air velocity will be:

$$\frac{\text{Air volume in 1 section}}{\text{Total sectional area of louvers}} = \frac{2m^3/sec}{0.3435m^2} = 5.83m < 7.4m$$

Next, the capacity of one section with the above stated louver arrangement is obtained.

The area of space per louver(S) is $S_1 + S_2$, and the following may be obtained:

$$S = S_1 + S_2 = 0.0229m^2 + 0.0076m^2$$

$$= 0.0305m^2$$

The louvers consists of blow and exhaust each numbering 15. The total number of louvers is 15 (blow) + 15 (exhaust) = 30 louvers. The total area of space for 30 louvers will be:

$$0.0305m^2 \times 30 = 0.195m^2$$

The sectional area of one section of the dryer is $1.75 \times 1.75 = 3.0625m^2$. The sectional area to be occupied by paddy will be:

$$3.0625m^2 - 0.915m^2 = 2.1475m^2$$

Since the capacity of dryer is two tons, volume (V), with the specific gravity of 0.54 of the paddy will be:

$$V = \frac{2 \text{ tons}}{0.54} \doteqdot 3.7m^3$$

Therefore, the length of the louver (Lm) required will be:

$$\frac{3.7}{2.1465} = 1.72\text{m}$$

If 1.75m is given as the length from the requirement in manufacturing, volume (V') will be:

$$V' = 2.1475\text{m}^2 \times 1.75\text{m} \fallingdotseq 3.76\text{m}^3$$
$$= 2.03 \text{ tons}$$

This will satisfy the requirements.

If (v) is given as the wind velocity from the bottom of the louver, the area of the lower part of the louver may be obtained from Fig. A.

$$(0.133 - 0.015)\text{m} \times 2 \times 1.75\text{m} = 0.413\text{m}^2$$

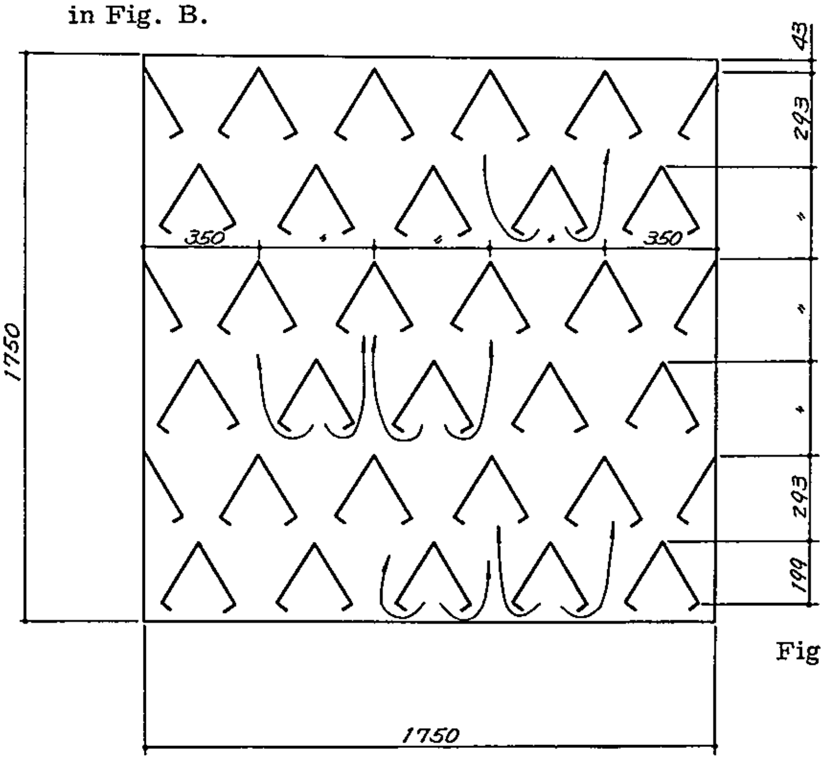
Since the number of louvers on blow side is 15, the total area will be

$$0.413 \times 15 = 6.195\text{m}^2$$

Therefore,

$$v = \frac{\text{Air delivery in 1 section}}{\text{Total area of louver on blow side}}$$
$$= \frac{2\text{m}^3/\text{sec}}{6.195\text{m}^2}$$
$$= 0.323\text{m/sec.} \qquad \dots\dots\dots\dots\dots\dots (2)$$

Accordingly, the sectional area of dryer one section will be as shown in Fig. B.



Outer dimension

1.75m x 1.75m

x 1.75m = 3.56m^3

Fig. B

C. Dryer fan

The required air volume obtained from B-(1) is $240m^3/min$.

Air pressure

From B-(2), the velocity of air blown by the louver (v) is 0.323m/sec. The air pressure (P_{1m}) in one meter layer of paddy is 160mmAq (P_{1m} = 160mmAq) may be obtained from air resistance curve. The thickness of paddy layer in Fig. B is 0.3 meter. Therefore, the necessary air pressure ($P_{0.3m}$) in the case of paddy layer in 0.3 meter thick will be:

$$P_{0.3m} = 160 \times 0.3 = 48mmAq$$

Assuming that the resistance of furnace, louvers, and duct is 62 mmAq, the total air pressure (P) will be:

$$P = 48mmAq + 62mmAq$$
$$= 110mmAq$$

From the graph shown in Fig. 27, No.4 turbo-fan SPR-30(7.5Kw) is to be used.

D. Revolution of rotary valve

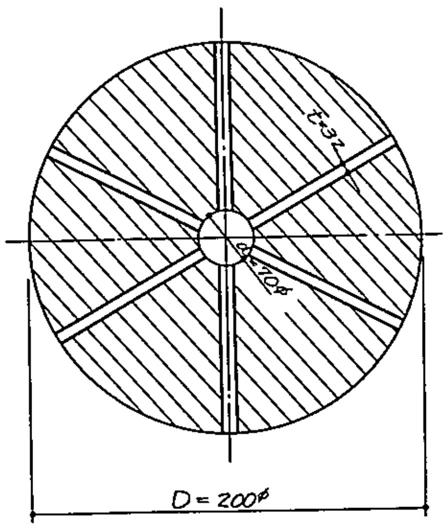


Fig. C

The sectional area is calculated from Fig. C (oblique line)

$$S = \frac{\pi}{4}(D^2 - d^2) - 6\left(\frac{D - d}{2} \times t\right)$$

$$= \frac{\pi}{4}(0.2^2 - 0.07^2)$$

$$- 6\left(\frac{0.2 - 0.07}{2} \times 0.0032\right)$$

$$= 0.0263m^2$$

When the length of the rotary valve L = 1.75m, the capacity of one louver (V) may be obtained:

$$V = 0.0263m^2 \times 1.75m$$
$$= 0.046m^3$$

In case of five(5) louvers, the total holding capacity will be:

$$0.046 \times 5 = 0.23m^3$$
$$= 0.124 \text{ tons}$$

With the revolution expressed by N, the paddy discharged by five (5) louvers in one revolution is 0.124 tons. Since the unloading capacity of the dryer is 10 tons per hour, the following may be obtained:

$$N = \frac{10\ t/hr}{60min.} \div 0.124\ t$$

$$= 1.34\ rpm$$

D. Furnace

Ambient conditions

Temperature	30°C
Humidity	90%

Assuming that the maximum temperature of hot air is 60°C, the suction enthalpy will be:

$i = 0.240\ t + x(596 + 0.46\ t)$, where; i: Suction Enthalpy Kacl/Kg
t: Suction Air Temp.
x: Absolute Humidity Kg/Kg

From H = 760mmHg, hs = 31.83mmHg, and $\varphi = 0.9$, the absolute humidity (x) will be:

$$x = \frac{0.6224hs}{H - \varphi hs} = \frac{0.622 \times 0.9 \times 31.83}{760 - 0.9 \times 31.83}$$

$$= 0.0244$$

Therefore, the suction enthalpy (i_{60}) at 60°C will be:

$$i_{60} = 0.240 \times 60 + 0.0244\ (596 + 0.46 \times 60)$$

$$= 29.6\ Kcal/Kg,$$

and the suction enthalpy (i_{30}) at 30°C will be:

$$i_{30} = 0.24 \times 30 + 0.0244\ (596 + 0.46 \times 30)$$

$$= 22.0\ Kcal/Kg$$

The carolific value will be:

$$= \text{Air volume} \times 60\ \text{min.} \times 1.05\ (i_{60} - i_{30})/0.8$$

$$= 240 \times 60 \times 1.05(29.6 - 22)/0.8$$

$$= 143.000Kcal/hr$$

(0.2Kw motor is to be used for fan.)

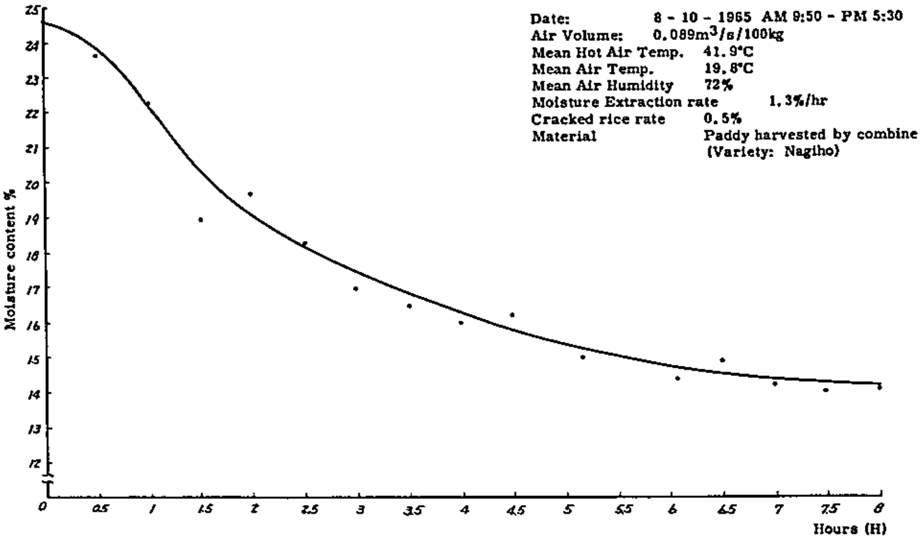


Fig 30 The test result of dryer in Japan (1)

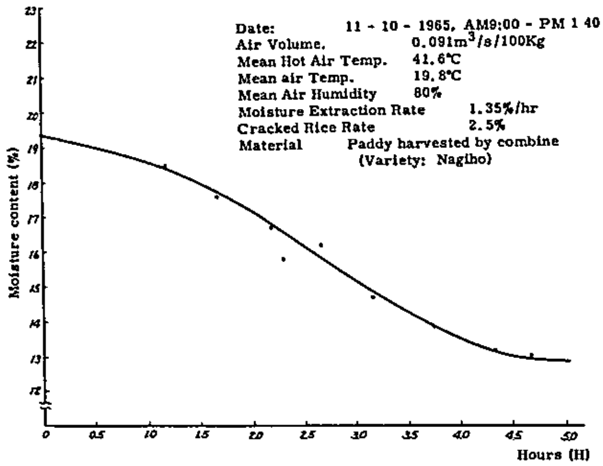


Fig. 31 The test result of dryer in Japan (2)

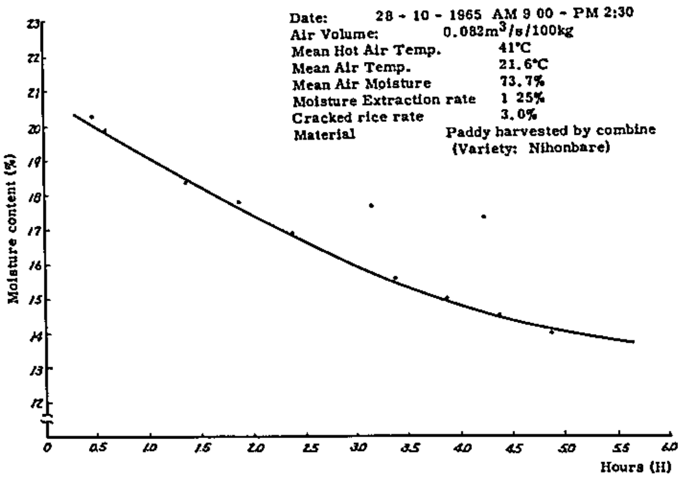


Fig. 32 The test result of dryer in Japan (3)

(4) Description of Building

i) Machine house (Control room and rest room included)

Floor area

Design A	15.000 m x 28.000 m = 420.000 m^2
Design B	15.000 m x 35.000 m = 525.000 m^2
Design C	Same as above

Control room (1st floor): 3.000 m x 3.500 m = 10.500 m^2

Rest room (2nd floor): 3.000 m x 3.500 m = 10.500 m^2

Construction and specifications

One-story steel frame construction

Control room and rest room are to be housed in a two story wooden building

Floor:	Concrete with trowel finishing
Foundation:	Reinforced concrete continuous footing, with wooden pile
Wall:	None
Roof:	Long colored corrugated iron sheet (held by hook) Long pitch colored corrugated iron sheet #28

Control room:

Floor:	Concrete with trowel finishing
Wainscot:	Concrete block, 15 cm thick up to a height of 1.000 m
Wall:	Concrete block in part and wooden sash with wire screen (Over-hand sash)
Ceiling:	Boarded ceiling

Rest room:

Floor:	Boarded floor, 3.00 cm thick
Wainscot:	Wooden grating, 20 cm thick up to a height of 1.200 m
Wall:	None
Ceiling:	Boarded ceiling, 3.00 cm thick

ii) Warehouse

Floor area

Design A	1.500 m x 40.000 m = 460.000 m^2
Design B	Same as above
Design C	Same as above

Construction:

Foundation:	Reinforced concrete footing with wooden pile
Floor:	Reinforced concrete floor

iii) Design Calculation for Feeding and Cooling Bin

1. Volume

Materials ....Paddy

Specific gravity: 0.54
Rest angle 35°

Volume: 5.5 tons

V-total = 5.5/0.54 = $10.2m^3$

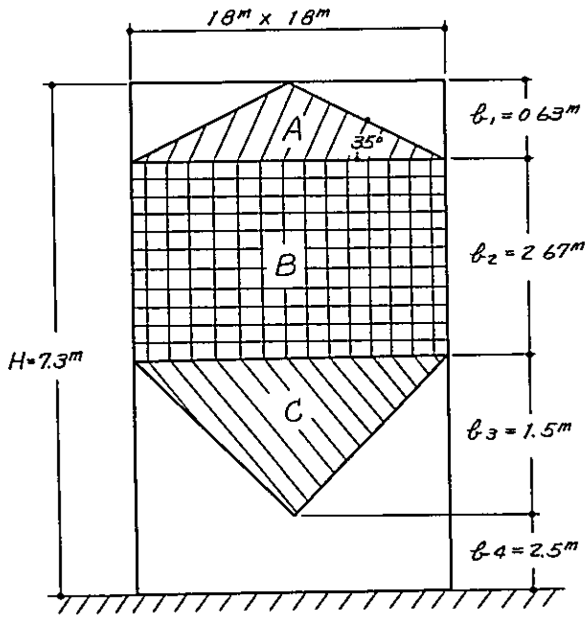


Fig. D

When h_3 = 1.5m and h_4 = 2.5m are the dimension of Fig. D, h_1 will be:

$$h_1 = \frac{1.8}{2} \times \tan 35°$$

$$= 0.9m \times 0.7 = 0.63m$$

Therefore, the volume of A (V_A) will be

$$V_A = \frac{1.8 \times 1.8 \times 0.63}{3}$$

$$= 0.68m^3,$$

and the volume of C (V_C) will be

$$V_C = \frac{1.8 \times 1.8 \times 1.5}{3}$$

$$= 1.62m^3.$$

The volume of B(V_B) will be:

$$V_B = V - total = (V_A + V_C)$$

$$= 10.2 - (0.68 + 1.62)$$

$$= 7.9m^3$$

Then, h_2 will be:

$$h_2 = V_B/1.8 \times 1.8 = 7.9/3.24 = 2.45m$$

2.67m is to be used instead of 2.45 m.

2. Aeration

(1) Feeding bin

a. Air delivery

When unit air volume(q) is $1/1,000m^3/sec/100Kg$ and the bin volume is 5.5 tons, the total air volume Q will be :

$$Q = \frac{1}{1,000} \times 5.5 = 0.055m^3/sec$$

$$= 3.3m^3/min.$$

b. Air pressure

Air velocity is to be expressed by V when the aeration area is $0.81m^2(0.9 \times 0.9)$,

$$v = \frac{0.55m^2/sec}{0.81m^2} = 0.068m/sec$$

From the paddy air resistance curve, the pressure of one meter paddy layer will be:

$$P_{1m} = 20mmAq,$$

and the pressure of four meter paddy layer will be

$$P_{4m} = 20mmAq \times 4 = 80mm\ Aq$$

120mmAq is to be used as P to make allowance.

c. Required power

The required wattage (w) may be calculated by the following formula:

$$W = \frac{Q \times P}{\eta \times 75} \qquad \text{where:} \quad Q \text{ is } 0.055m^3/sec,$$

P is 120mmAq, and η is 0.4.

$$W = \frac{0.055 \times 120}{0.4 \times 75}$$

$$= 0.22\ PS$$

Therefore, 0.75Kw motor is to be used.

(2) Cooling bin

a. Air delivery

When unit air volume (q) is $5/1,000m^3/sec/100Kg$, total air volume (Q) is calculated in the same manner as (1).

$$Q = \frac{5}{1,000} \times 55 = 0.275m^3/sec$$

$$= 16.5m^3/min.$$

b. Air pressure

The aeration area is divided into the bin body and hopper.

v': air velocity in bin body

v'': air velocity in hopper

and $v' = 0.275m^3/sec/3.24m^2$
$= 0.085m/sec$

$v'' = 0.275m^3/sec/0.81m^2$
$= 0.34m/sec$

Therefore, P'_{1m} = 25mmAq, P''_{1m} = 150mmAq

P_{3m} = 25mmAq x 3 = 75mmAq

$P_{0.75m}$ = 150mmAq x 0.75 = 105mmAq

The total air pressure will be:

P_{total} = 75mmAq + 105mmAq

= 180mmAq 200mmAq

c. Required power

Wall:	External and internal: boarded wall, 10.000 cm thick, collaps (rabbet joint)
Ceiling:	None
Roof:	Long colored corrugated iron sheet (held by hook) One side colored long pitch corrugated iron sheet #28

iii) Generator house

Floor area

Design A	7.000 m x 3.000 m = 24.500 m^2
Design B	Same as above
Design C	Same as above

Construction

Foundation:	Reinforced concrete with trowel finishing
Wall:	None
Roof:	Long colored corrugated iron sheet (held by hook) One side-colored long pitch corrugated iron sheet #28

iv) Structural calculation for machine house and warehouse

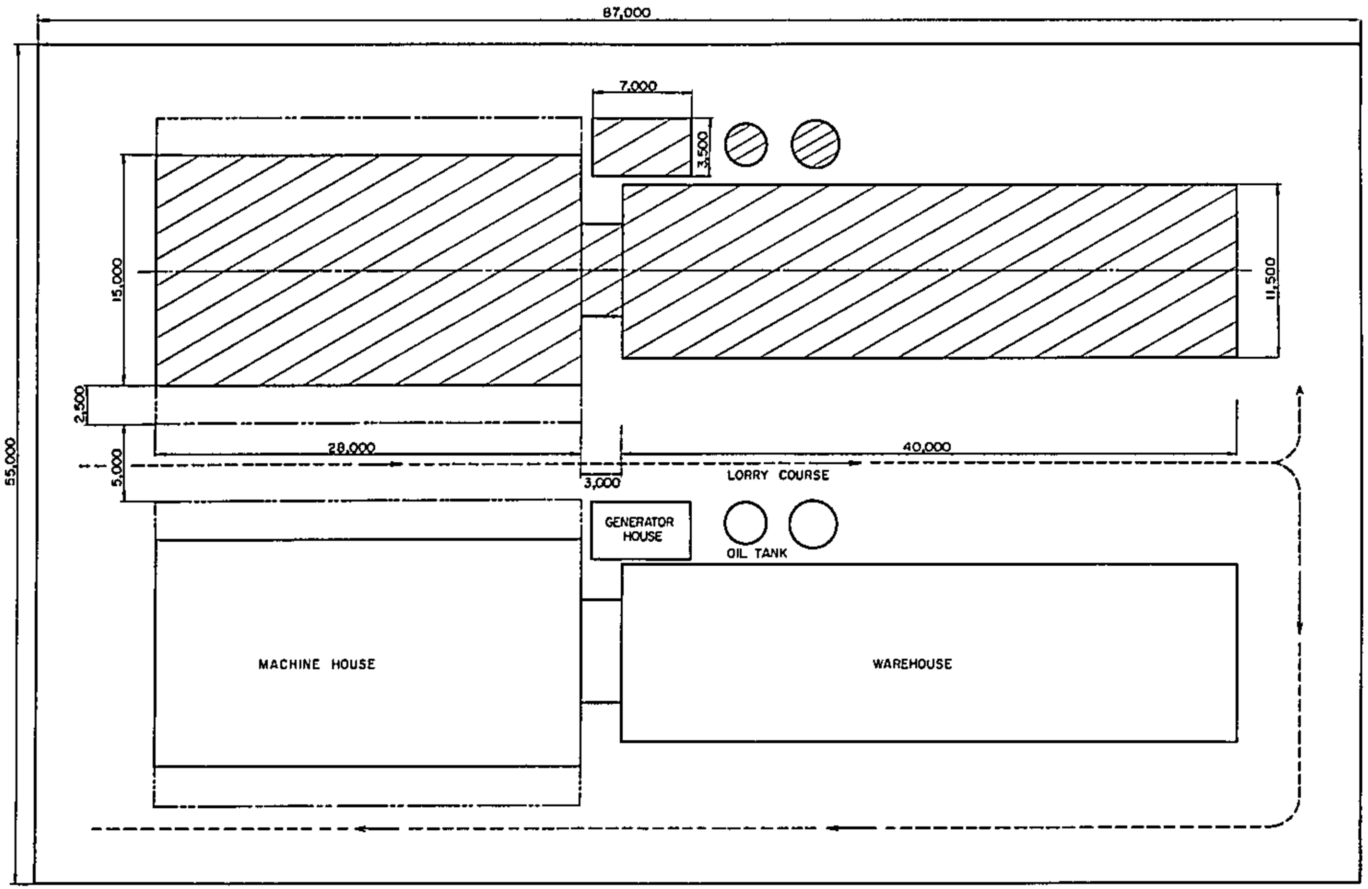
See Appendix 1

(5) Drawings of Design

i) Machines

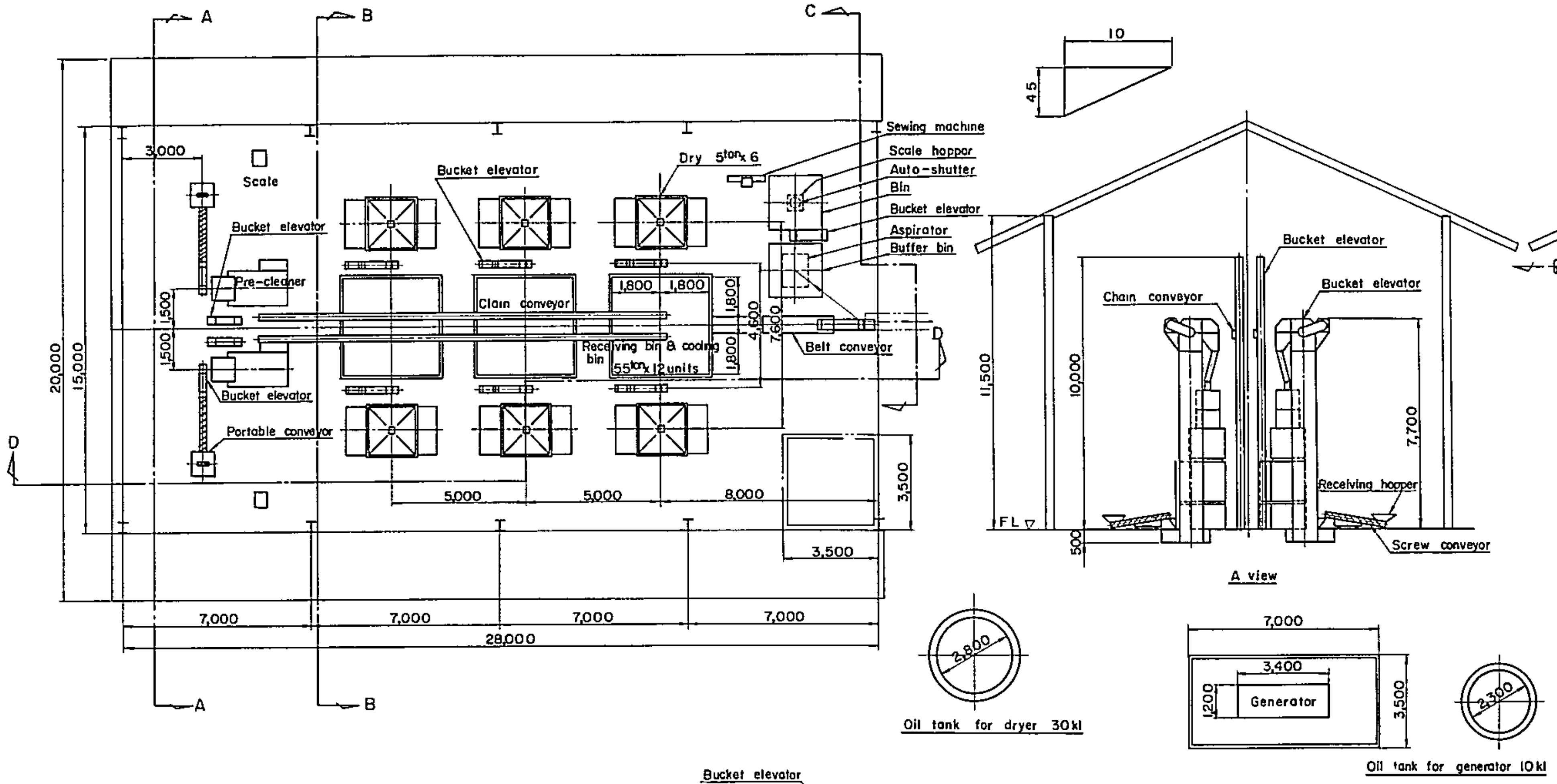
ii) Buildings

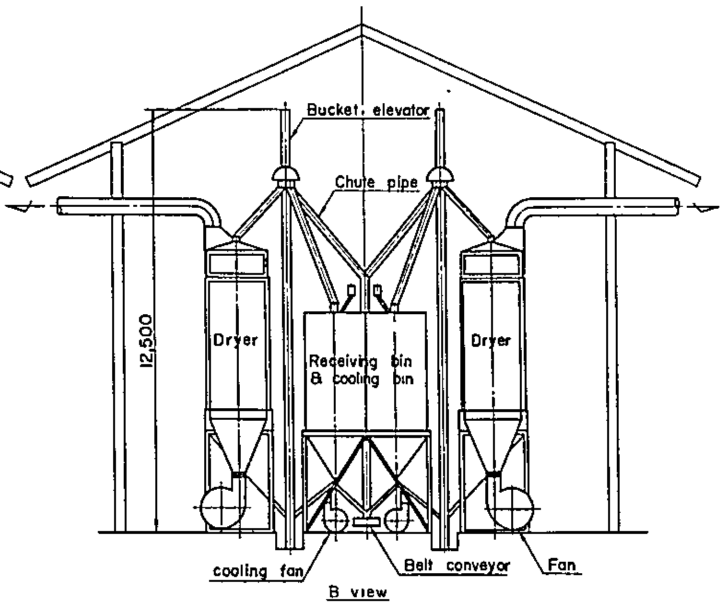
See Drawings 1 - 16



	AREA (M^2)
MACHINE HOUSE	420 00
WAREHOUSE	460 00
GENERATOR HOUSE	24 50
TOTAL	904 50

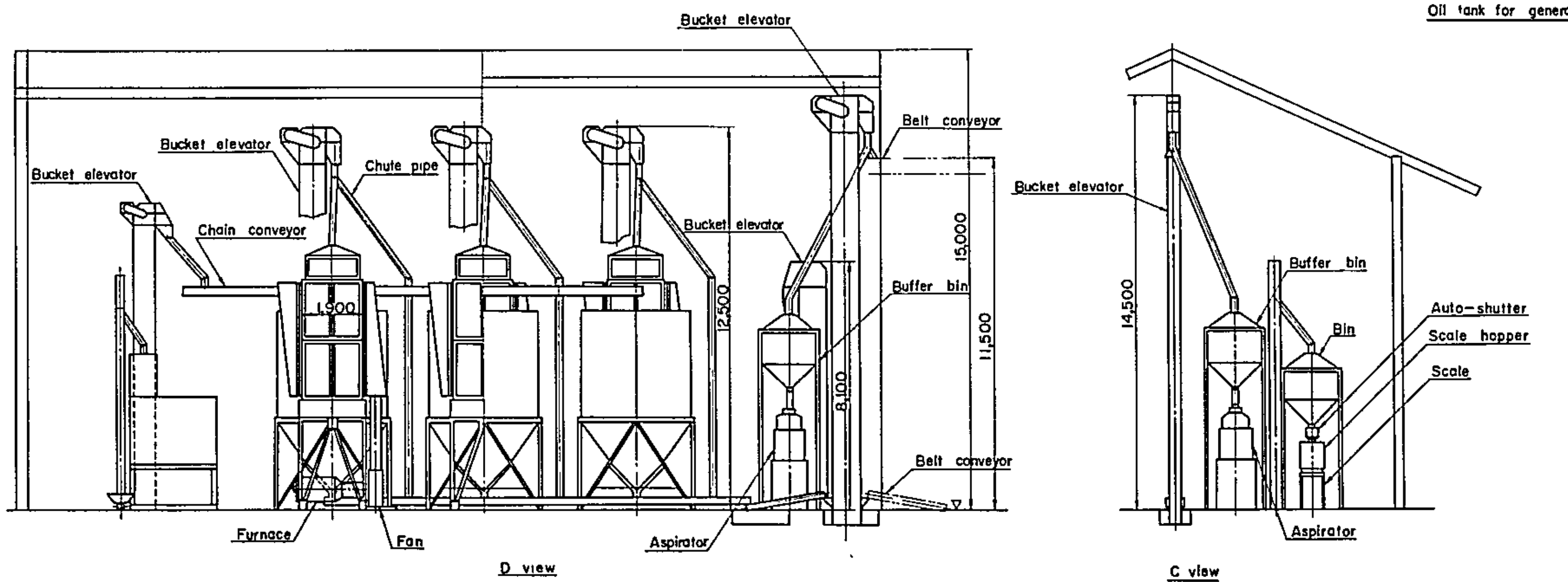
Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	I
TITLE	COMPLEX LAY-OUT (DESIGN-A)
SCALE	1/930
DATE	JULY, 1970



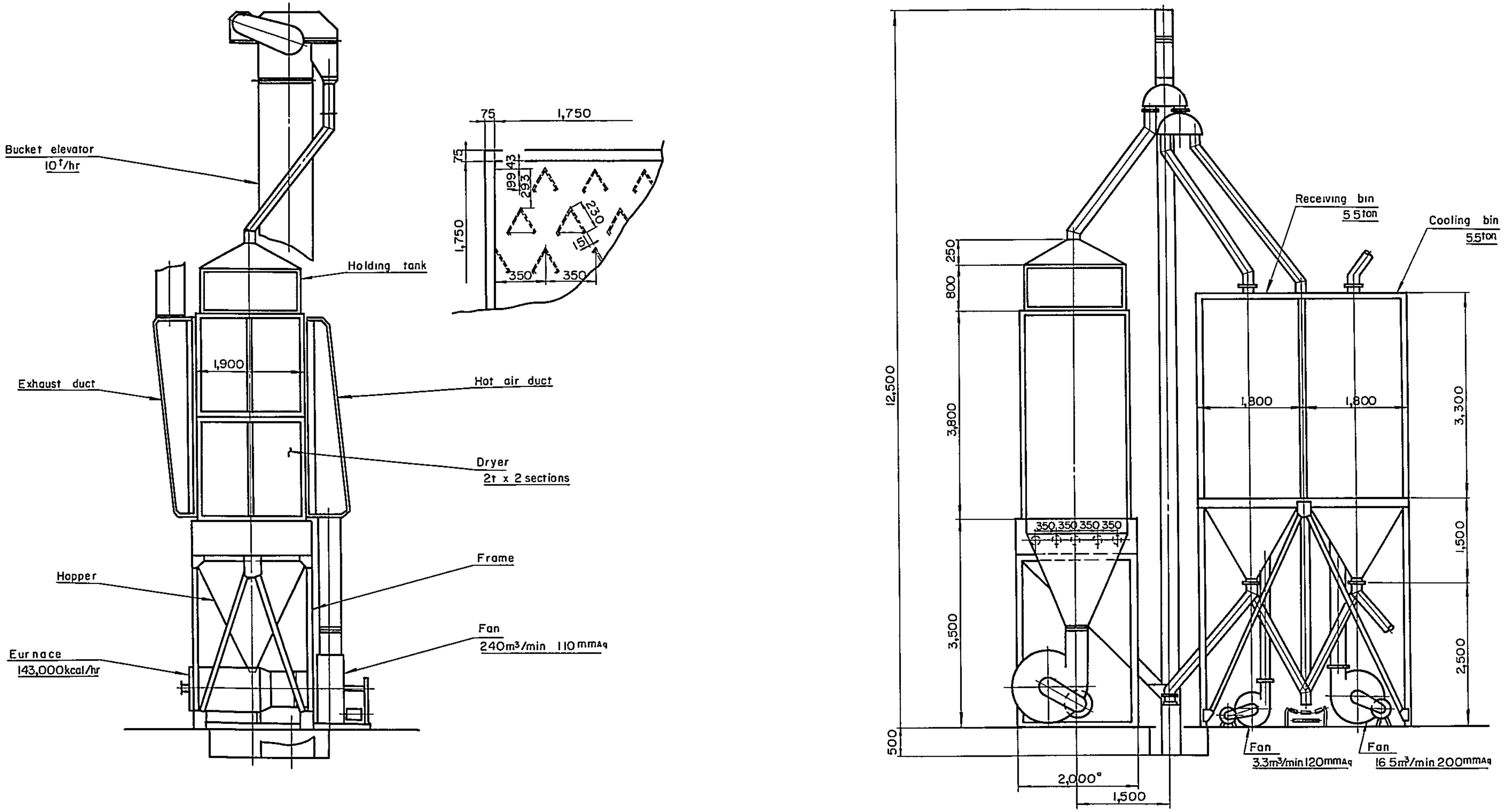


Capacity & performance

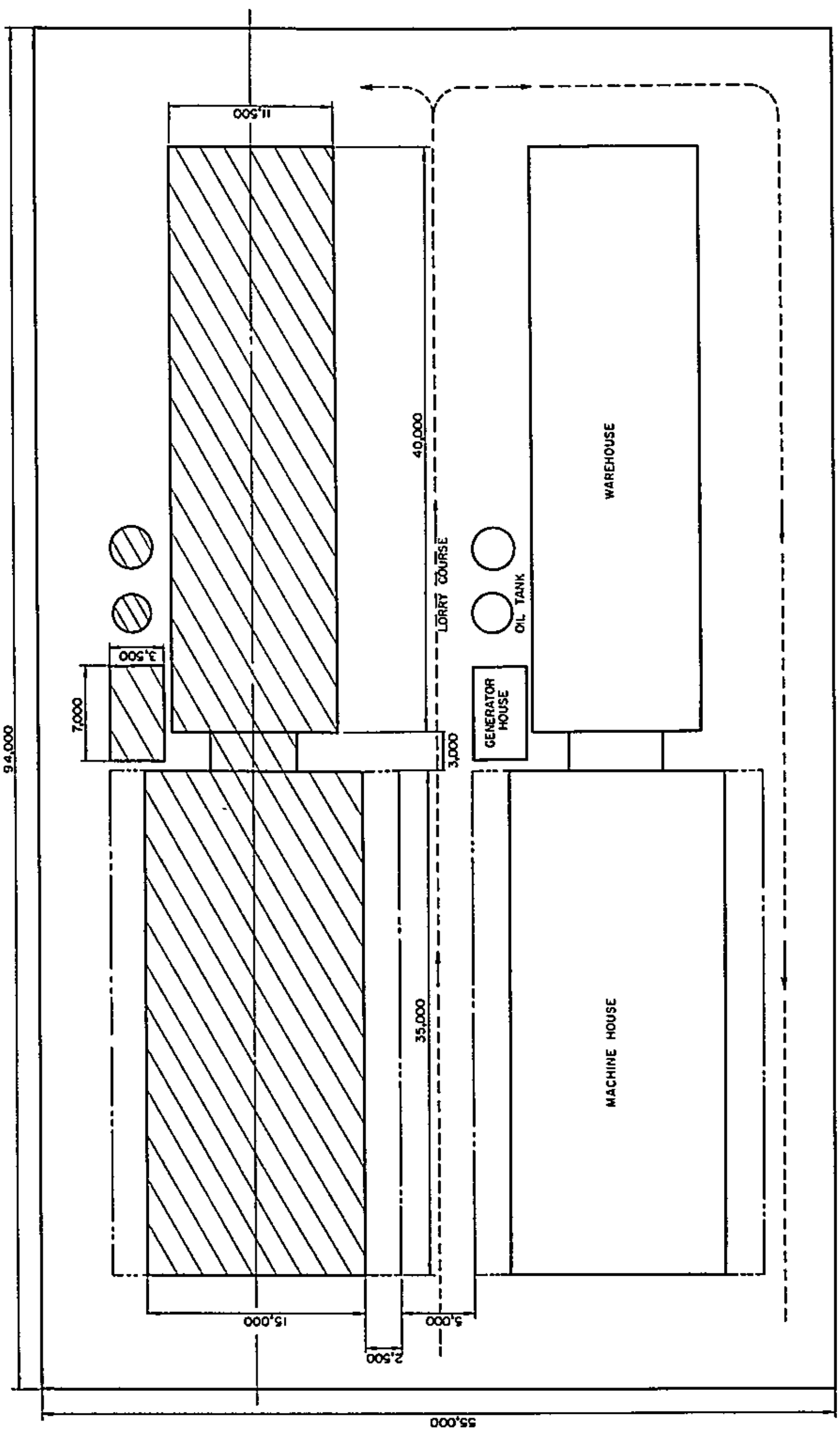
1	Initial moisture content		23 %
2	Final moisture content		14 %
3	Moisture extraction per hour		1 1 % / Hr
4	Moisture extraction		23 %−14 %= 9 %
5	Drying capacity		54T/Day
6	Required drying time		82 Hrs
7	Conveying capacity	Receiving	5T/Hr
		Drying	10T/Hr
		Discharge	20T/Hr
8	Receiving bin & cooling bin		55T x 12
9	Dryer holding capacity		5T x 6
10	Precleaner		5T/Hr x 2
11	Cleaner		5T/Hr x 1
12	Receiving scale		500kg x 2
13	Scale (with auto-shutter)		1
14	Sewing machine		1



Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	2
TITLE	MACHINE LAY-OUT (DESIGN−A)
SCALE	1/645
DATE	JULY, 1970



Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	3
TITLE	DRYER
SCALE	1/221
DATE	JULY, 1970

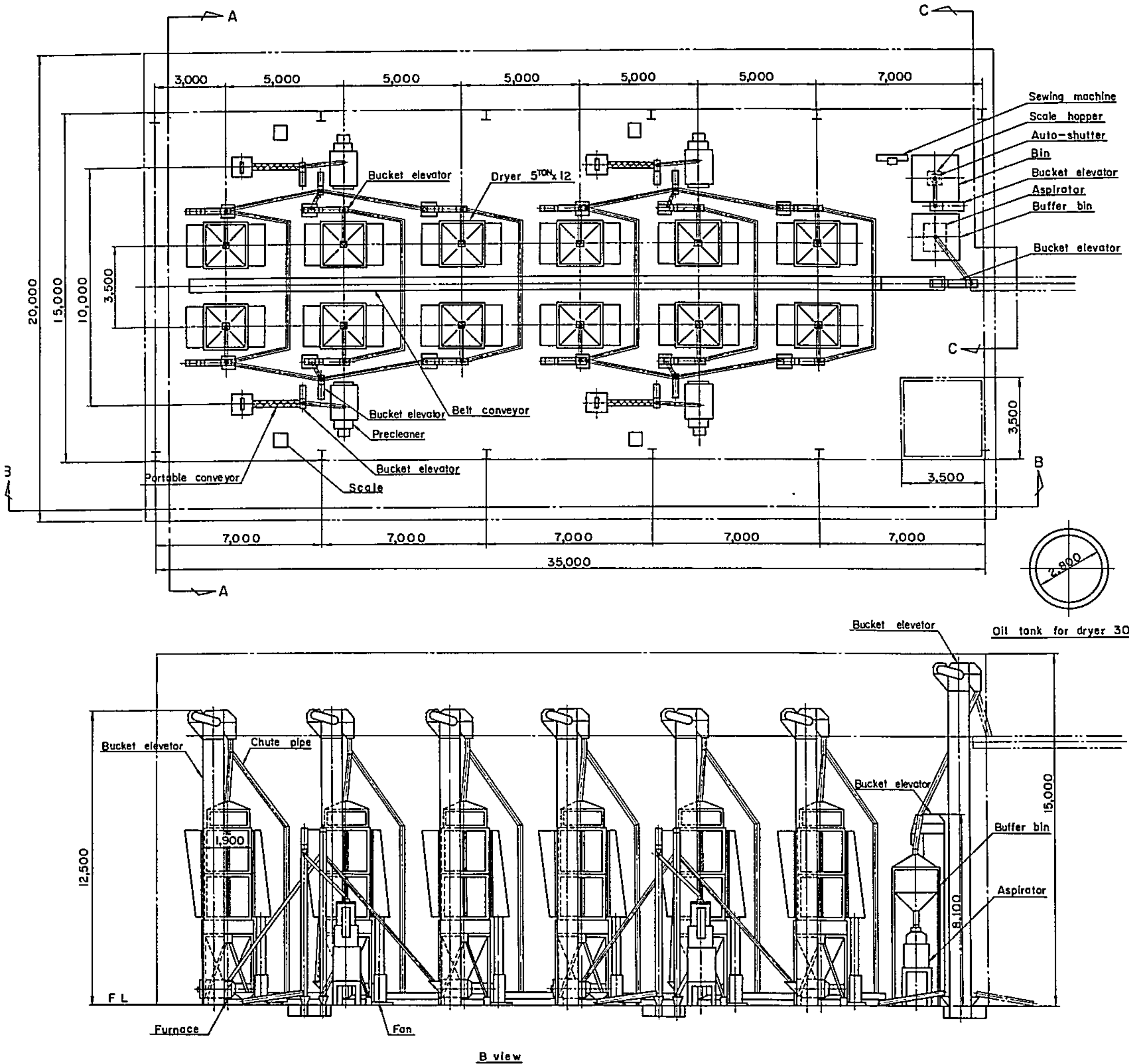


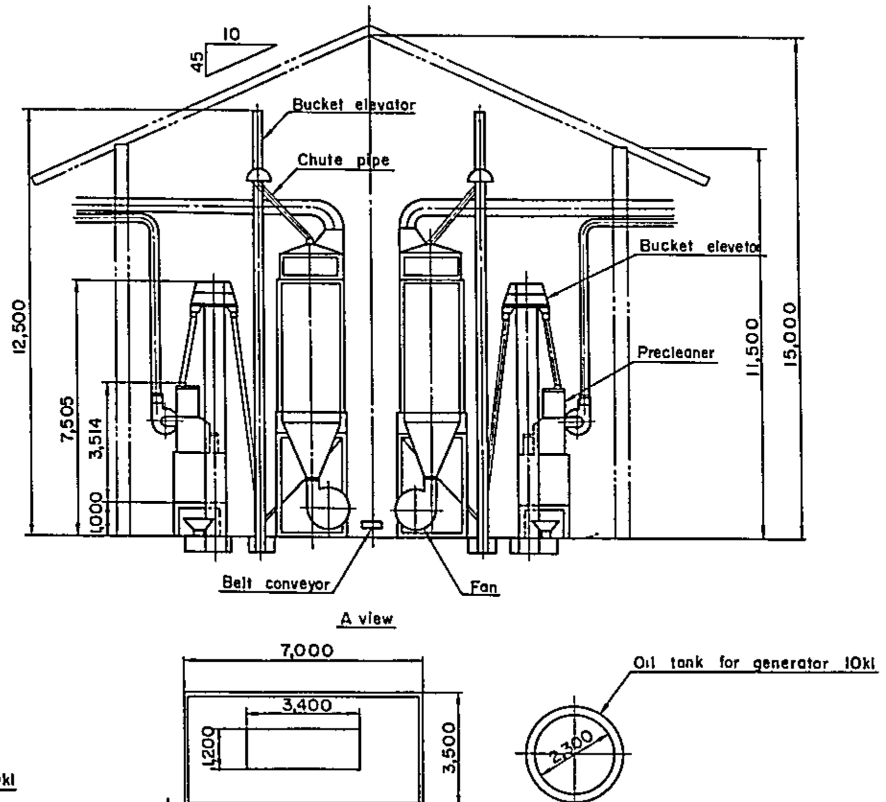
	AREA (M²)
MACHINE HOUSE	525.00
WAREHOUSE	460.00
GENERATOR HOUSE	24.50
TOTAL	1009.50

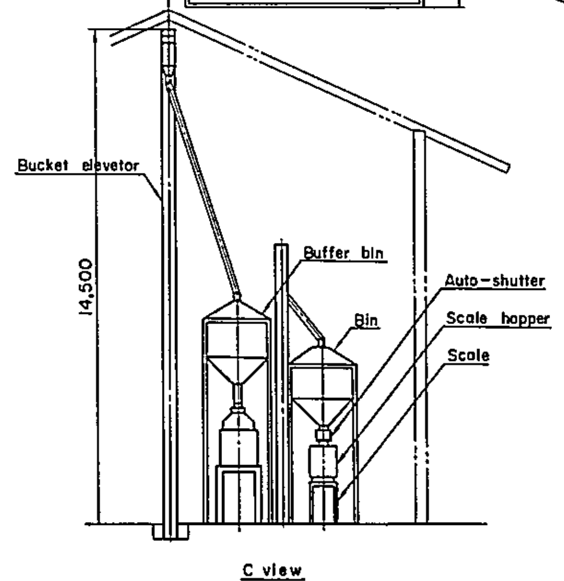
Overseas Technical Cooperation Agency

Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA

DRAWING NO	4
TITLE	COMPLEX LAY-OUT (DESIGN-B & C)
SCALE	1/950
DATE	JULY, 1970



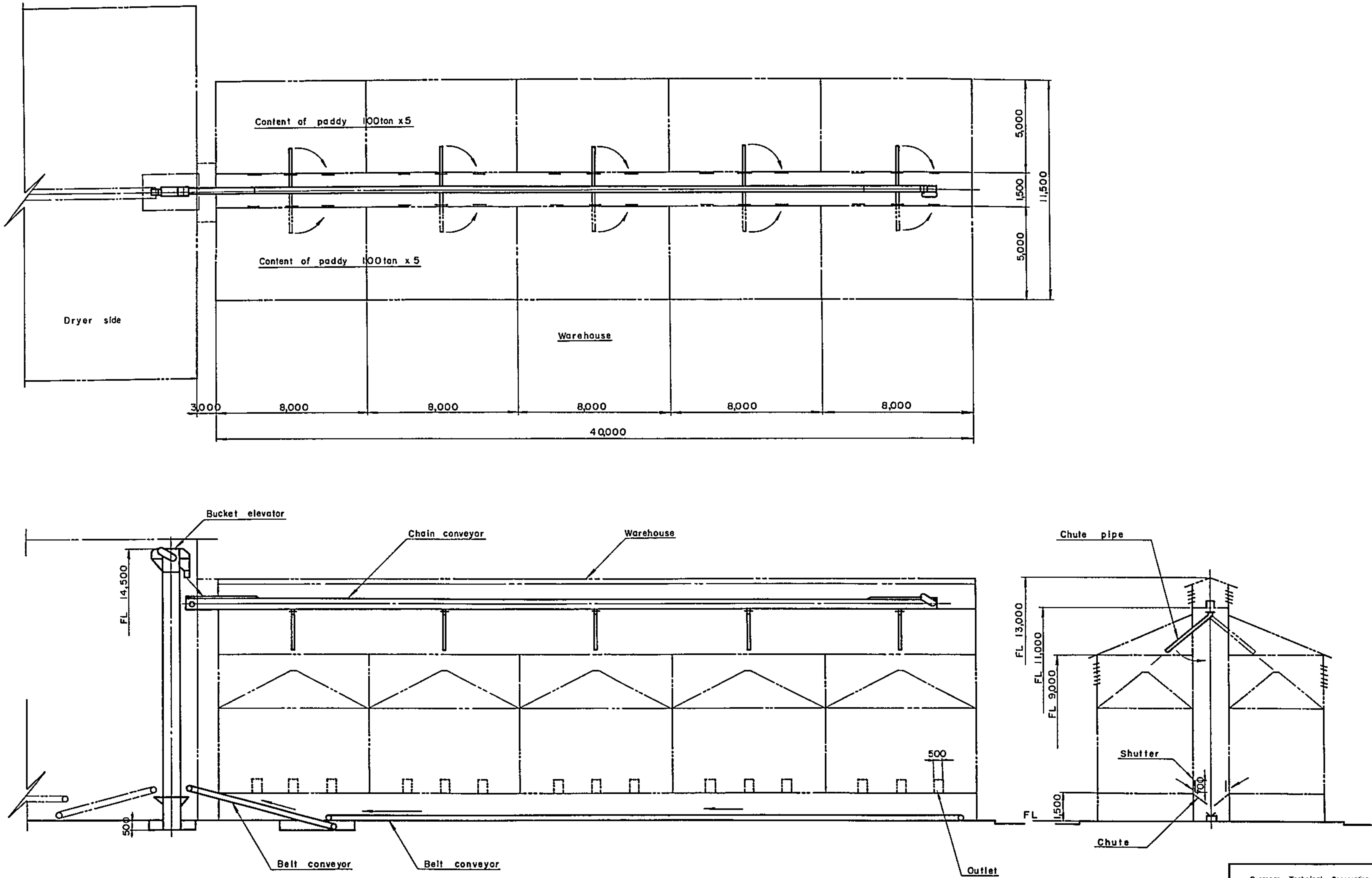




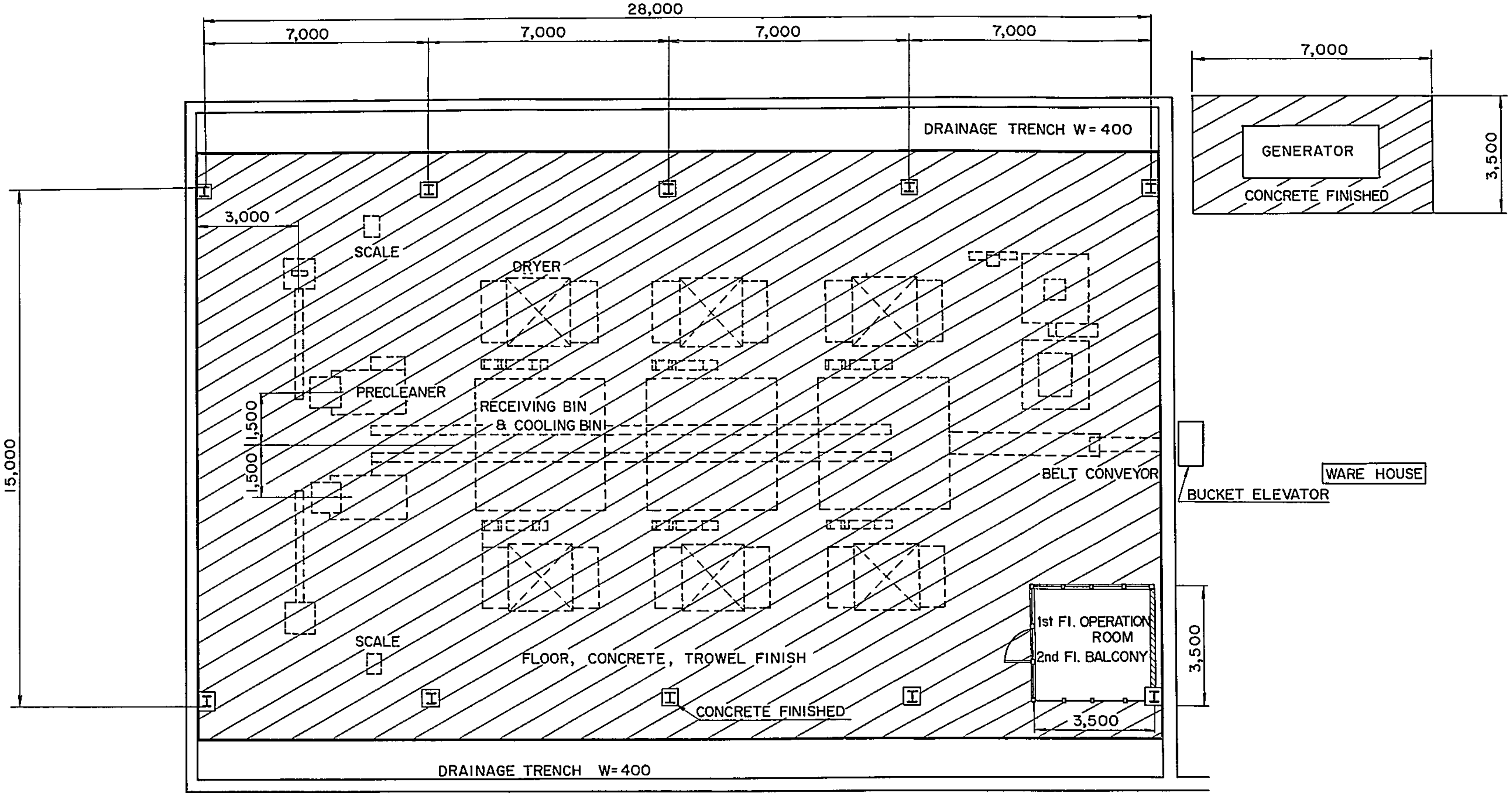
Capacity & performance

1	Initial moisture content	23%
2	Final moisture content	14%
3	Moisture extraction per hour	0.53% /Hr
4	Moisture extraction	23%-14%=9%
5	Drying capacity	54^T/Day
6	Required drying time	17 Hrs
7	Conveying capacity. Receiving	6^T/Hr
	Drying	12^T/Hr
	Discharge	24^T/Hr
8	Dryer holding capacity	5^T x12
9	Precleaner	5^T/Hr x4
10	Cleaner	5^T/Hr x1
11	Receiving scale	500kg x4
12	Scale (with auto-shutter)	1
13	Sewing machine	1

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	5
TITLE	MACHINE LAY-OUT (DESIGN-B & C)
SCALE	1/690
DATE	JULY, 1970



Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	6
TITLE	WAREHOUSE
SCALE	1/770
DATE	JULY, 1970

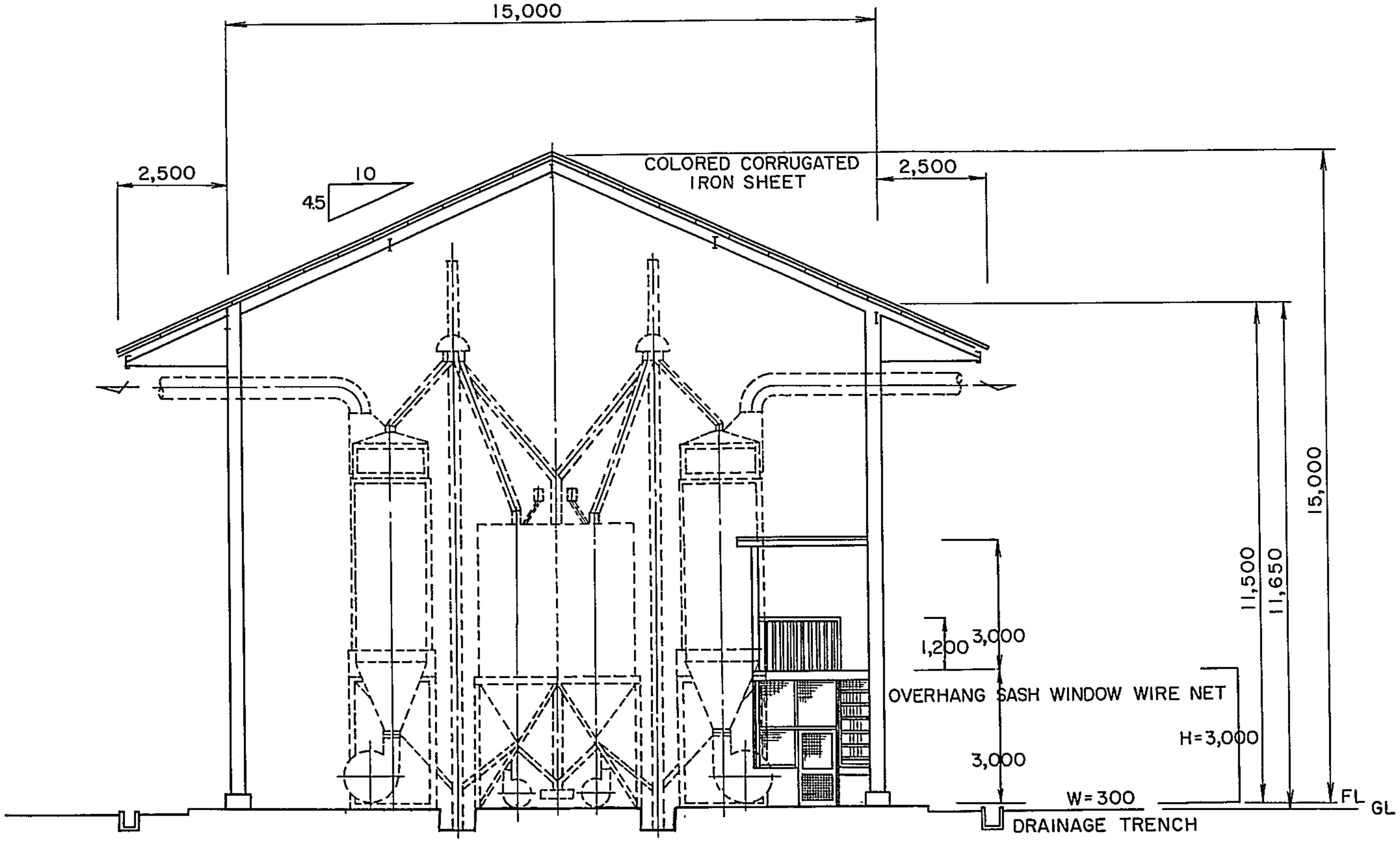


MACHINE HOUSE PLAN

— PLANNING OUTLINE —

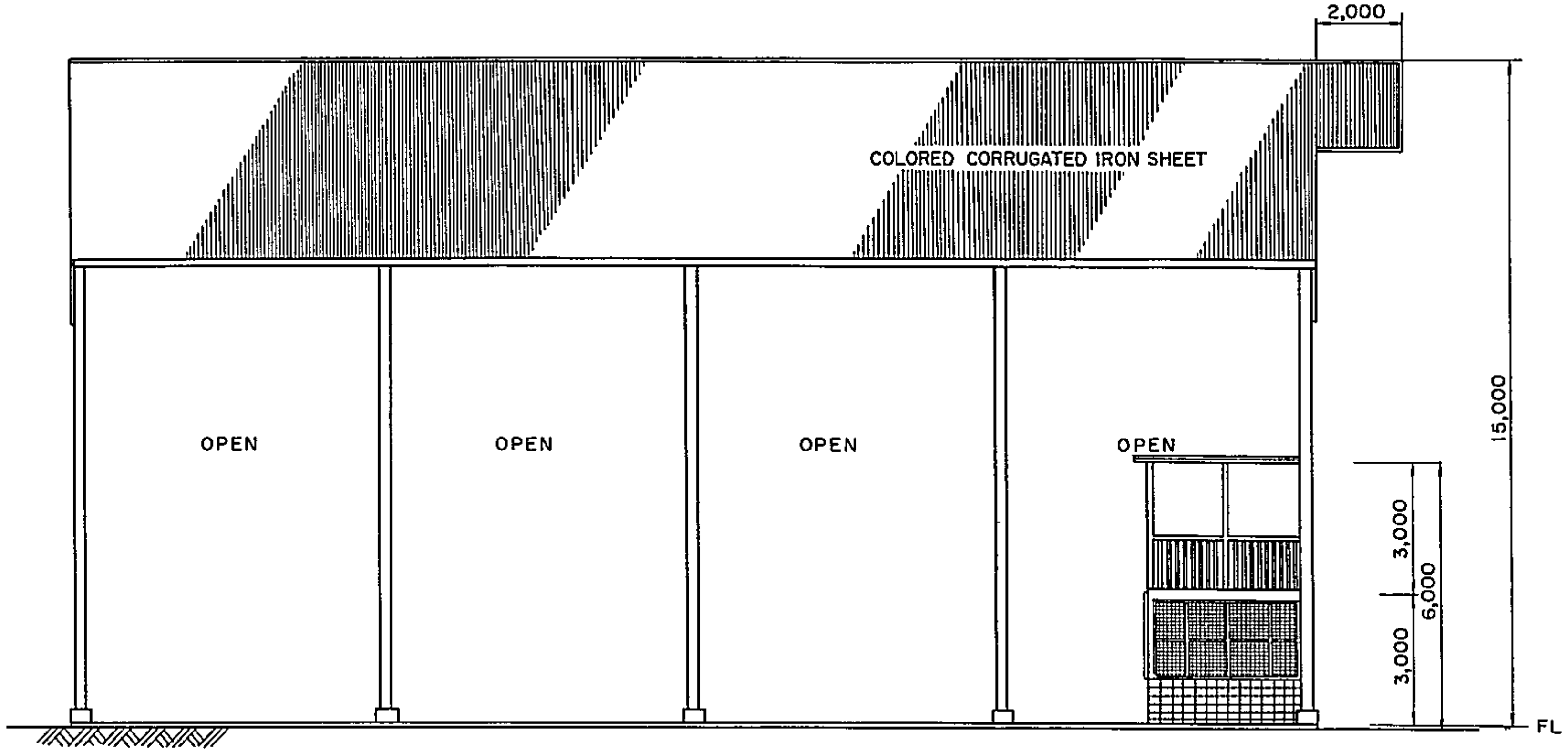
STRUCTURE & SIZE	:	STEEL STRUCTURE, 525 $^{M^2}$
FOUNDATION	:	REINFORCED CONCRETE
FLOOR	:	CONCRETE FINISHED BY TROWEL
WALL (OPERATION ROOM)	:	CONCRETE BLOCK, OVER HANG SASH WINDOW WITH WIRE NET
ROOF	:	COLORED CORRUGATED IRON SHEET

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	7
TITLE	MACHINE HOUSE PLAN (DESIGN – A)
SCALE	1/300
DATE	JULY, 1970



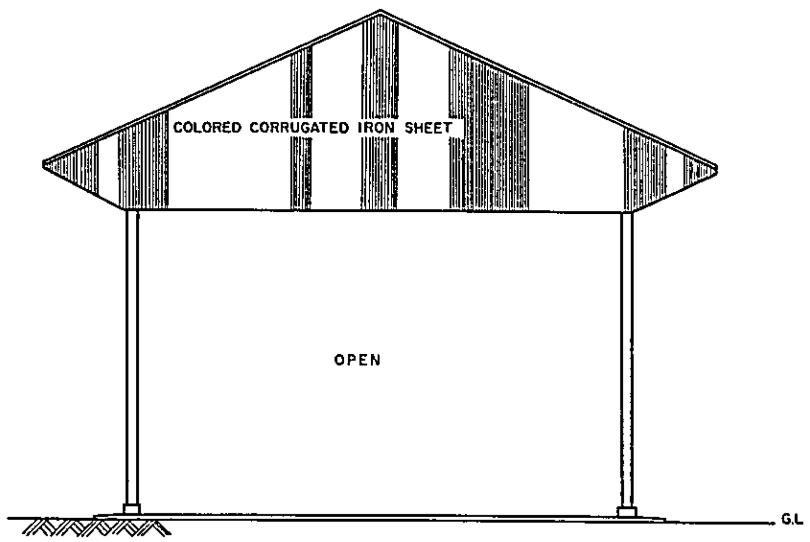
SECTION

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	8
TITLE	MACHINE HOUSE SECTION (DESIGN-A)
SCALE	1/159
DATE	JULY, 1970

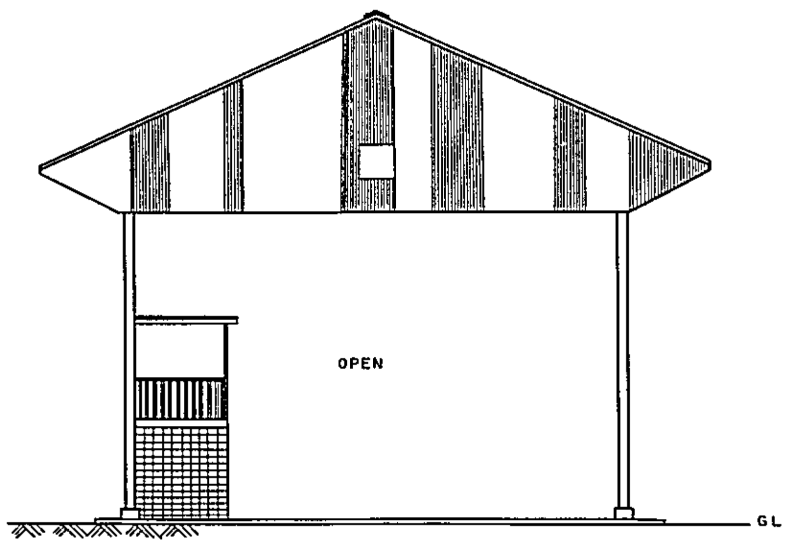


ELEVATION

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	9
TITLE	MACHINE HOUSE ELEVATION (DESIGN-A)
SCALE	1/154
DATE	JULY, 1970

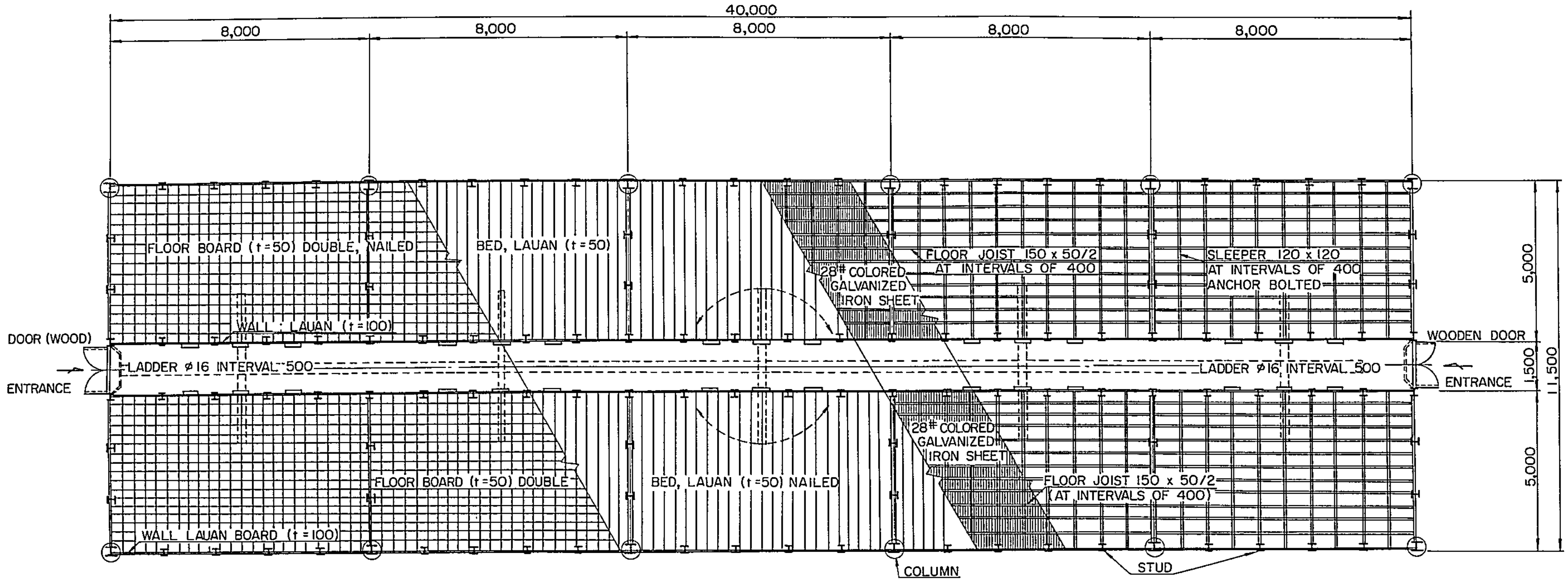


ELEVATION



ELEVATION

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	10
TITLE	MACHINE HOUSE ELEVATION
SCALE	1/202
DATE	JULY, 1970



— PLANNING OUTLINE —

STRUCTURE & SIZE ; STEEL STRUCTURE 460 M^2 000

FOUNDATION ; REINFORCED CONCRETE

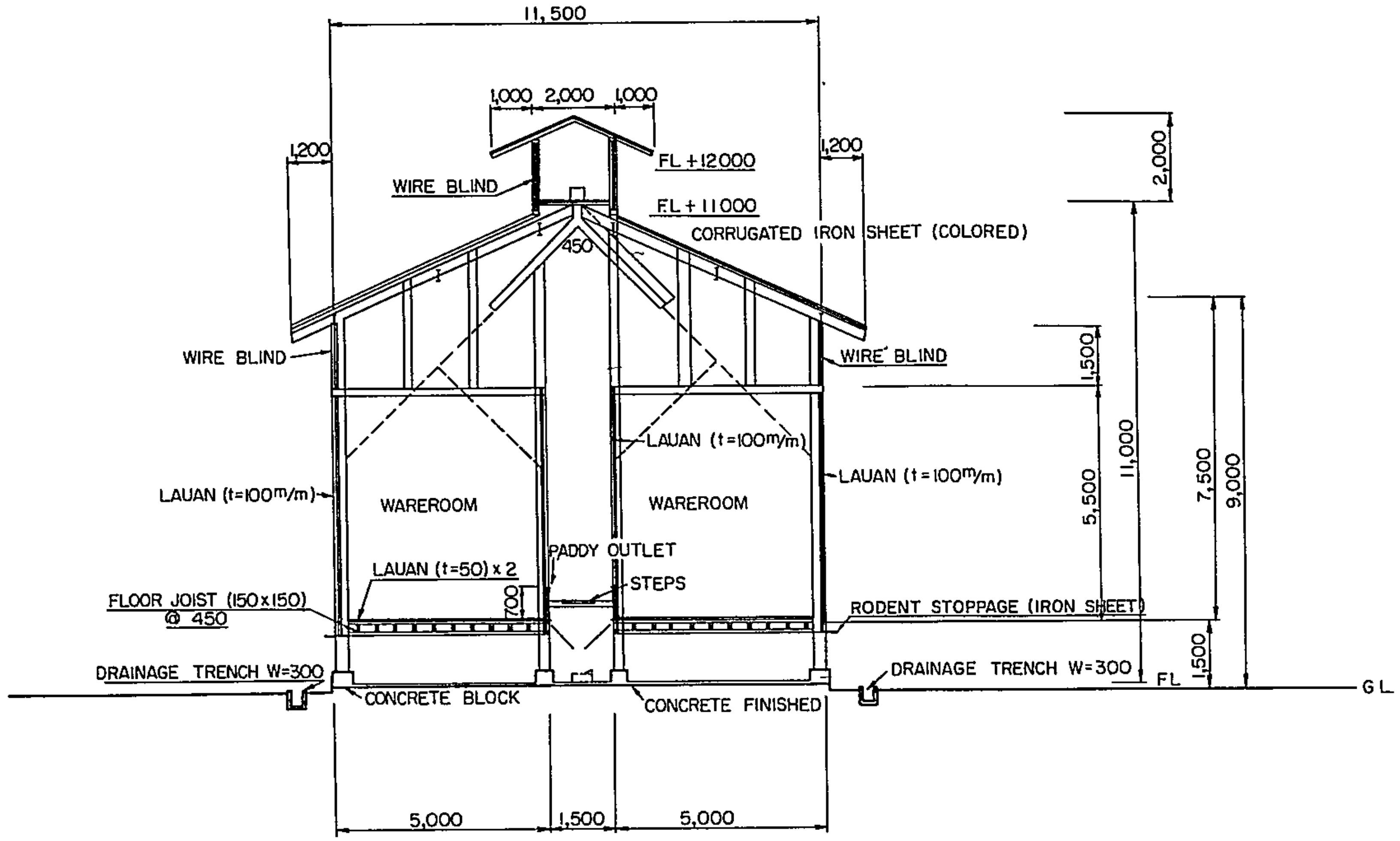
FLOOR ; DOUBLE, LAUAN BOARD (t = 50) x 2
AND CONCRETE ON THE GROUND

WALL ; LAUAN BOARD (t = 100)
(BOTH OUTSIDE AND INSIDE WALLS)

ROOF ; COLORED CORRUGATED IRON SHEET O.P.

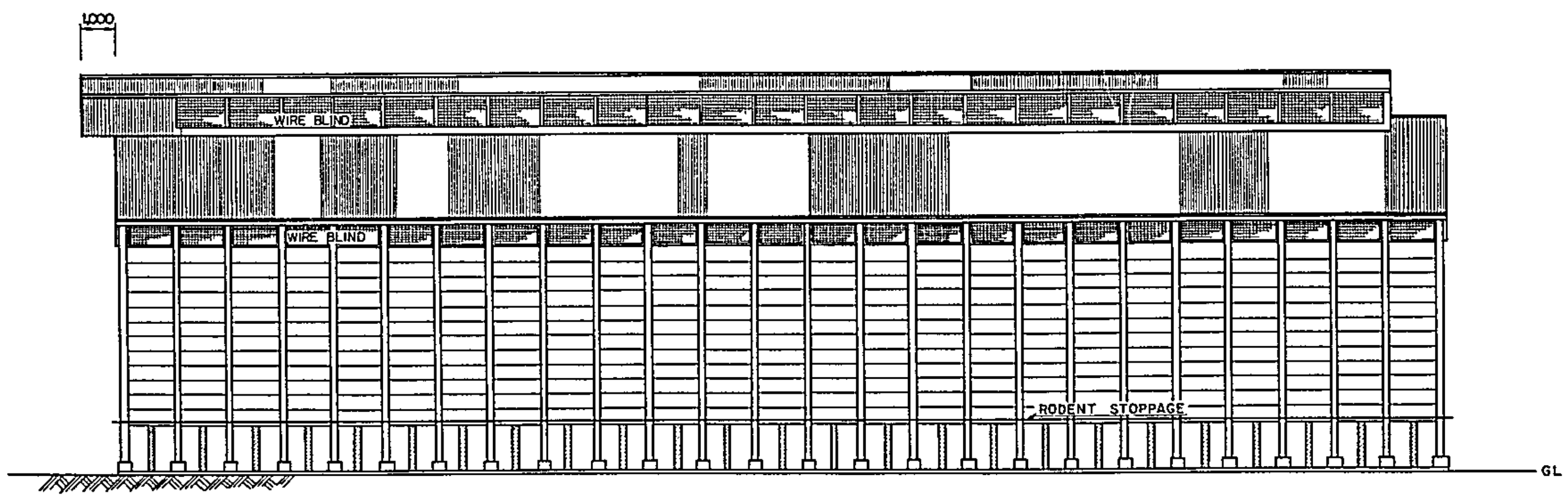
WAREHOUSE PLAN

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO.	11
TITLE	WAREHOUSE PLAN
SCALE	1/200
DATE	JULY, 1970



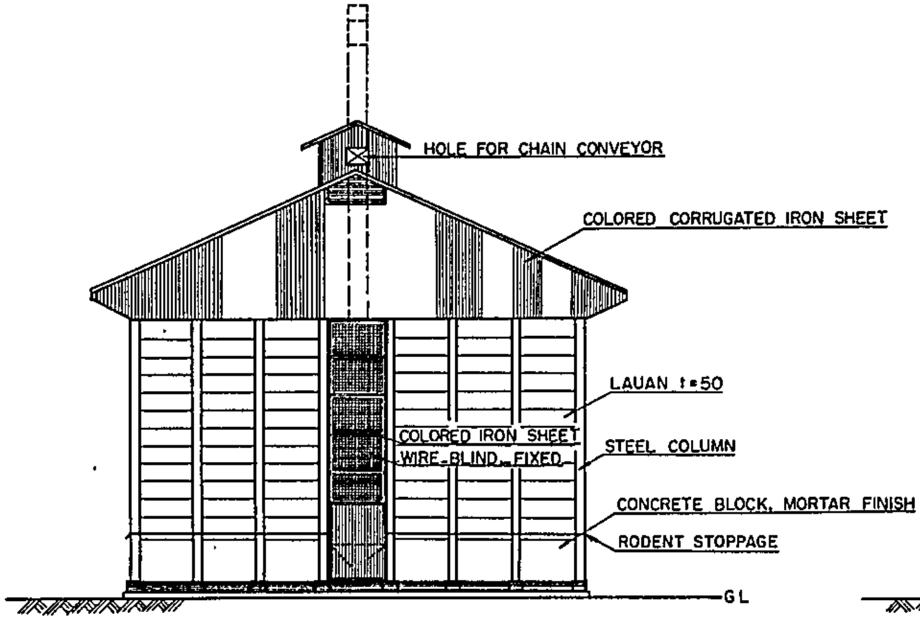
Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	12
TITLE	WAREHOUSE SECTION
SCALE	1/143
DATE	JULY, 1970

SECTION

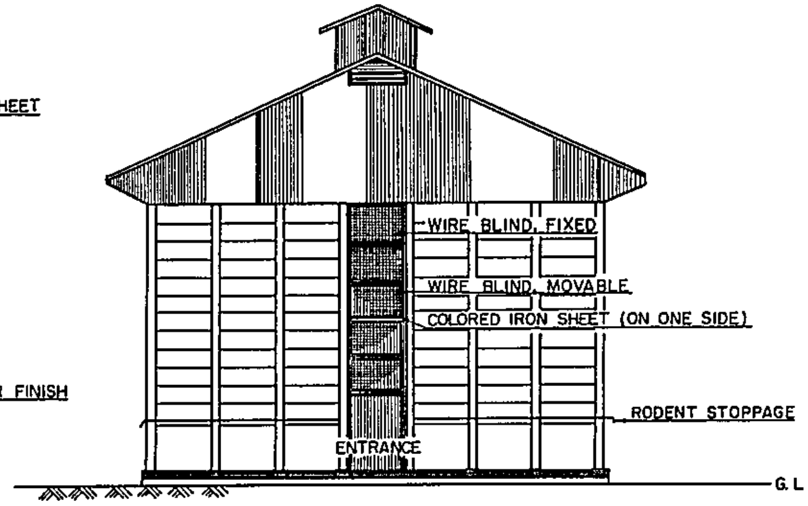


Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO.	13
TITLE	WAREHOUSE ELEVATION
SCALE	1/200
DATE	JULY, 1970

ELEVATION

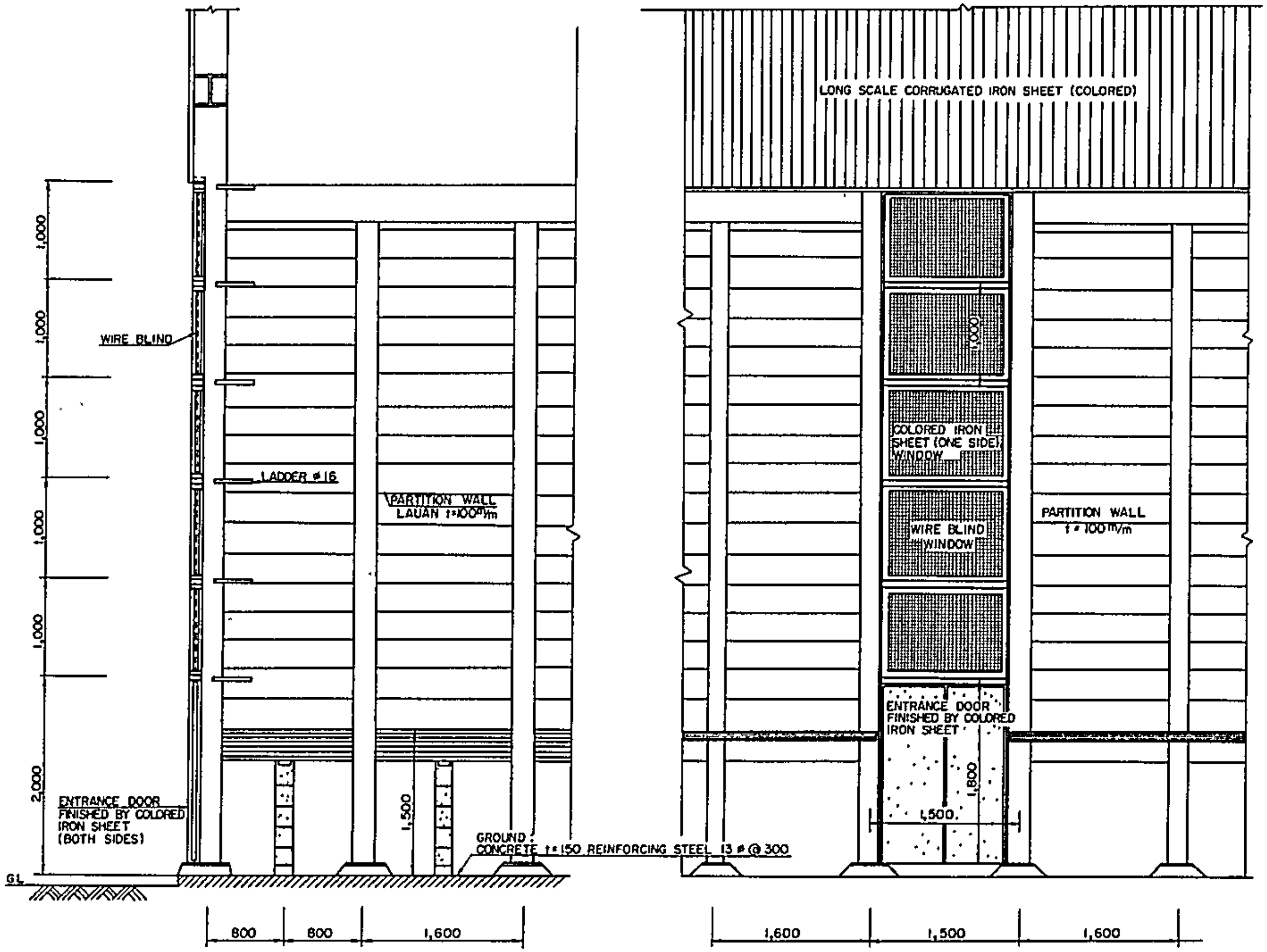


ELEVATION



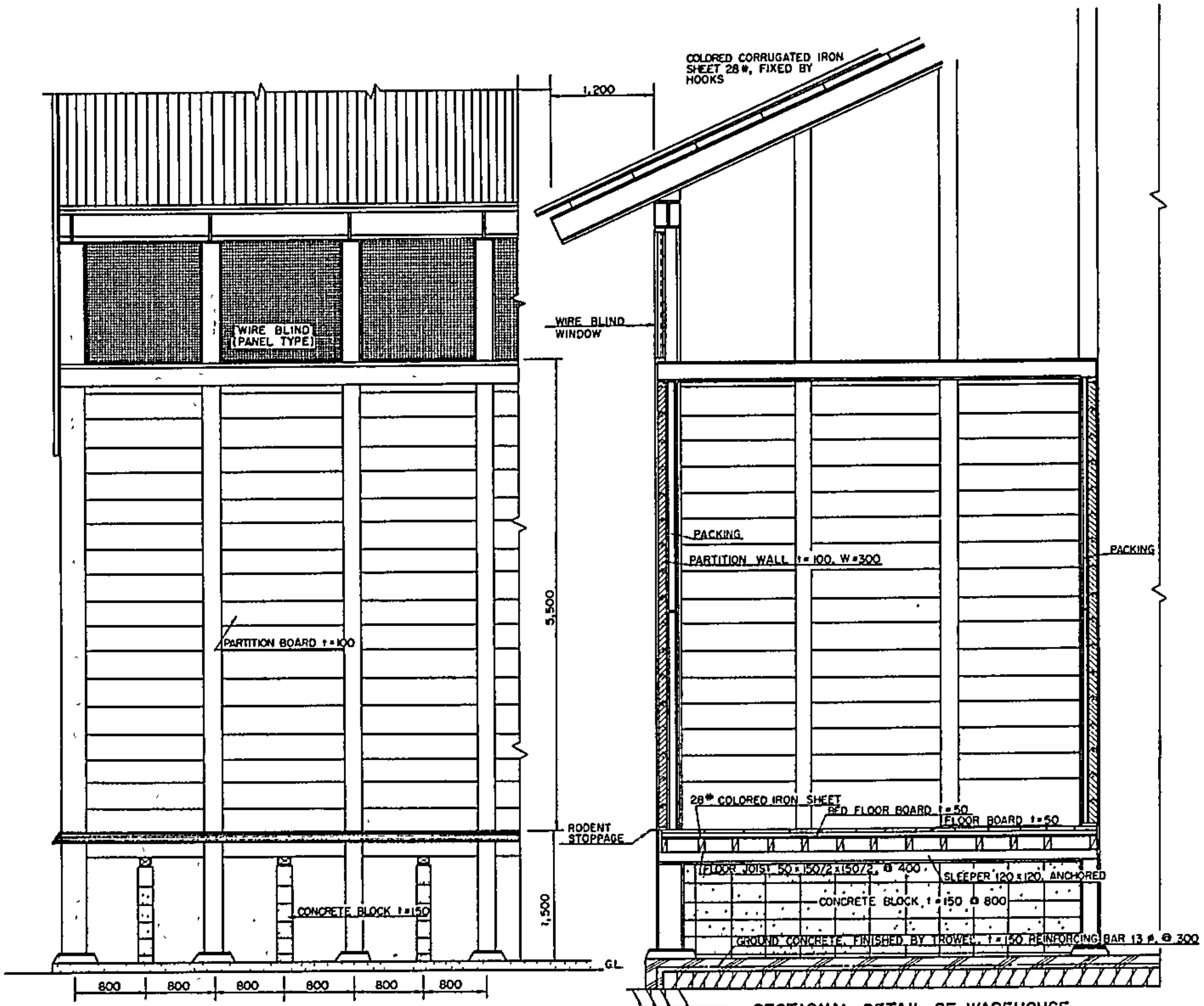
ELEVATION

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	14
TITLE	WAREHOUSE ELEVATION
SCALE	1/179
DATE	JULY, 1970



SECTIONAL DETAIL OF WAREHOUSE ENTRANCE

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	15
TITLE	SECTIONAL DETAIL OF WAREHOUSE
SCALE	1/111
DATE	JULY, 1970



SECTIONAL DETAIL OF WAREHOUSE

Overseas Technical Cooperation Agency	
Paddy Drying & Storage Project on the Muda Irrigation Scheme MALAYSIA	
DRAWING NO	16
TITLE	SECTIONAL DETAIL OF WAREHOUSE
SCALE	1/122
DATE	JULY, 1970

4. Estimated Cost of the Unit Complex

(1) Basis for the Estimation

i) The cost of machinery was estimated on the basis of the prevailing prices in Japan on the assumption that all the machinery (including auxiliary equipment) would be purchased from Japan. However, as the estimate was made on the cost of only those facilities and equipment which were the minimum requirements under the specifications, it is necessary to provide spare parts of the value equivalent to about 10% of the total estimated cost.

ii) Though construction materials for machine house, warehouse and generator house are available in Malaysia except a few items such as steel frame, etc., the estimate on the cost of construction materials in this case was based on the prevailing prices in Japan for the convenience of calculation.

iii) Though some of the machinery may be procured in Malaysia, assumption was made that all the machinery would be shipped from Japan as indicated in paragraph i) above and packing charges and shipping charges (Freightage between Yokohama and Butterworth) were roughly estimated.

iv) Though it may not be appropriate to estimate the cost of such field work as the installation of machinery and building construction on the basis of the the prevailing costs in Japan, a rough estimate was made for information purpose only.

v) Cost of land, expenses for the survey of land bearing capacity and the cost of earthworks were excluded from the estimate.

vi) As the estimate of the cost was made under the conditions stated above, it should be used only as a guide in the estimation of the cost by the Malaysian side. As specifications, drawings and a detailed estimate of the cost of buildings are attached to the report to aid the estimation in Malaysia, it will be necessary to make a re-estimate of the cost, particularly the cost of construction materials and the field work, using these information.

(2) Estimated Cost (For details, see next cumulative cost table)

Unit: M$

Description	Design A	Design B	Design C
(i) Machinery	450,260	575,710	621,790
(ii) Buildings	580,598	614,957	614,957
(iii) Others	163,250	194,880	203,410
(iv) Total	1,194,108	1,385,547	1,440,157

Note: Details of estimate on the cost of buildings are described in Appendix 2.

As shown in the above table, the estimated cost becomes higher in the order of Designs A, B and C.

The difference between Design A and Design B stems from the fact that against six dryers (with six feeding bins and six cooling bins) required by Design A, a total of 12 dryers are required by Design B with corresponding number of receiving facilities and conveying equipment and that the floor area of the machine house by Design B is larger than that by Design A.

The difference between Design B and Design C stems from the fact that while the number of dryers is the same for both designs, dryers with larger fans and furnaces are required by Design C with corresponding rise in the cost. Buildings are the same for both designs.

Estimated cost in Malaysia (For information only)

The above estimate on the cost was based on the conditions described in the foregoing paragraph i). The revised estimate with the consideration given to the existing situation in Malaysia will be as follows.

Unit: M$

Design	Original Estimate	Revised Estimate
A	1,194,108	998,000
B	1,385,547	1,176,000
C	1,440,157	1,226,000

The above revised estimate was based on the following conditions.

(a) The cost of machinery is to remain the same as in the original estimate.
(b) The cost of field work (buildings and installation of machinery) is to be reduced to about 1/2 of the original estimated cost.
(c) The cost of lumber among the construction materials is to be reduced to about 1/2 of the original estimated cost (The cost of steel frames which are assumed to be imported from Japan is to remain the same as in the original estimate).
(d) Some modifications are to be made to the cost of cement and aggregates by taking into account the local prices of these materials.

In the detailed estimate for buildings and related works (Appendix 2) the items marked as (Local) require a re-estimate by Malaysian side. Therefore, if an accurate estimate is made on these items and a re-study is made on the overall cost after checking into the posibility of purchasing some of the machinery in Malaysia, it will be possible for the Malaysian side to obtain a reasonable estimate on the cost.

(3) Detailed Estimate of Construction Costs for Buildings
See Appendix 2.

Table 10 Cumulative cost table of the unit complex (M$)

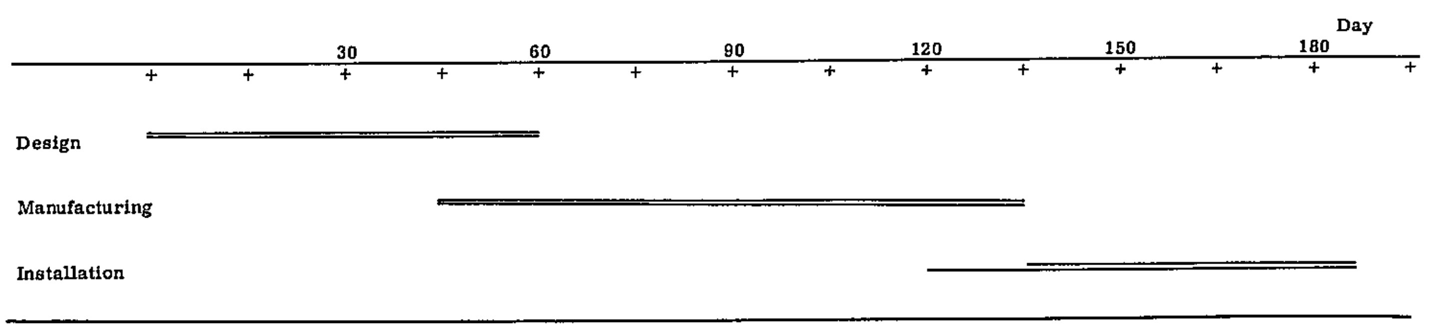
Description	Design A Spec.	Design A No.	Design A Price	Design A Total	Design B Spec.	Design B No.	Design B Price	Design B Total	Design C Spec.	Design C No.	Design C Price	Design C Total
1. Receiving												
(1) Receiving scale		2	6,840	13,680		4	6,840	27,360		Same as B		
(2) Receiving hopper		2	1,280	2,560		4	1,280	5,120		Do		
(3) Precleaner	6-10ton/hr.	2	12,820	25,640		4	6,840	27,360		Do		
(4) Frames & chute pipes		2 sets	1,280	2,560		4 sets	850	3,400		Do		
Sub-total				44,440				63,240				63,240
2. Drying												
(1) Dryer	5 ton	6	10,680	64,080	5 ton	12	9,570	114,840	5 ton	12	10,680	128,160
(2) Dryer fan		6	2,990	17,940		12	2,140	25,680		12	2,990	35,880
(3) Furnace		6	8,120	48,720		12	6,410	76,920		12	8,120	97,440
(4 Hot air duct & exhaust duct		6 sets	3,160	18,960		12 sets	2,990	35,880		12 sets	3,160	37,920
(5) Oil tank for dryer		1	5,980	5,980		1	5,980	5,980		1	5,980	5,980
(6) Fuel pump		1 set	3,850	3,850		1 set	3,850	3,850		1 set	3,850	3,850
(7) Feeding bin & cooling bin	5.5 ton	12	2,990	35,880		-	-	-		-	-	-
(8) Fan of feeding bin	5.5 ton	6	210	1,260		-	-	-		-	-	-
(9) Fan of cooling bin		6	850	5,100		-	-	-		-	-	-
Sub-total				201,770				263,150				309,230
3. Inspection												
(1) Electric resistance moisture meter		4	430	1,720		Same as A				Same as A		
(2) Infrared ray moisture meter		4	510	2,040		Do				Do		
Sub-total				3,760				3,760				3,760
4. Conveying												
(1) Receiving bucket elevator	5t/hr.x10m	2	3,290	6,580	5t/hr.x10m	4	3,290	13,160		Same as B		
(2) Bucket elev. to dryer	-	-	-	-	5t/hr.x10m	4	3,290	13,160		Do		
(3) Feeding chain conveyor	5t/hr.x15m	2	4,870	9,740	-	-	-	-		Do		
(4) Bucket elev. for dryer	10t/hr.x12.5m	6	5,560	33,360	*10t/hr.x12.5m	12	5,130	61,560		Do		
(5) Belt conv. for warehouse	20t/hr.x14m	1	3,590	3,590	20t/hr.x30m	1	7,260	7,260		Do		
(6) "	20t/hr.x3m	1	1,030	1,030	20t/hr.x3m	1	1,030	1,030		Do		
(7) Bucket elev. for "	20t/hr.x14m	1	11,110	11,110	20t/hr.x14m	1	11,110	11,110		Do		
(8) Chain conv. for "	20t/hr.x40m	1	17,000	17,090	20t/hr.x40m	1	17,090	17,090		Do		
(9) Belt conv. of outlet	15t/hr.x33.6m	1	7,180	7,180	15t/hr.x33.6m	1	7,180	7,180		Do		
(10) "	15t/hr.x8.6m	1	1,710	1,710	15t/hr.x8.6m	1	1,710	1,710		Do		
(11) Bucket elev. for cleaner	5t/hr.x9m	1	3,290	3,290	5t/hr.x9m	1	3,290	3,290		Do		
Sub-total				94,680	(*without chute pipes)			136,550				136,550
5. Cleaning & bagging												
(1) Buffer bin		1	2,560	2,560		Same as A				Same as A		
(2) Aspirator		1	5,300	5,300		Do				Do		
(3) Clean paddy bin		1	2,560	2,560		Do				Do		
(4) Auto-shutter		1	640	640		Do				Do		
(5) Scale hopper	60Kg	1	130	130		Do				Do		
(6) Platform scale	150Kg	1	170	170		Do				Do		
(7) Sewing machine		1	1,450	1,450		Do				Do		
(8) Frame & support		1 set	470	470		Do				Do		
Sub-total				13,280				13,280				13,280
6. Electrical device												
(1) Generating facility		1 set	47,000	47,000			47,000	47,000		Same as B		
(2) Oil tank of generator		1	3,420	3,420			3,420	3,420		Do		
(3) Fuel pump		1	1,710	1,710			1,710	1,710		Do		
(4) Distributing board, operation board and wiring materials		1	23,100	23,100			26,500	26,500		Do		
Sub-total				75,230				78,630				78,630
7. Warehouse facility												
(1) Throwing-in facility (chute pipe)		1 set	5,560	5,560		Same as A				Same as A		
(2) Discharging facility (shutter)		1 "	11,540	11,540		Do				Do		
Sub-total				17,100				17,100				17,100
Total (1 - 7)				450,260				575,710				621,790
8. Building												
(1) Machine house		1 set		122,308				156,672		Same as B		
(2) Warehouse		1 "		449,573				449,573		Do		
(3) Generator house		1 "		8,717				8,717		Do		
Sub-total				580,598				614,957				614,957
9. Packing charge of machines & equipments		1 set		68,380				76,920				76,920
10. Shipping charge		1 set		30,770				32,490				32,490
11. Installation charge		1 set		64,100				85,470				94,000
Sub-total				163,250				194,880				203,410
Grand total				1,194,108				1,385,547				1,440,157

Note: (1) The cost is estimated from construction of one unit of complex, so that it will be discounted to construct more than two complexes.

(2) The transportation fee from the port to the site and the dispatch expense of person for construction are excluded here.

(3) It takes about five(5) months to manufacture after order in Japan.

Reference: The time schedule for construction of 2000 ton-unit in Japan.



5. Operation of the Unit Complex

(1) Assignment and Number of Operating Personnel per Unit Complex

Assignment of personnel	Design A	Design B	Design C
Factory manager	1	1	1
Main staff (Agricultural mechanical engineer)	1	0.5	0.5
Auxiliary personnel (Night-shift workers)	1	0.5	0.5
Receiving and shipping personnel	2	2	2
Laborers	5	5	5

(2) Operating Expenses

i) Fuel Consumption of Fuel and Lubricant

Fuel for power generators and dryers and the consumption of fuel and lubricant is as shown in Table 11 and 12.

Table 11 Consumption of Fuel

Design	Machine	Number	Hourly consump. (liter)	Running hour (hour)	No. of Running day	Daily consump. (liter)	Total fuel consump. (liter)
A	Generator	1	57	24	42	1,368	57,456
	Dryer	6	14.3	16.5	42	1,415.7	59,459.4
	Total					2,783.7	116,915.4
B	Generator	1	57	24	42	1,368	57,456
	Dryer	12	9	17	42	1,836	77,112
	Total					3,204	134,568
C	Generator	1	57	24	42	1,368	57,456
	Dryer	12	14.3	17	42	2,917.2	122,522.4
	Total					4,285.2	179,978..4

Table 12 Consumption of Lubricant

Design	Diesel oil		Lubricating oil		Grease	
	Month (liter)	42 days (liter)	Month (liter)	42 days (liter)	Month (liter)	42 days (liter)
A	10	15	15	22.5	1.8	2.7
B	10	15	18	27	1.8	2.7
C	10	15	18	27	1.8	2.7

ii) Estimated Operating Costs per 2,000 ton Unit

Operating cost of the complex varies greatly with the calculation method to be used. In other words, operating cost varies depending on whether the annual personnel expense and depreciation cost should be burdened solely by the off season cropping, or whether depreciation cost or maintenance cost of buildings and warehouses should be added to operating cost, or whether salaries of all complex staff should be included in operating cost. For this reason, the operating cost shown in Table 13 is only an example of variable operating costs. The costs of lubricating oils and greases are included in repair and maintenance costs, however the table does not include depreciation of buildings, incidental expense such as personnel expense for office helpers and watchmen and interest on the capital cost.

Table 13 Example of operating costs

Unit M$

Item	Design A	Design B	Design C
1. Fuel (Generator, dryer) light oil	$19,291 @116,915.4 x 0.165¢	$22,204 @134,568 x 0.165¢	$29,786 @179,978.4 x 0.165¢
2. Repair & maintenance	$ 9,005 2 % of the cost of machine $450,260 x 0.02	$11,514 $575,710 x 0.02	$12,436 $621,790 x 0.02
3. Personnel expenses	$26,340 @ Factory manager: $6,900 575 x 12 months x 1 1 person	$22,200 Same as A	$22,200 Same as A
	@Main staff: $5,040 420 x 12 months x 1 person	$2,700 420 x 12 months x 0.5 person	Same as B
	@Auxiliary personnel $3,600 300 x 12 months x 1 person	$1,800 300 x 12 months x 0.5 person	Same as B
	Receiving & shipping personnel $3,600 150 x 12 months x 2 persons	Same as A Same as A	Same as A Same as A
	Laborer $7,200 120 x 12 months x 5 persons	Same as A	Same as A
4. Depreciation	$45,026 Depreciation will be made over a 10 year period 450,260 x 0.1	$57,571 Same as A 575,710 x 0.1	$62,179 Same as A 621,790 x 0.1
Total	$ 99,662	$113,489	$126,601

(3) Training Subjects

Among the operating personnel of the complex, the Factory Manager, who has overall responsibility of the plant and mechanical engineers, the main staff of the complex, are to be the object of training.

Subjects to be covered by training course are as follows:

1. Classroom activities
   a. Dryer and theory of drying
   b. Conveyor system
   c. Air-heating furnace
   d. Blower
   e. Feeding and discharge mechanism
   f. Fuel and lubricants
   g. Storage
   h. Quality standards and inspection
   i. Paddy cultivation
   j. Others

2. On-the-job training on the management and operation of the complex
   a. Management plan
   b. Paddy collection and transport plans
   c. Shipping and sales plans
   d. Cost accounting
   e. Operation of machinery

As no classroom activity is required for the training of machine operators, the acquisition of operating techniques is the main requirement for them. Therefore, on-the-job training at the complex for about a month will be sufficient.

(4) Points to be given Special Attention for the Operation of Complex

For the operation of the complex, it is necessary to establish careful and detailed paddy collection programs. It will be very convenient if the following sequence is followed in planning paddy collection.

Designation of paddy collection area for the complex (Accurate estimation of per acre yield) - Formulation of paddy planting programs for the designated paddy collection area (Determination of paddy varieties to be planted and planting period with consideration given to the harvesting season or paddy collection period) - Formulation of paddy cultivation management programs (Implementation of working plans focusing on fertilization and prevention of damage by disease and insects) - Formulation of daily harvesting programs (Harvest plan by taking into account reaping and threshing method and capacity) - Formulation of daily paddy collection programs (Plan with the consideration given to the distance of transportation and collection methods) - Modification of programs in actual operation of the complex (Even when the programs have been worked out in the above sequence the scheduled quantity of paddy collection may change sometimes due to weather condition at time of harvesting and for other reasons. Therefore, it will become necessary to adjust the quantity of paddy collection by taking into account the capacity of the complex so that a great fluctuation in the daily quantity of paddy transported to the plant may be avoided).

The operation of the complex should be based on these programs but special attention should also be given to the following points in operating the complex during the process subsequent to the collection of paddy.

i) Moisture Content of Paddy and Quantity of Paddy Collection

The maximum quantity of paddy, the unit complex can receive a day is 54 tons under Design A and Design B when the moisture content of paddy is 23% and 57 tons under Design C when the moisture content is 28%. In actuality, however, the moisture content of paddy transported to the complex from various parts of the region is not in such uniform range as 23% or 28%. Accordingly, if 57 tons of paddy with the moisture content of 28% was received, drying of this quantity in a day would not be possible under Design A. In other words, the quantity of paddy to be received in a day must be adjusted by taking into account the moisture content of individual paddy delivered. Relationship between the moisture content and the weight of paddy may be easily determined from Table 14. It is important, therefore, to know how to use this table and maintain appropriate quantity of paddy for the treatment in the complex at all times.

Table 14 Weight conversion table for paddy drying

Moisture content after drying % \ Moisture content before drying	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15
30																
29	.9859															
28	.9722	.9861														
27	.9589	.9726	.9863													
26	.9459	.9595	.9730	.9865												
25	.9333	.9467	.9600	.9733	.9867											
24	.9211	.9342	.9372	.9605	.9737	.9868										
23	.9091	.9221	.9351	.9481	.9610	.9740	.9870									
22	.8974	.9103	.9231	.9359	.9487	.9615	.9744	.9872								
21	.8861	.8987	.9114	.9241	.9367	.9494	.9620	.9747	.9873							
20	.8750	.8875	.9000	.9125	.9250	.9375	.9500	.9625	.9750	.9875						
19	.8642	.8765	.8889	.9012	.9136	.9259	.9383	.9506	.9630	.9753	.9877					
18	.8537	.8659	.8780	.8902	.9024	.9146	.9268	.9390	.9512	.9634	.9756	.9878				
17	.8434	.8554	.8675	.8795	.8916	.9036	.9157	.9277	.9400	.9518	.9639	.9759	.9880			
16	.8333	.8452	.8571	.8690	.8810	.8929	.9048	.9167	.9286	.9405	.9524	.9643	.9762	.9881		
15	.8235	.8353	.8471	.8588	.8706	.8824	.8941	.9059	.9176	.9294	.9412	.9529	.9147	.9765	.9882	
14	.8140	.8256	.8372	.8488	.8605	.8721	.8837	.8953	.9070	.9186	.9302	.9419	.9535	.9651	.9767	.9884

$$Y = \frac{100 - \alpha}{100 - \beta}$$

Y : Index of weight after drying

α: Moisture content before drying (%)

β: Moisture content after drying(%)

ii) Grading of Paddy by Moisture Content

It is advisable that paddy is dried under homogeneous conditions as much as possible. For this purpose, it is necessary to pay special attention to paddy cultivation methods and techniques to prevent variation in the quality of paddy at time of harvesting, as stated in paragraph (i) above. In actuality, however, it is extremely difficult to expect all the harvested paddy to be of uniform quality and therefore it is unavoidable that the paddy of different moisture contents are received and dried at the complex. Under current design, however, the adoption of batch type dryer is contemplated to cope with this situation and therefore no specific problems are considered to be encountered. In the case of 5 ton lot, for example, drying the paddy having different moisture contents, 23% or 28%, in the same lot will result in the finishing moisture content of 14%. This figure is the average and the variation may range from 12% to 16%. As a result, insufficient or excessive drying of paddy may be unavoidable. Therefore, when there is variation of 2 to 3% or more in the moisture content of the paddy, a separate lot must be provided or the paddy must be sorted out and dried in a separate dryer. To insure accurate sorting of paddy, the use of gunny bags with labels of different colors is very convenient.

iii) Measurement of Moisture Content of Paddy

To insure proper drying of paddy, the moisture content of paddy must be measured accurately. Two types of moisture meters - infrared ray type and electric resistance type - are available. When the moisture content of paddy is relatively high (Over 20%), the use of electric resistance type meter results in the error in a greater range and therefore the use of infrared type meter is recommended instead. For the measurement of transported paddy, infrared ray type should be used as a matter of course. However, this type requires a relatively long measuring time and it is desirable that several meters are provided to speed up the measurement. Operators of moisture meters must fully understand the procedures for the operation of the meter and sampling should be taken at over two different points, not one point, to insure accurate measurement.

iv) Pre-Cleaning of Paddy

The most important thing in the operation of cleaners including pre-cleaners and final cleaners is to maintain uniform flow-down and a constant flow rate. Variation in the flow rate will not result in satisfactory cleaning of paddy. The pre-cleaner adopted by the current design is equipped with the scalper which removes foreign matters of large size such as straw and jute strings and the aspirator which removes light materials such as dust and takes out small particles such as immatured paddy and finally selects out the grains of uniform particle size.

Attention must be paid to the fact that the weight of these foreign matters is included in the weight of paddy at time of initial scaling. From the weight of the transported paddy, the weight of finished paddy having the final moisture content may be obtained with the use of the weight conversion table described in paragraph (ii).

To maintain accurate information on "The weight at the initial scaling", "Weight of foreign matters", "Net weight", "Moisture content" and "Estimated weight at the finishing stage", it is necessary to provide and maintain recording cards.

v) Temporary Storage of Transported Paddy

The need for proper operation of dryer is, of course, an important factor but the way transported paddy is handled prior to drying operation is more important. As the dryer is used twice in a day under Design A, the dryer is equipped with an auxiliary storage bin with a ventilator. Under Design B and Design C, meanwhile, a paddy storage yard is considered. At any rate, it is very important to start drying of transported paddy as early as possible, within 8 hours in the case of paddy in storage bin and within 4 hours in the case of paddy stored in open yard. It is very likely, however, that the paddy is not handled properly on its way to the complex in some cases. For example, the paddy in gunny bags may be left in the paddy field or at roadside for a prolonged time under direct exposure to the sun and the paddy of deteriorated quality may be brought in to the complex in some cases. For such events, it will be necessary to take appropriate steps to check the quality of paddy at time of receiving and handle paddy of sub-standard quality as a separate lot.

vi) Operation of Dryer

The dryer designed under current design has a drying chamber with a holding capacity of about 4 tons and a holding tank placed over the drying chamber, with a holding check capacity of one ton. Thus, the total holding capacity of the dryer is about 5 tons. The main purpose of the holding tank is to prevent the decrease in drying efficiency when the content of the drying chamber (paddy) decreases in volume during drying process.

Prior to the start of drying operation, the dryer must be filled up with paddy first. As the dryer is designed to operate as simply as possible, no specific techniques are required on the part of operators. To insure accurate and stable drying, however, constant attention must be paid to the ventilation, temperatures, and quality of paddy during drying operation and to the moisture content at the final stage. Whether the ventilation is normal or not may be determined by checking the revolution of ventilator fan. It is important to check the revolution of the fan, as the speed of revolution decreases sometimes due to the slippage of belt or other reasons. As long as the revolution of the fan is normal, no special adjustment is required on the amount of ventilated air.

Strictly speaking, the temperature of hot air must be adjusted according to the change in the atomospheric temperature and relative humidity but generally it will be sufficient to control the temperature of hot air to the level of the atmospheric temperature plus 15 - 20 degrees C (To 45 degrees C when the atmospheric temperature is 30 degrees C). Under current design the maximum temperature in the dryer is set to 60 degrees C by adding 30 degrees to the assumed atmospheric temperature of 30 degrees C.

As the purpose of drying is to evaporate moisture contained in the paddy and carry the moisture out to the atmospher by means of ventilator, it is necessary to heat up the paddy to accelerate the evaporation of moisture. Therefore, the temperature of paddy ín the dryer must be raised to some extent but an excessive rise of the temperature brings about adverse effects on the quality of the paddy. Generally, drying at the temperature of 40 degrees C or so brings about satisfactory results within a specified drying time and without causing any damage to the quality of paddy. Besides, attention must be paid to the fuel feeding rate and proper operation of air valve on the furnace to insure complete combustion of fuel. Incomplete combustion of fuel often causes the paddy to give off an odor and degrades the quality of the paddy.

vii) Cooling

Cooling of paddy is accomplished mainly by shutting off furnace after drying and then blowing cold air into the dryer, as stated previously. Under Design A, however, cooling of paddy in the dryer is not possible and the first drying must be given in the cooling tank. Since there are two similar tanks provided under this design - storage bin and cooling bin - care must be exercised not to put paddy in the storage bin by mistake, because the volume of air flow in the storage bin is far less (about 1/5 of that in the cooling bin) and it is not possible to cool paddy within a limited time.

It is important to take paddy out of the cooling bin while maintaining the temperature of paddy within the atmospheric temperature plus 5 degrees C, though there is limit to the cooling time.

viii) Storage

Paddy after cooling is carried into storage house but under current design paddy may be shipped directly after final cleaning, when necessary. If procedures described in paragraphs (i) through (viii) above are followed and equipment are operated by qualified operators, there will be very little possibility for the deterioration of the quality of paddy in storage. It is important, however, to confirm the quality of paddy in storage by frequent inspection of the condition of warehouse and samplings at appropriate time.

ix) Maintenance of Equipment and Safety of Personnel

The maintenance of equipment is everyday's job and it is particularly important that equipment are thoroughly cleaned at the end of harvesting season. Also, unless equipment are maintained in good working condition through careful inspection and test operation prior to use in harvesting season, mechanical failure may develop during full-fledged operation of the complex.

Attention must always be paid to the safety of personnel at work. Care should be exercised to prevent accidents involving injury to personnel by conveyor belt or chains and fires which may be caused by careless handling of fuel and improper handling of furnace after drying operation.

6. Arrangement of Complexes in the Muda Scheme Area

(1) Estimation of Paddy Production in the Muda Scheme Area

The area benefited by the Muda Scheme, covering some 260,000 acres, is divided into 4 districts and the main course of the Kedah River divides the region almost equally into the North Region consisting of Districts 1 and 2 and the South Region consisting of Districts 3 and 4, as shown in Fig. 33. Each district is further divided into 5 to 9 localities and each locality is placed under the charge of Farmers' Association (hereinafter referred to as FA) which is responsible for the promotion of double cropping in the project area.

In determining the size and number of complexes, the first step to be taken is the estimation of paddy production in each locality. Shown in the Table 15 is the estimated production of paddy in each locality calculated on the area of paddy field by assuming the acre-yield to be 500 Gantangs (1.25 tons).

As no official figures were available as to the accurate acreage of paddy field in the South Region where revisions have just been made to the division recently, rough figures obtained from a map of 1 inch: 1 mile reduced scale with the use of a planimeter were used. While there is a wide distribution of Telok Series soil having extreme acidic and sulphurous nature, which belongs to Soil Class IV, in the central part of the district and covers more than a half of the whole paddy field, fertile Class I soil is dominant in the South Region with the exception of part at the southeastern corner where similarly acidic poor soils are seen. Convenience of irrigation and drainage may vary with each locality, but in view of the difficulty to make an accurate estimate on the yield in the coming off-season cropping for each locality and on the basis of the past statistics, Table 16 though there had been reports that the double cropping pilot farms, which had begun operation recently, achieved the level of 700 - 800 gtgs/acre, the acre-yield was estimated at a uniform level of 500 gtgs/acre for all localities. This estimate may be considered reasonable as a macroscopic estimate for the limited period of the next several years.

Table 15 Estimated paddy production by localities in the Muda Scheme Area

Localities	Paddy Acreage	Estimated Production per Season @1.25 ton/ac	Quantity to be treated by complexes
North Region			
District I			
A. Arau	6,910	8,638	4,000
B. Kuala Perlis	9,030	11,288	6,000
C. Kangar	4,990	6,238	3,000
D. Kg. Tambun Tulang	7,840	9,800	4,000
E. Simpang Empat	10,900	13,625	8,000
Sub-total	39,670	49,589	25,000
District II			
A. Kodiang	9,610	12,013	6,000
B. Lana Bulu Canal	11,650	14,563	6,000
C. Kuala Sanglang	11,540	14,425	7,000
D. Tunjang	9,840	12,300	6,000
E. Kub. Sepat/A.Biak	11,060	13,825	7,000
F. Ayer Itan	8,940	11,175	6,000
G. Jitra	7,690	9,613	5,000
H. Anak Bukit/K. Batas	8,820	11,025	6,000
I. Sg. Kub. Rotan	11,020	13,775	7,000
Sub-total	90,170	112,714	56,000
Total (North)	129,840	162,303	81,000
South Region			
District III			
A. N-E of Alor Star	14,854	18,567	9,000
B. Limbong Tajar	12,224	15,280	8,000
C. Derga	11,546	14,432	7,000
D. T. H. Idris (Tobiar)	11,987	14,984	7,000
E. Bukit Raya	8,192	10,240	5,000
F. Pendang	4,371	5,464	3,000
Sub-total	63,174	78,967	39,000
District IV			
A. Telok Chengai	11,181	13,976	7,000
B. Peng. Kundor	5,958	7,448	4,000
C. Kangkong	10,214	12,768	6,000
D. South of Sg. Sala	8,730	10,912	5,000
E. Sg.-Choras	12,845*	16,056	8,000
F. Sg.-Daun	8,781	10,976	5,000
G. Dulang	9,363	11,704	5,000
Sub-total	67,072	83,840	40,000
Total (South)	130,246	162,807	79,000
Grand Total	260,086	325,110	160,000

* Including Banggol Sawa, located southeast corner

Table 16 Statistics on paddy acre-yield in Kedah State

Unit: Gantangs/Acre

Year	Main season	Off-season	Year	Main season	Off-season
1950-51	419	281	1960-61	505	476
1951-52	350	563	1961-62	443	451
1952-53	440	481	1962-63	471	390
1953-54	405	411	1963-64	367	354
1954-55	379	528	1964-65	521 (534)	463
1955-56	379	367	1965-66	527 (537)	492
1956-57	406	460	1966-67	523 (541)	449
1957-58	397	553	1967-68	436	416
1958-59	347	543	1968-69	451	391
1959-60	450	423	1969-70	395	-
Average for 51-60	397	461	Average for 61-70	464 (468)	431

Source: Revised Paddy Statistics, 1950-1967. Kuala Lumpur, Feb., 1968
(For 1968-70 .... Statistics of Kedah State Government)

Note: 1. Figures of acre-yield are based on harvested area (not on planted area), however figures in brackets are obtained from the total production divided by harvested area.

2. Average on main season crops for 20 years are 430.5 (432.6) gtgs/acre.

3. Acreage for off-season crops exceeded over 2,000 acre only after 1962. Average for 8 years after 1962 is 425.7 gtgs/acre.

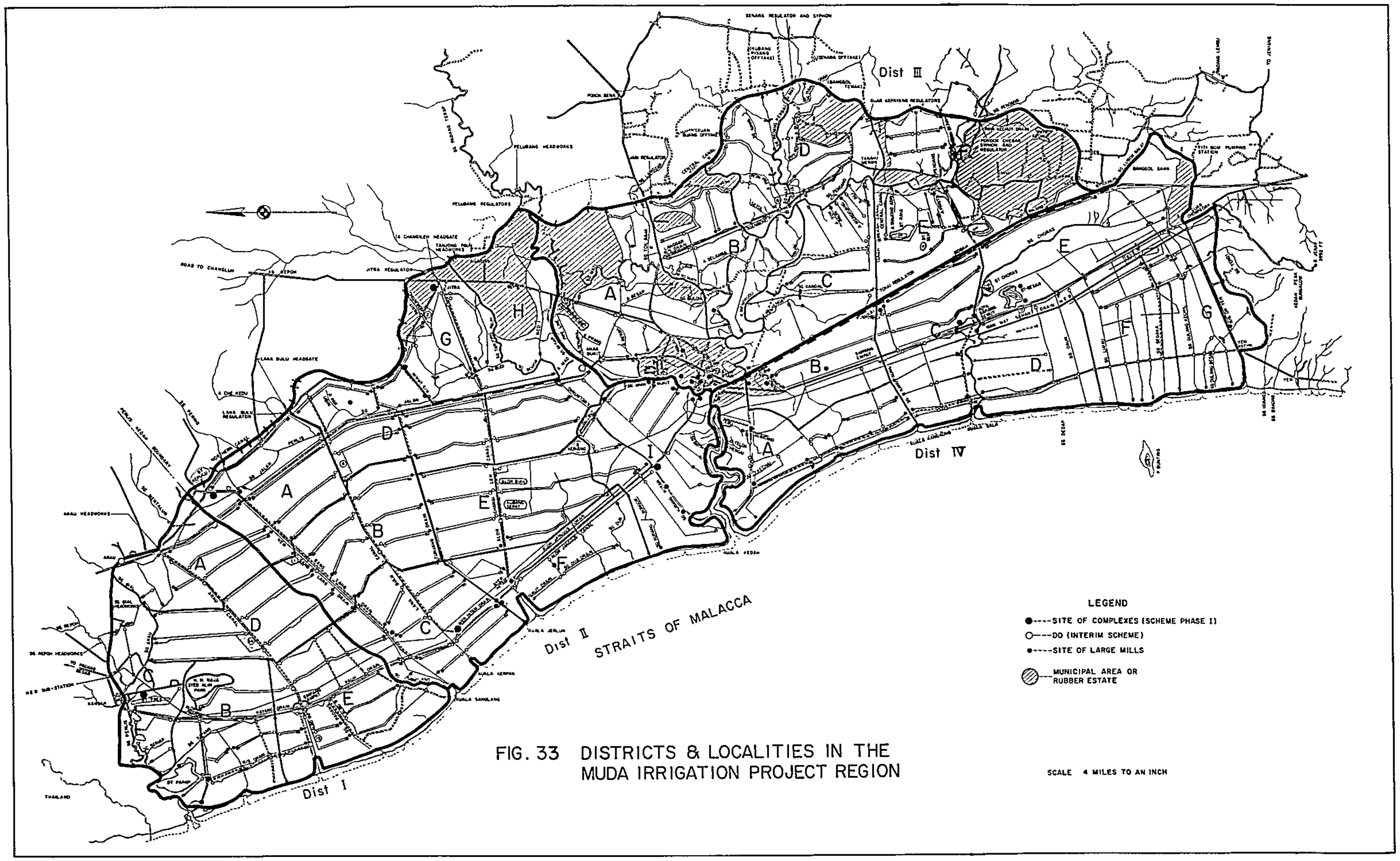


FIG. 33 DISTRICTS & LOCALITIES IN THE MUDA IRRIGATION PROJECT REGION

According to Table 15 the production of paddy in each of North and South Regions is more than 160,000 tons. Since the plans worked out by FAMA and MADA authorities envisages artificial drying of 50% of the total production, the total quantity of paddy to be treated in the whole project area is estimated as 160,000 tons.

Figures for each locality shown in the table represent a half of the estimated production but some allowances were made for certain localities by the soil map.

(2) Farmers' Association and the Method of Paddy Collection

For final arrangement of complexes, the area and method of paddy collection as well as the level of paddy production must be known first but there still are many uncertain factors.

FA is expected to play a leading role in the collection of paddy as well as in paddy production. However, the inauguration of FA coincides with the start of double corpping in all the localities and therefore it seems rather difficult to expect much from FA under present circumstances.

The majority of farmers will be cultivating double crops after 1971 for the first time and if the result of this attempt is not satisfactory in comparison with their efforts, farmers will lose interest in the continuation of double cropping. It is absolutely important, therefore, to take some measures for the encouragement and protection of farmers.

The establishment of FA, which provides guidance for farmers on technical matters and furnishes farmers with necessary supplies and aims at marketing farm products under favorable conditions for farmers, has been promoted throughout the country as a pure farmers' organization under the auspices of the Division of Agriculture. In the case of Muda Scheme area, however, the start of double cropping seems to have prompted the organization of FA.

In this country farm houses are arranged along the roads or rivers in a line and there is no center in the village. In some cases, even the village limits are not distinct. Besides, the number of farm households fluctuates greatly each year and an accurate estimate on the number of farmers is said to be very difficult. The efforts of MADA in establishing localities as a unit of FA by overcoming various difficulties peculiar to the locality and unfamiliar to the activities of agricultural associations, must be appraised highly. In actuality, however, the collection of paddy at the initial stage of double cropping must be handled by agents which include FA, too. Designated dealers purchase paddy from farmers with the licence and loans provided by FAMA and deliver paddy to the complex. When they achieved the level exceeding the quantity specified by FAMA according to the amount of loans they received, they will be able to deliver the quantity in excess of their obligation to other millers. The members of FA are not necessarily obligated to sell their paddy to FA and there is also a limit to the amount of funds, FA can furnish to the farmers. Consequently, there will be severe competition among agents in the collection of paddy in terms of both quality and quantity of paddy. It will be extremely difficult to grasp the whole picture of distribution channel for paddy, and to forecast the area of collection in advance under present condition even when the location of complexes was finally decided. Assuming that considerably a large quantity of paddy is flowing out of the localities and districts, it is considered more advantageous to locate the complex in the site convenient for transportation and adopt the centralized drying system from a commercial point of view. On the other hand, it is very likely that the localities not favored by good roads will remain as the production area of low grade paddy and farmers will lose interest in the double cropping. This is not only in contradiction to the purpose of the complex which aims at promoting the benefits of farmers and expanding paddy production but also diminishes the significance of establishing localities as a place of FA's activities. In order to satisfy these conflicting demands, a compromise must be worked out from a long-range point of view.

The capacity of drying facilities possessed by the millers in Kedah State as of June 1970 is estimated at about 9,600 tons/30 days. These millers are not capable to handle 50% of the total paddy production even with the expansion of their facilities and therefore will not be in competition with FAMA's complexes in artificial drying of paddy in the near future. But their abilities in sun-drying can not be ignored. It is also conceivable that the farmers in the area under favorable location conditions give sun-drying to their crops, though in limited scale. Therefore, the degree of utilization of the complexes by farmers will be a major factor in determining the capacity of each complex. If the collection of paddy falls short of the estimated quantity, the complex will prove to be a waste of investment. It will be safe, therefore, to establish complexes of a moderate size initially and plan for gradual expansion of their capacity in the future (The reason for giving conservative estimate on the acre-yield in the report was to be on the safe side in this respect).

(3) General View on the North Region

In the North Region where reticulation system had been in progress for several years, the first off-season cropping began in 1970 and the area of cultivation was estimated at 80,000 acres. As a provisional measure to meet the requirement for drying the paddy of off-season cropping, FAMA decided to provide three large complexes, each having a capacity of 10,000 tons. Construction of these complexes was nearing completion when the survey was made by the team. As double cropping will be practiced in almost the whole region in 1971, the establishment of large identical complexes in five localities was planned under the Project First Phase and the land was already acquired in preparation for the construction. It is understood that the three complexes constructed under interim scheme will be relocated to any of the five localities mentioned above. Now, something must be done for the remaining 3,000 tons out of the 8,000 tons, the total quantity to be treated within the region.

District 1 covers paddy fields in Perlis State and is divided into A, B, C, D & F localities. The land for the construction of a complex has already been acquired south of Kangar, the State capital. As the quantity of paddy requiring treatment in C locality amounts to only 3,000 tons, it will be possible to bring 2,000 tons from neighboring A locality, 3,000 tons from B locality and 2,000 tons from D locality.

It will be more practical to transport part of the remaining quantity to District II but this matter will be discussed further at a later stage. Here, in order to set a policy of handling the paddy within the State, promote the moral of

FA and ensure impartial development of all localities, the plan which envisages the establishment of one complex in each locality will be taken up for discussion.

For A, B and D localities, small complex having a capacity of 2,000 tons to 3,000 tons may be sufficient but E locality will require a complex having a capacity of 8,000 tons. D locality is situated in the zone where soils are extremely acidic and therefore, the promotion on acre-yield would be difficult. On the other hand, the most of E locality are under favorable condition having Class I soils and the above figures are the result of adjustment made on the estimated production shown in Table 15.

Though the area along the coast in E locality includes some portions where off-season cropping is expected to begin in 1972, it is advisable to make allowances for extra capacity for the event the acre-yield exceeds the estimated production.

District II. This district covers an extensive area between Perlis/ Kedah boundary and the Kedah River and is divided into nine localities, from A to I. The localities where construction of large complexes is planned under the Project First Phase are A, C, G and I localities. Assuming that the holding capacity of one complex is 10,000 tons, the quantity of paddy transported to the complex will be as follows.

Locality	Location	Quantity to be treated within locality (tons)	Quantity transported from outside of locality (tons)
A	Kadiang	6,000	2,000 from B, 2,000 from D
C	Simpang Empat Kerpan	7,000	2,000 from B, 1,000 from F
G	Jitra	5,000	2,000 from D, 3,000 from H
I	Sungei Baru	7,000	1,000 from E, 1,000 from F

As a result, each of the remaining localities - B, D, E, F and H - will need additional facilities having a capacity of 2,000, 2,000, 5,000, 4,000 and 3,000 tons respectively. It is desirable that these additional complexes be located close to FA office as long as the location condition is permissible in view of the above stated purpose.

Since the North Region must have the facility for 80,000 tons completed by the time of off-season harvesting in 1971, construction of one additional complex in each of the nine localities in addition to the five localities planned by FAMA is considered unreasonable from the standpoint of limited time.

Even when the shortage of treating capacity under the Project First Phase is compensated by the establishment of a large complex, there will still be need for the construction of three additional complexes. Assuming that each of these additional complexes is located (1) in the vicinity of Simpany Empat, District I-E, (2) in the vicinity of Tunjang, District II-D and (3) in the neighborhood of Alor Biak FA, District II-E, respectively, the estimated quantity of paddy collected will be as shown in the Table 17. Tunjang seems to be a little too close to Jitra but each of the five roads along the irrigation or drain canals will be linked to one of the complexes and traffic will be more convenient.

Table 17 Estimated quantity of paddy to be treated by complexes in the North Region

Locality	Quantity to be treated within locality (ton)	Quantity expected to be transported from outside of locality (ton)	Total (ton)
Dist-I C	3,000	4,000 from B 1,000 from D	8,000
E	8,000	2,000 from B 3,000 from D	13,000
Dist-II A	6,000	4,000 from A 2,000 from B 4,000 from 1-A	10,000
C	7,000	2,000 from B 3,000 from F	12,000
D	6,000	4,000 of D 2,000 from A 2,000 from B	8,000
E	7,000	3,000 from H	10,000
G	5,000	2,000 from D 3,000 from H	10,000
I	7,000	3,000 from F	10,000
Total in North region	81,000		81,000

The above is the movement of paddy on the assumption that there will be no change in the present road network. It is also known from the above table that there will be a considerable fluctuation in the quantity of paddy to be handled in each complex. With the batch system, however, the number of dryers in each complex may be adjusted without restrictions when need arises and the design of the complex may be determined according to the requirement of each locality. Assuming that the size of all complexes is uniformly determined to be 10,000 tons, there should be no difficulties in filling each other's needs because of good road network connecting each complex.

It will be necessary to provide telephone communication system between complexes and between FA offices and complexes to ensure smooth collection of paddy. If the capacity of one complex is expanded, the number of complexes required may be reduced accordingly but further efforts should be made for the improvement of road network. What is needed most as a prerequisite to the establishment of complexes is to improve road network by paving the aforementioned five travers roads as early as possible and select roads among many farm roads along the distributary(every other road, if possible) for improvement to enable the passage of 1 to 2 ton lorries even in the rainy season. It is also advisable to extend the road between Kuala Perlis and Raja Syed Alwi Park to the vicinity of Arau and build a new road from Simpang Tiga, Kulang Rotary to Jitra. As two highways run from north to south along the main canal and the coast side transportation of paddy by large lorries will not be difficult if improvements were made to the above mentioned traverse roads. Eventually, it will be necessary to build a new center highway to connect FA office in Alor Biak with Kangar. Under the First Phase Project of FAMA, each complex is to be provided with five 6.5 ton lorries. The traffic of such heavy vehicle is possible only on the highway and improved traverse roads. Farm roads will only be able to allow the traffic of 3 ton lorries at the most even when the farm roads are improved to the extent possible.

Under current project it is necessary to reload bags of paddy at the collection points but if the complex dispersion plan was adopted, 2 to 3 ton lorries will become the main force of paddy transportation and the trouble of reloading of paddy will be eliminated. Transportation of paddy from paddy fields to farm roads is a major obstacle to the improvement of paddy collection method and many difficulties are anticipated. This subject, however, will be taken up at a later stage and the discussion will be limited to pointing out the close relationship between the location of complex and the road improvement project.

(4) General View on the South Region

This region is situated south of the Kedah River and the inland area bordered by the railway line is designated District III and the area along the coast is designated District IV. While District III is divided into six localities - A to F - and has a complicated topography and waterway systems, causing inconvenience for transportation, District IV has orderly waterways and may be regarded as an extension of the North Region.

District IV is divided into seven localities - A to G. Generally speaking, waterway facilities in this region lag behind the North Region and only A locality in District III is scheduled to start off-season cropping in 1971. The quantity of paddy to be treated in this locality is estimated at about 9,000 tons. In B, C and E localities of District IV the area of off-season cropping in 1971 is a half of the total acreage and the production in each locality is estimated at 2,000 to 3,000 tons. The quantity of paddy requiring treatment is estimated to amount to about 7,000 tons. As a provisional measure, it is more realistic to provide two complexes in this district.

In District III -A, construction of FA office is planned at the point where the road branches off at Hutan Kampong. This point is the center of the locality and occupies a strategic point of traffic, therefore it is advisable to provide a complex having a capacity of 10,000 tons at this point. Though the idea of retaining the existing complex in Anak Bukit may be justifiable as a provisional measure to handle crops harvested in 1971, it is still important to secure land for the construction of a new complex. Off-season cropping is scheduled to start in the part of adjoining B locality in 1971 but the paddy harvested may be handled together with the paddy produced in A locality.

For District IV, the establishment of one complex having a capacity of 10,000 tons in the vicinity of Simpang Empat will be sufficient to accommodate crops from three localities - B, C and E - in terms of quantity. In the case of E locality where there is not a single good road, extreme difficulties are expected in the transportation of paddy. For this reason, it is advisable to provide one additional complex in Kg. Bt. Menunggol, District IV-E, along the main road. In such a case the capacity of the complex in Simpang Empat may be set at 5,000 tons and that of the complex in Bt. Menunggol may be set at 2,000 tons with the intention of expanding the capacity in and after the following year. It is advisable that the arrangement of complexes be preceded by a road network improvement project.

In District III there is only one highway which runs from north to south. It is essential, therefore, to improve this highway to make it capable to handle traffic of heavy vehicles and build an additional good road. The new road should be routed almost in parallel to the existing railway line to connect Junun with Alor Star. Then it will also be necessary to build new traverse roads running in the east-west direction to connect the above two main highways. It is desirable that at least four traverse roads be provided, one in each of B and E localities and two in C locality. These roads should extend to the east end so that D and E localities may be benefited.

In District IV, the B'worth - Alor Star highway runs through almost the center of the district and the pavement of the road along the coast is being progressed. When the above mentioned new road which runs in parallel to the railway line is completed, transportation of paddy in B, C and E localities will become more convenient. With the addition of these roads, the road network in the northsouth direction will be complete but as far as the east-west direction is concerned, it is necessary to build three or four new roads to connect highways running in the north-south direction. As the traffic volume on the highway increases every year and the complexes located right along the highway may become an obstacle to the traffic in the future, it is advisable to provide complexes a little far from the roadside.

An estimate on the quantity of paddy to be treated in the whole South Region by year is shown in the following table. If one complex is to be provided in each locality, the capacity of each ones will be as shown in Table 18, under the column Total (A). The capacity and the area of paddy collection for each complex in the event of the adoption of the policy of establishing large complexes following the pattern in the North Region is also shown under the column Total (B).

Table 18 Estimated quantity of paddy to be treated by complexes in the South Region

Locality		Year 71	72	73	Total (A) (ton)	From outside of locality	Total (B) (ton)
Dist-III	A	9,000			9,000	3,000 from B	12,000
	B		8,000		8,000		
	C		4,000	3,000	7,000		7,000
	D			7,000	7,000	5,000 from B	12,000
	E		3,000	2,000	5,000	3,000 from F	10,000
						2,000 from IV-E	
	F			3,000	3,000		
Sub-total		9,000	15,000	15,000	39,000		
Dist-IV	A		3,000	4,000	7,000	2,000 from B	7,000
	B	2,000	2,000		4,000		
	C	3,000	3,000		6,000	2,000 from A	10,000
						2,000 from B	
	D			5,000	5,000	2,000 from E	12,000
						5,000 from F	
	E	2,000	4,000	2,000	8,000		
	F		5,000		5,000		
	G			5,000	5,000	4,000 from E	9,000
Sub-total		7,000	17,000	16,000	40,000		
Total		16,000	32,000	31,000	79,000		79,000

Although no final decisions had been made on the site of each complex at time of the survey by the team, FA offices had informally decided to locate all along the highways. This arrangement may be unavoidable under present road conditions but the offices will have to be located on the outer line of each locality in many case if FA's decision become formal and such arrangement will not be convenient for FA's activities. For the localities where double cropping is scheduled in and after 1972 there is still sufficient time to reconsider this plan. It is advisable that a further study be made on the location of complex by taking into consideration the aforementioned new road project. Construction of FA office and the complex side by side will require a tract of 7 to 8 acres and the acquisition of land along the highway is considered quite difficult. There are a considerable number of localities where the selection of suitable site for FA office can not be made unless new roads are provided.

(5) Estimation of the Cost of Large Scale Complex

An attempt would be made to calculate the cost of complex of 10,000 ton capacity. Theoretically, the complex of 10,000 ton capacity will require five units for one unit is designed for a capacity of 2,000 tons. In actuality, however, a total of four units will be sufficient for the complex of this size by the operation for 5 days more, since the design of the unit allows for reserve capacity to a considerable extent. See 3-(3)-ii)

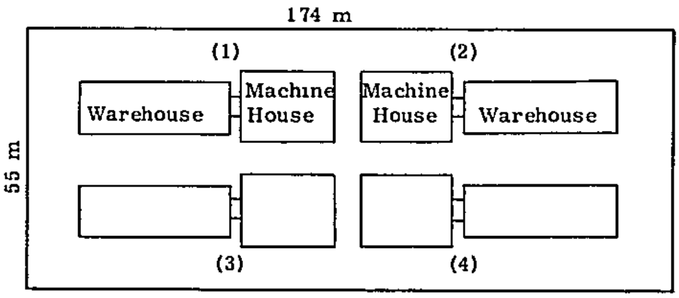
Maximum capacity of the unit will be:

5 tons x 6 dryers x 2 cycles = 60 tons/day

60 tons x 42 days = 2,520 tons (Wet) = 2,256 tons (Dry)

2,256 tons x 4 = 9,024 tons   10,098 tons per 47 days

In this case, the following arrangement of machine house, concentrated in the center, as shown in the chart below, will be convenient for the management of complex.



Land area including lorry roads will be 174m x 55m = 9,570m^2 = 2.36 acre (See Drawing 1), however the capacity of warehouse is limited to 4,000 tons.

An estimate on the cost of the 2,000 ton unit, described in Chapter 4 may be reduced by the discount of price when an order was placed for a large number of units, but in this calculation a simple multiplication will be used. Expense for the dispatch of engineers at time of construction is not included. Assuming that the unit under Design A and the cost of M$998,000, which is a revised estimate of one unit are used for the calculation, the cost of one complex will be as follows. Figures in bracket represent a total of 5 units.

Cost of land	25,000	According to FAMA
Cost of civil work	352,640	
Cost of complex	3,992,000	998,000 x 4
	(4,990,000)	(998,000 x 5)
Total	M$4,369,640	
	(5,367,640)	

For 16 units, the cost will be M$69,914,240 (85,882,000). When 5 complexes planned under the First Phase Project are excluded, the cost of 11 units will be M$48,066,040 (59,044,000).

The cost for each year will be:

1971	21,848,000 (26,838,000)	5 complexes
1972	13,109,000 (16,103,000)	3 complexes
1973	13,109,000 (16,103,000)	3 complexes
Total	M$48,066,000 (59,044,000)	11

(6) Problems on the Assembling of Paddy

Construction of new roads and improvement of the existing roads are essential for smooth transportation of paddy from farm roads to the complex. However, it must be realized that the bottleneck in the paddy collection is in the stage before the transportation by vehicle. In each compartment (800 - 1,000 acre) the number of field roads is limited and where there are any, they are usually in poor condition and serve only as a foot-path.

These field roads are not passable even by farmers pushing their bicycles after rainfall and it is very difficult for the farmers to carry paddy from the field to farm road in the off-season cropping period.

Even if the paddy in gunny bags is to be carried to farm roads, there will still be need for many hands and the employment of extra hands will reduce income of farmers. For this reason, MAFA is planning to introduce small Kids or tractor drawn sleys in an attempt to improve the means of transportation in the field. Yet, this type of transport can not be applied to all the paddy field in the region.

Field roads may be provided along the field canal of the reticulation system at time of excavation for building field canal. For the implementation of this plan, however, understanding and cooperation of farmers must be obtained at first. Since the cost of construction of these canals and field roads will have to be burdened mainly by local farmers, a rapid progress in the work of this type can not be expected until such time as the farmers themselves come to realize the need for such work under the guidance of FA and from their own experiences in double cropping. It is recommended that the plan be initiated by demonstrating proper arrangement of field canals and field roads in the existing pilot farm or selected site for the time being. (The purpose of pilot farms should be shifted gradually to setting examples of scheduled assembling of paddy).

It seems that the small unit, a branch of FA, is provided at one to three places in each compartment. In District II-E where FA began its activities for the first time, 11 small units were observed. These small units will become collecting points of paddy when farmers sell their paddy to agents in the future. Disposal of paddy may be carried out at farm house or on the roadside or in many other ways. Since the paddy should be brought into the complex on the day of threshing to prevent deterioration of paddy quality as a rule, it is advisable to provide temporary storage bins equipped with ventilator for the event it is unavoidable to pile up bags of paddy at the collection points.

In providing tempoeary storage bins, priority should be given to FA's small units to protect the interest of FA members.

Malpractice on the part of agents such as unreasonable demand for discount of selling price after false assessment of moisture content or false handling of weight scale is a major cause of farmers losing interest in the production and therefore should be dealt with strictly.

FA is in the position to accept the paddy of high moisture content or low grade, which other agents would not accept. If the paddy of such inferior quality increases in the quantity, deterioration of the business of FA or the complex will not be avoidable. To cope with such situation, it may be necessary to expand storage facilities and make them to pre-drying facilities.

After all, this idea comes close to the concept of one complex in each locality. When the FA plays a leading part in the collection of paddy and becomes capable of pre-drying the paddy to a moisture content of about 16% in the future, the operation of large complexes will be more stable even with Malti-pass system. Completeness of field canals and field roads within the compartment is indispensable also for the implementation of scheduled collection of paddy described in Chapter 5.

In order to secure regular collection of proper amount of paddy corresponding to the capacity of each complex, it is important to control paddy production in terms of timing and cultivation area. For this purpose, irrigation and drainage must be provided for every specified block.

(7) Conclusion

As the complex construction project drawn up by FAMA and MADA has a strong color of emergency measures aimed at encouraging and stabilizing double cropping for the extensive area, it may be unavoidable that various requirements for smooth operation of complex are not yet completely satisfied. It is conceivable that while efforst are being made for the expansion of paddy production through promotion of double cropping, the increase in farmers' income and the promotion of farmers' organization, the requirements for the operation of complex will be fulfilled step by step. With the progress of double cropping and while the country is nearing the complete self-sufficiency in the supply of rice, there will be a growing demand for the improvement of quality as well as the increase in the production. This is because the import of Thai rice, which is considered to be the best at present, may be discontinued if self-sufficiency was attained. The improvement of quality of paddy can be achieved mainly through the improvement of varieties and cultivation method but the modernization of drying and storage method also has an important role to play and for such reason the complex under discussion has been planned.

Various measures required for the scheduled collection of paddy may be regarded as the requirements for the improvement of cultivation method and must be related with overall project for the development of rural area together with the improvement of infrastructures such as the construction of roads and installation of telephone lines between complexes and between FA offices and complexes. As the establishment of complexes will be a turning point for the modernization of rural area, its arrangement must be planned from a long-range point of view. On the other hand, in view of the urgency for handling crops in 1971 when double cropping will begin in the whole area of North Region and in part of South Region and also in consideration of the convenience of FAMA or MADA which will be responsible for the operation of complexes for sometime after their establishment, it is considered more realistic to provide large complexes in the area where traffic is convenient. This may be unavoidable as a provisional measure but it is feared that this plan might widen regional differences and cause the loss of interest of farmers in double cropping in the area where the benefits of the complex may not be felt so great.

As the complex with the batch system may be broken down into 2,000 ton units and each unit may be moved to any location, it will be necessary to adjust the arrangement of complexes for proper distribution in the future. The acre-yield of paddy may vary with each locality as matter of course and the production in excess of the estimated level of 500 gtgs/acre is also conceivable. With the promotion of farmers' organization, utilization of complex will also be intensified and there will be need for the expansion or relocation of complexes in the future. It is hoped that the arrangement of complex be made so as to contribute to the elimination of regional differences and to the balanced development of the whole region of double cropping.

APPENDIX

Appendix 1

Structural Calculation for Machine House and Warehouse
(Design A)

(1) Machine House

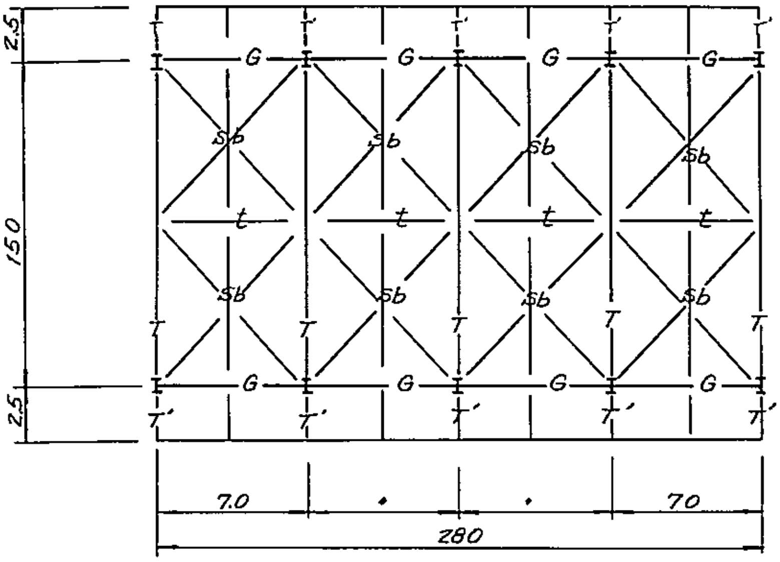
Description

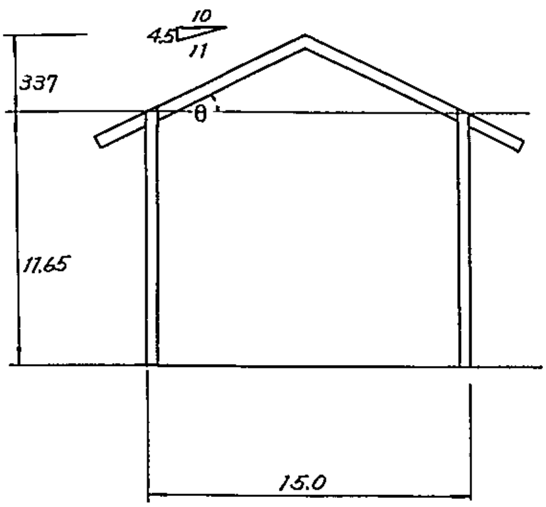
This in an one-story steel frame building to be used as a machine house and its dimensions are 28 meters in ridge direction, 15 meters in span and 11.65 meters in eaves height. The pitch of roof is 4.5/10 and corrugated iron sheet is used for roofing. No external walls are provided.

Construction of the building employs double hinge gabled roof frames spaced at 7 meter intervals and sub-beams provided between frames and joined to the ridge with the beams. As no external walls are provided, the ridge direction is of the rigid frame construction to withstand horizontal force without providing bracing. For horizontal load, the occurence of earthquakes was not considered and only wind pressure was considered. The maximum design with velocity is 30 m/sec and the wind pressure applied to each rigid frame was considered to be burdened by each frame. For wind pressure at gable side, horizontal beams are provided to connect both sides so that the wind pressure may be burdened by rigid frame on the side.

Foundation is to be the single footing using wooden piles (15 cm in dia. and 10 m in length).

For steel frame, H-shape steel is to be used and the assembly of frame in the shop is to be done by welding and the assembly in the field is to be done with use of high tension bolts.





$\cos \theta = .91$
$\sin \theta = .41$

fc : Allowable compressional stress of concrete
ft : Allowable stress of steel
w : Unit load of design
W : Total loads
M : Bending moment
P : Axial force
Q : Shearing force
l' : Internal
l : Length
Z : Modulus of section
N : Axial force
RN : Allowable bearing stress
at : Sectional area of reinforcing steel
φ : Circumferential length of reinforcing steel

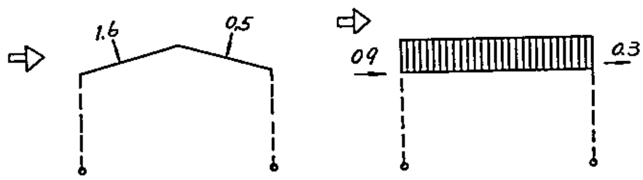
Description of building

Use :	Machine house
Structure :	One storied steel structure
	Roofing : Colored corrugated iron sheet
	External wall : None
Allowable unit stress:	fc = 45 kg/cm^2 (Long-age strength), 90 kg/cm^2 (Short-age strength)
	ft = 1, 600 kg/cm^2 (Long-age strength), 2, 400 kg/cm^2 (Short-age strength)
	Pile : Wooden pile
	Earthquakes: None
	Wind velocity : 30 m/sec, wind pressure $q = 30\sqrt{15} = 116$ kg/m^2

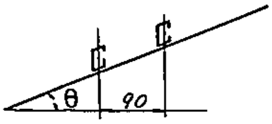
§ 1. Design loads

Roof :	Corrugated iron sheet	10 kg/m^2	kg/m^2
	Purlin	5	15
	sb	5	20
	t	10	30
	Truss	25	55
External wall :	Corrugated iron sheet :	10	50 kg/m^2
	Stud:	40	

Coefficient of wind force :



§ 2. Purlin



$\omega = 20 \rightarrow 40\,Kg/m^2$

$\ell' = .9 \qquad \ell = 4.5\,mm$

$W = .04 \times .9 \times 3.5 = .126\ t$

$$M_{max} = M_o = \frac{1}{8} \times .126 \times 350 = 5.52\ tcm < \begin{matrix} \cos\theta = 5.02 \\ \sin\theta = 2.26 \end{matrix}$$

(Under vertical load)

(Long-age strength) C 75×45×15×2.3

$$\sigma = \frac{5.02}{9.9} + \frac{2.26}{4.24} = .51 + .54 = 1.05\ t/cm^2 < 1.4\ t/cm^2$$

(Under wind pressure) $1.6 \times 116\,Kg/m^2 = 186 + 20 = 206\,Kg/m^2$ (Short-age strength)

(wind)(Fixed load)

□ 100×100×2.3

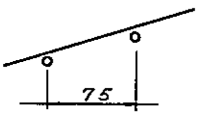
$M_x = 5.02 \times 206 / 40 = 20.6$

$M_z = 2.26 \times \quad〃 \quad = 11.7$

Members of purlin are to be □

$$\sigma = \frac{20.6}{27.6} + \frac{11.7}{27.6} = .75 + .43 = 1.13 < 2.1\ t/cm^2$$

§ 3. Sub Beam (Sb)



(Fixed load)(Wind)

$\omega = 25 \rightarrow 40\,Kg/m^2 \qquad W = 25 + 186 = 211\,Kg/m^2$

$\ell' = 3.5 \qquad \ell = 7.5$

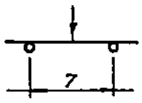
$W = .211 \times 3.5 \times 7.5 = 5.55\ t$

$$M_{max} = M_o = \frac{1}{8} \times 5.55 \times 750 = 520\ tcm$$

$Z = 520 / 2.1 = 248\,cm^3$

H 250×125×6×9 ($Z = 324\,cm^3$)

§ 4. Tie Beam (t)



$\omega = 30 + 186 = 216\,Kg/m^2$

$\ell' = 7.5 \qquad \ell = 7.$

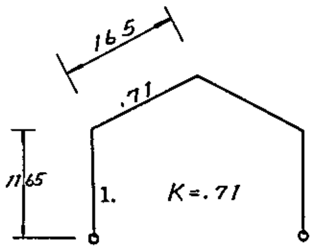
$P = .216 \times 7.5 \times 7 = 11.4\,t$

$M_{max} = M_o = \frac{1}{4} \times 11.4 \times 700 = 2000\,tcm$

$Z = 2000 / 2.4 = 832\,cm^3$

H $400 \times 200 \times 8 \times 13 \qquad Z = 1.190\,cm^3 > 832\,cm^3$

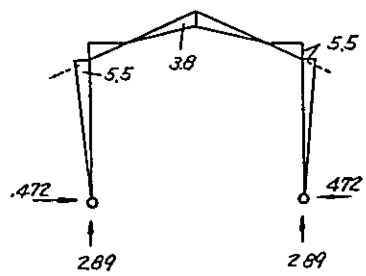
§ 5. Rigid frame (T)



$\omega = 55\,Kg/m^2 \qquad \ell' = 7.m \qquad W = .55 \times 7 = .385\,t/m$

$W\ell = \qquad = 5.78$

$W\ell^2 = \qquad = 86.7$



$11.65^2(3 + .71) + 3.37(3 \times 11.65 + 3.37)$

$= 136 \times 3.71 + 3.37 \times 38.37 = 506 + 129 = 635$

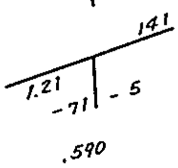
$H = \frac{86.7}{32} \cdot \frac{\overset{93.2}{8 \times 11.65} + \overset{16.9}{5 \times 3.37}}{635}$

$= 2.71 \times \frac{110.1}{635} = 2.71 \times .174 = .472\,t$

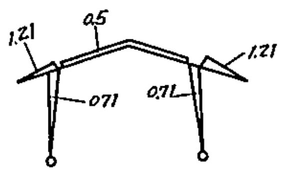
$M = .472 \times 11.65 = 5.5\,tm$

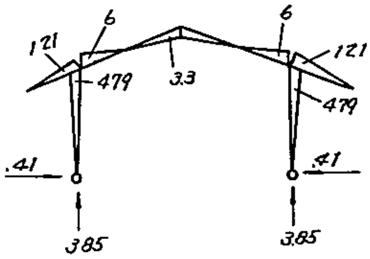
$Mc = -.472 \times 15 + 86.7/8 = -7.1 + 10.9 = 3.8\,tm$

$V = 5.78/2 = 2.89\,t$

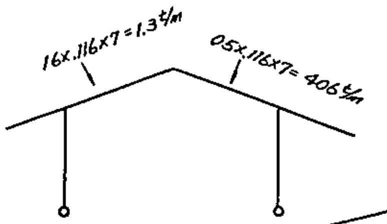


$M = \frac{1}{2} \times .385 \times 2.5^2 = 1.21\,tm$





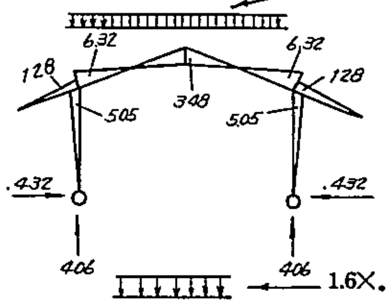
(Under wind pressure)



$0.5\times.116=.058\ t/m^2$

$.058\ t/m^2/.055=1.05$ times

(I)



$1.6\times.116-0.5\times.116=.186-.058=.128\ t/m^2$

$0.128\times7=0.9\ t/m$

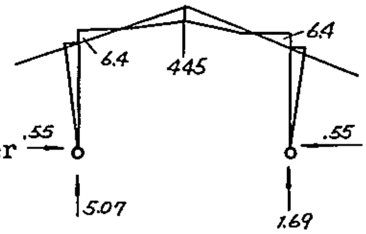
$$H=\frac{.9\times15^2}{64}\cdot\frac{110.1}{635}=316\times.174=.55\ t$$

$M=.55\times11.65=6.4\ tm$

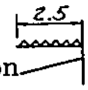
$Mc=-.55\times15+12.7=4.45\ tm$

$V=\frac{3}{8}\times .9\times15=5.07\ t$ $\quad V=1.69\ t$

(II)
Center



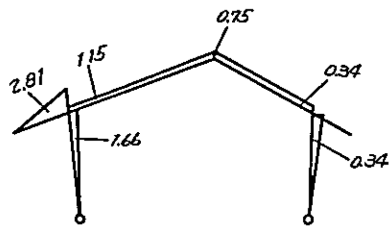
Protrusion

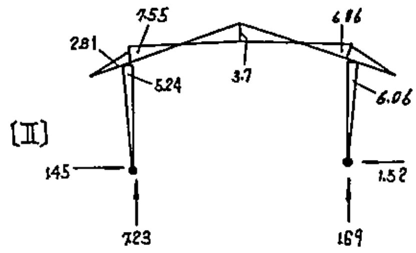


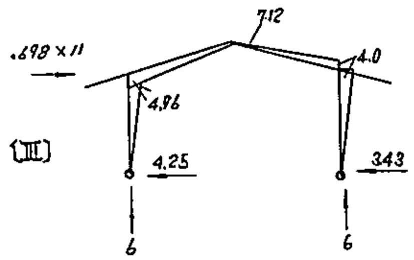
$M=\frac{1}{2}\times.9\times2.5^2=2.81$

$V=.9\times2.5=2.16$

(I)







$$1.3 \times \sin\theta = .533 \quad] \; .698 \times 11$$

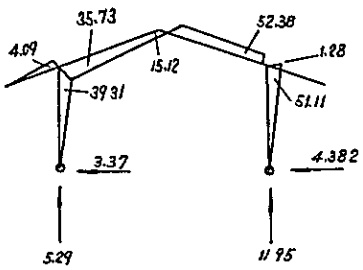
$$.406 \times \sin\theta = .165$$

$$H = \frac{.698 \times 11.65}{4} \times \frac{2 \times .71 \times 11.65 + 3(2 \times 11.65 + 3.37)}{635}$$

$$= 2.05 \times \frac{16.6 + 80}{635}$$

$$= .311 \times 11 = 3.43 \text{ t}$$

Total load under wind pressure
(I) + (II) + (III)



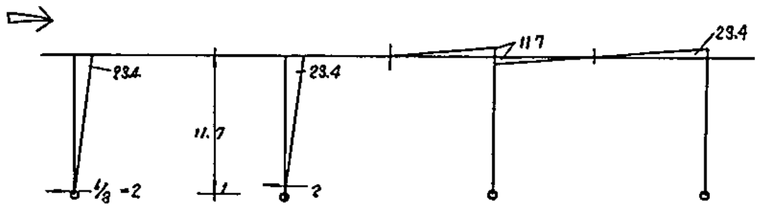
$$V = \frac{.698 \times 11.65}{15} = .542 \times 11 = 6. \text{ t}$$

$$Mc = -.311 \times 15 + \frac{.698 \times 11.65}{2}$$

$$= -4.67 + 4.06 = -.61 \times 11.$$

$$= -7.12 \text{ tm}$$

Direction of cross–beam



Wind pressure $.116 \times 1.2 \times 10 \times 4.3 = 6$ t

(Fixed load)(Wind) (Fixed load)(Wind)

Column ↓ $P = 3.85 + 11.75 = 15.6\,t$ ↔ $P = 3.85 + 5 = 8.85\,t$

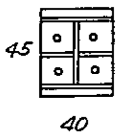
$M = 4.79 + 51.11 = 55.9\,tm$ $M = 1 + 23.4 = 24.4\,tm$

H 400×400×13×21 $X = \frac{1100}{10} = 110$ $\omega = 2.02$

$$\downarrow\ \sigma = \frac{2.02 \times 15.6}{218.7} + \frac{5590}{3330} = .15 + 1.68 = 1.83 < 2.4\,t/cm^2$$

$$\leftrightarrow\ \sigma = \frac{2.02 \times 8.85}{218.7} + \frac{2440}{1120} = .08 + 2.18 = 2.26 < 2.4\,t/cm^2$$

Base of column



$A = 40 \times 45 = 1800\,cm^2$ $\sigma = 8.7\,Kg/cm^2$

Base Plate

$M = 0.85 \times 10 \times 20^2 = 340\,tm$

$$t = \sqrt{\frac{6 \times 340}{1600}} = \sqrt{1.28} = 1.13 \rightarrow 15mm \text{ (thickness)}$$

↓ Desing of Rigid frame (T)

(Fixed load) (Wind)

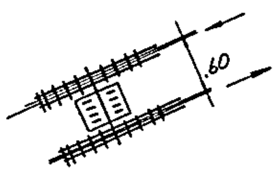
$M = -6 + 52.38 = 46.38\,tm$

$Z = 46380/2.1 = 2200\,cm^3$

H 600×200×11×17 $Z = 2590\,cm^3 > 2200\,cm^3$

Joint $N = \frac{46.38}{6} = 77\,t$

High tension bolt ϕ 22 mm $n = \frac{77}{12.3} = 6.3 \rightarrow 8$ each



ϕ 19 mm $n = \frac{77}{8.89} = 8.7 \rightarrow 10$ each

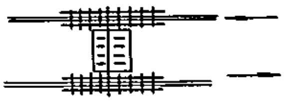
Design of Girder (G)

$M = 1 + 23.4 = 24.4\ tm$
(Fixed (Wind)
load)

$$Z = \frac{2440}{2.1} = 1160\ cm^3$$

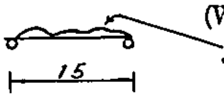
H $450 \times 200 \times 9 \times 14$ ($Z = 1490\ cm^3$)

Joint $N = 24.4 / .45 = 54\ t$



High Tension bolt $\phi 19\ mm$ $n = \frac{54}{8.89} = 6.1 \rightarrow 8$ each

Wind bracing beam, gable side



(Wind)(Coefficient) (ℓ')
$.116 \times 1.2 \times 4.3 = .6\ t/m$

$$M_{max} = M_o = \frac{1}{8} \times .6 \times 15^2 = 16.9\ tm = 1690\ Kgcm$$

$$Z = 1690 / 2.4 = 702\ cm^3$$

H $402 \times 200 \times 8 \times 13$ $Z = 1190\ cm^3 > 702\ cm^3$

Stud, gable side (Wind)(Coefficient)(ℓ')
$g = .116 \times 1.2 \times 3.75 = .522\ t/m$

$\ell' = 3.75$

$$M_{max} = M_o = \frac{1}{2} \times .522 \times 5^2 = 6.42\ tm = 642\ tcm$$

$$Z = 642 / 2.1 = 306\ cm^3$$

H $250 \times 125 \times 6 \times 9$ $Z = 324\ cm^3 > 306\ cm^3$

T' Over-hang beam T'

$M = 1.21 + 4.09 = 5.3\ tm = 530\ tcm$

$$Z = 530 / 2.1 = 251\ cm^3$$

H $250 \times 125 \times 6 \times 9$ $Z = 324\ cm^3 > 251\ cm^3$

Joint $N = 530 / 25 = 21.2\ t$

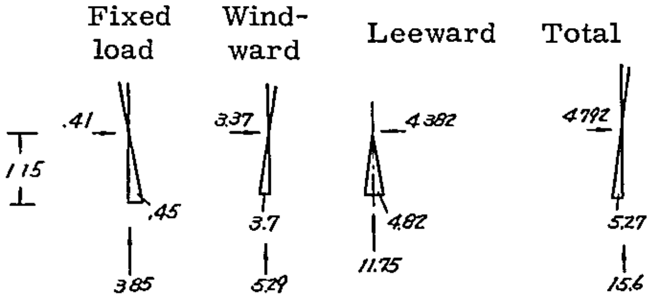
High tension bolt $\phi 16\ mm$ $n = \frac{21.2}{6} = 3.55 \rightarrow 4$ each

§6 Desing of foundation

Pile : Wooden pile Top end 15cm $\ell = 10M$

Pile bearing capacity : $A = \frac{3}{4} \times 15^2 = 177 cm^2$

$RN = 177 \times 70 = 12300 Kg/each = 12.3t \rightarrow 10t/each$

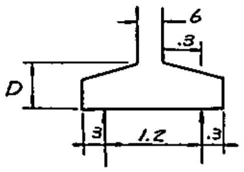


Dead load of foundation including earth $1 \times 1.8 \times 2 = 3.8 t$

15.6 t

19.4 t

$e = \frac{5.27}{19.4} = .272 < \frac{1.8}{6} = .3$



Large Small

$N = \frac{5.27}{12} = 4.4t$

$\frac{\pm 9.7}{14.1}$ or $5.3t/each < 20t/each$

$Q = 9.7 t$

$M = 9.7 \times .3 = 2.91 tm$

$D = 80cm$

$at = \frac{2.9\beta}{1.4 \times .73} = 2.85$ $\phi 13mm$ $\frac{1.33 \times 100}{2.85} = 46.8$

$\varphi = \frac{1.14 \times 9700}{8.1 \times 73} = 18.7$ $\phi 13mm$ $\frac{4.08 \times 100}{18.7} = 21.8$

} 20cm (Pitch)

(2) Warehouse

Description

This is an one-story building to be used as a warehouse, with dimensions of 40 meters in ridge direction, 11.5 meters in span and 9 meters in eaves height, and is divided into 10 small sections each having dimensions of 5 m x 8 m. The pitch of roof is to be 1/10 and roofing is to be corrugated iron sheet. External walls are to be boarded walls.

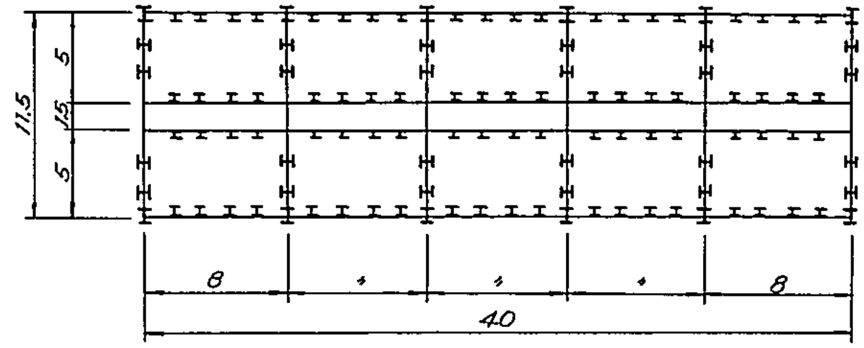
Construction of the building employs double hinge gabled roof frames spaced at 8 meter intervals and sub-beams provided between frames and joined to the ridge with tie beams.

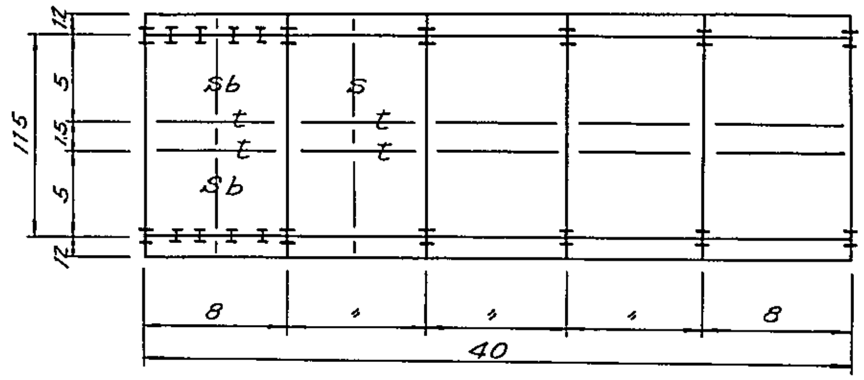
Studs are provided at 1.8 meter intervals in ridge direction and at 1.7 meter intervals in span direction and each stud is joined to others with tie rods and bracing to withstand the load of paddy against wall. Each section is designed to be independent of one another and is able to withstand sufficiently the full load of paddy.

For horizontal load, consideration was given to the above mentioned lateral pressure exerted by paddy and wind pressure. The maximum wind velocity of 30 m/sec was considered. The occurrence of earthquakes was not considered. The wind pressure applied to rigid frame was considered to be burdened by each frame. For the wind pressure at gable side, horizontal beams are provided to connect both sides so that the wind pressure may be burdened by bracing on both sides.

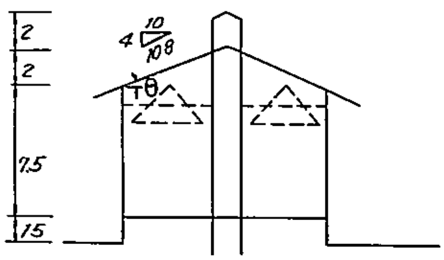
Foundation is to be the single footing using wooden piles (15 cm in dia. and 10 m in length) and linked with underground cables.

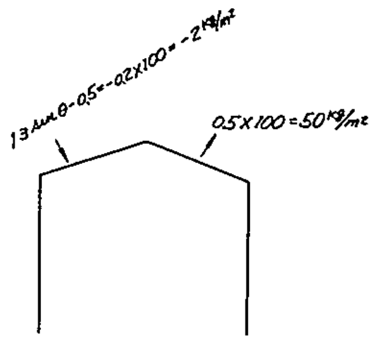
For steel frame, H-shape steel is to be used and assembly of frame in the shop is to be done by welding and assembly in the field is to be done with use of high tension bolts.





sin θ = .37
cos θ = .925





fc : Allowable compressional stress of concrete
ft : Allowable stress of steel
w : Unit load of design
W: Total loads
M : Bending moment
Q : Shearing force
τ : Allowable shearing stress

Z : Modulus of section
l' : Internal
l : Length
N : Axial force
RN: Allowable bearing stress
at : Sectional area of reinforcing steel
φ : Circumferential length of reinforcing steel

Description of building

Use : Warehouse

Structure : One storied steel structure

Roofing : Corrugated iron sheet

External walls : Boarded walls

Allowable unit stress: fc = 45 kg/cm^2 (Long-age strength), 90 kg/cm^2 (Short-age strength)

ft = 1,600 kg/cm^2 (Long-age strength), 2,400 kg/cm^2 (Short-age strength)

Pile : Wooden pile

Earthquakes : None

Wind velocity : 30 m/sec, $q = 30 \sqrt{11} = 100$ kg/cm^2

§ 1. Design loads

		(Dead weight)	(Load)
Roof :	Corrugated iron sheet	10 kg/m^2	kg/m^2
	Purlin	5	15
	sb	5	20
	t	10	30
	Truss	20	50

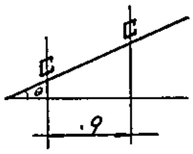
External wall : 150 kg/m^2

Unit weight of paddy : 0.53 x 1.19 = 0.63 t/m^3

Coefficient of friction between tank wall and content (paddy) : f = 0.7

Angle of internal friction : 40 degrees

§ 2. Purlin



$\omega = 15 \rightarrow 40 \mathrm{Kg/m^2}$

$\ell' = .9 \qquad \ell = 4$

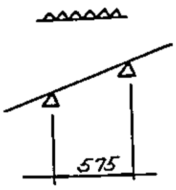
$W = .04 \times .9 \times 4 = .144\,t$

$Mo = \frac{1}{8} \times .144 \times 400 = 7.2\,tcm < \begin{matrix} \cos\theta = 2.66 \\ \sin\theta = 6.17 \end{matrix}$

[100×50×20×23

$\sigma = \frac{6.17}{16.1} + \frac{2.66}{6.06} = .39 + .45 = .84 < 2.1\,t/cm^2$

§ 3. Sub beam (Sb)



$\omega = 20 \rightarrow 40 \mathrm{Kg/m^2}$

$\ell' = 4 \qquad \ell = 5.75$

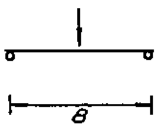
$W = .04 \times 4 \times 5.75 = .92\,t$

$Mo = \frac{1}{8} \times .92 \times 575 = 66.2\,tcm$

$Z = 66.2 / 2.1 = 31.5\,cm^3$

H 200×100×5.5×8 ($Z = 184\,cm^3$)

§ 4. Tie beam (t)



$\omega = 30 \rightarrow 40 \mathrm{Kg/m^2}$

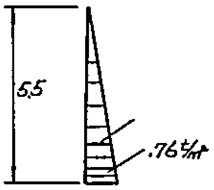
$P = .04 \times 4 \times 5.75 = .92\,t$

$Mo = \frac{1}{4} \times .92 \times 800 = 184\,tcm$

$Z = 184 / 2.1 = 88.7\,cm^3$

H 200×100×5.5×8 ($Z = 184\,cm^3$)

§ 5. Design of wall

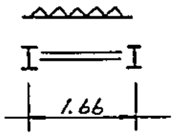


Per bin $W = 5 \times 8 \times 5.5 \times 0.63 = 139.0\,t$

$C = \tan^2\left(45^\circ - \frac{40^\circ}{2}\right) = \tan^2 25^\circ$

$= .4663^2 = .218$

$P = C\,Wh = .218 \times 0.63 \times 5.5 = .76\,t/m^2$



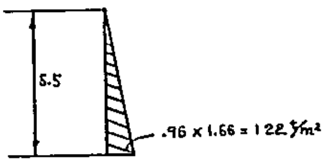
$Mo = \frac{1}{8} \times .76 \times 1.66^2 = .244\,tm = 24.4\,tcm$

$Z = 24.4 / .070 = 356\,cm^3$

Thickness of board (10cm) $Z = \frac{100 \times 10^2}{6} = 1660\,cm^3 > 356\,cm^3$

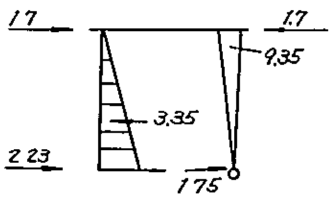
stud

(5cm) $Z = \frac{100 \times 5^2}{6} = 416\,cm^3 > 356\,cm^3$



$Mo = 0.064 \times 1.22 \times 5.5^2$

$= 2.37\,tm = 237\,tcm$



$W = 1.22 \times 5.5 / 2 = 3.35\,t$

Axial force of column $.15 \times 1.66 \times 5.5 = 1.32$

$.63 \times 1.66 \times 2.5 \times 0.7 = 1.74$

$3.06\,t$

(M = 935 tcm
P = 3.06 t

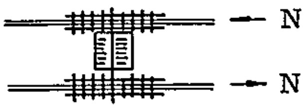
$X = \frac{530}{6.29} = 85 \qquad \omega = 1.41$

Column, beam H 250×250×9×14

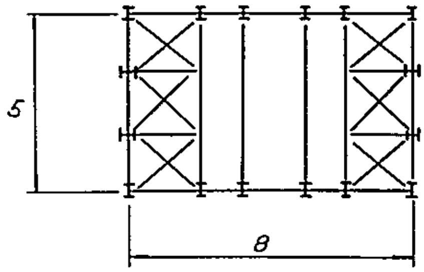
$\sigma = \frac{1.41 \times 3.06}{92.18} + \frac{935}{867}$

$= .05 + 1.08 = 1.13\,t/cm^2 < 1.6\,t/cm^2$

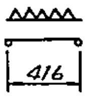
Joint $N = 935/25 = 37.5\,t$



High tension bolt 19φ $n = \frac{37.5}{5.93} = 6.3 \rightarrow 8$ each



Floor board (Slab)



$\omega = .63 \times 5.5 = 3.47\ t/cm^2$

$W = 3.47 \times 1 \times .416 = 1.45\ t$

$Mo = \frac{1}{8} \times 1.45 \times 41.6 = 75.4\ tcm$

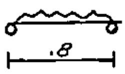
$Z = 7.54 / 0.07 = 108 cm^3$

Thickness of board

(50 mm) $Z = \frac{100 \times 5^2}{6} = 416 > 108$ $\tau = \frac{.725 Kg}{100 \times 5} = 1.45 < 7$

(30 mm) $Z = \frac{100 \times 3.0^2}{6} = 150 > 108$ $\tau = \frac{.725}{100 \times 3} = 2.41 < 7$

Floor joist, sleeper



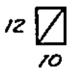
$\omega = 3.49\ t/m^2$

$\ell' = .416 \quad \ell = .8$

$W = 3.47 \times .416 \times .8 = 1.16\ t$

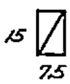
$Mo = \frac{1}{8} \times 1.16 \times 80 = 11.6\ tcm$

$Z = 11.6 / .07 = 166 cm^3$



$\tau = \frac{3}{2} \times \frac{580}{20 \times 10} = 217 Kg/cm^2 < 7$

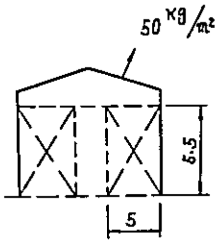
$Z = 240 cm^3 > 166$



$Z = 282 cm^3 > 166$

Design of wall surface bracing

Wind pressure



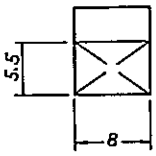
Roof . 05×7.25×8×sin θ = 1.08 t

Wall . 1×1.2×8×3.75=3.6 t

4.68 t

Bracing

N=4.68×1/2×7.5/5=3.5 t φ19 mm



4 Places

Wall . 1×1.2×1×5.75=. 59 t

〃 . 1×1.2×3.75×5.75=2.6 t

} 3.14 t

Bracing

N=3.14/2×9.7/8=1.9 t φ16mm

Axial force of column

Roof : 0.050×8. × 7=2.8 t

Wall : 0.15 ×1.66 ×5.5=1.32 t

Paddy : 0.63 ×1.66^2× 5=8.7 t

12.82 t

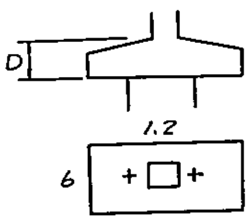
Design of footing

Pile : 10t/each

Dead load of foundation including earth: . 6×1.2×2=1.44 t

12.82 t

14.26 t



D = 80 cm

↔ 13 φ Pitch 20 cm

Foundation of Floor support

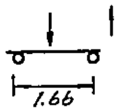
Foundation wooden pile

Puddy	$.63 \times 1.66 \times 5 \times 5 = 26.2\,t$	} 26.7t
Floor	$.05 \times 1.66 \times 5 \quad = .5$	

$n = 26.7/10 = 3$ each $\times 2 = 6$ each

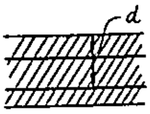
Foundation slab

$P = .63 \times 5 \times .83 = 2.61$



$M = \frac{1}{8} \times 2.61 \times 1.66 = .542\,tm$

$D = 20cm \qquad d = 15cm$

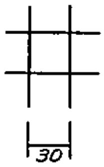


Reinforcing steel

$a_t = \frac{.542}{1.4 \times .15} = 2.6 \qquad \phi 13mm \quad 51cm$

$\varphi = \frac{1.14 \times 1310}{8.1 \times 15} = 123 \qquad \phi 13mm \quad 33.2cm$

} 30cm (Pitch)



Appendix 2

DETAILED ESTIMATE OF CONSTRUCTION COSTS FOR BUILDINGS (DESIGN A)

Unit : M$

No.	Description	Dimensions & type	Quantity	Unit	Unit Price	Amount	Remarks
I	Machine house		1	each		108,632	
II	Warehouse		1	"		395,877	
III	Generator house		1	"		7,650	
	Sub-total					512,159	
IV	Temporary works common to all buildings						
	Cost of provisional power facilities and purchased power	(Power bill included)	1	Compl.		2,735	Local
	Cost of provisional water supply	(")	1	Compl.		641	"
	Cost of provisional machinery & equipment	(")	1	"		2,564	"
	Cost of temporary building	Materials and billeting facilities included	1	"		855	"
	Field office	" "	1	"		855	"
	Provisional communication and office expenses		1	"		855	"
	Test, research and clean-up of premises		1	"		2,564	
	Sub-total					11,068	
V	Common expenses						
	Transportation	From workshop to port	1	Compl.		5,128	
	Miscellaneous expenses	"	10%			52,243	
	Sub-total					57,371	
	Total					580,598	

I	CONSOLIDATED TABLE FOR MACHINE HOUSE						
1	Temporary works		1	Compl.		4,214	
2	Banking		1	"		6,511	
3	Reinforced concrete work		1	"		15,264	
4	Steel works		1	"		64,347	
5	Concrete block work		1	"		436	
6	Carpentry		1	"		3,032	
7	Wooden fixture work		1	"		1,239	
8	Metal works		1	"		6,350	

No.	Description	Dimensions & shape	Quantity	Unit	Unit Price	Amount	Remarks
9	Plaster work		1	Compl.		920	
10	Painting		1	"		1,872	
11	Miscellaneous works		1	"		2,686	
12	Piling			"		1,761	
	Total					108,632	
I	BREAKDOWN OF ESTIMATED COST AND QUANTITY FOR MACHINE HOUSE						
1	Temporary works						
	Cost of leveling stake materials		420	M2		359	Local
	Cost of materials for external acaffolds		1,040	"	1.7	1,778	"
	Cost of hanging scaffolds		420	"	1.3	539	"
	Cost of scaffolds board		300	each	2.1	641	"
	Cost of protection materials		420	M^2	1.7	718	"
	Full size sectional details		1	Compl.		51	"
	Transportation of materials for field office					128	"
	Sub-total					4,214	
2	Banking						
	Excavation		86	M^3	4.3	368	Local
	Backfilling		40	"	3.4	137	"
	Disposition of surplus		46	"	2.6	118	"
	Macadam foundation		70	"	4.3	299	"
	Concrete sub-slab°		10	"	8.5	85	"
	Concrete placing	Ready mixed concrete used 180 kg	140	"	6.8	957	"
	Erection & dismantling of scaffolds	Including ladders	1,040	M^2	1.7	1,778	"
	Erection & dismantling of hanging scaffolds		420	"	1.7	718	"
	Rubble		70	M^3	25.6	1,795	"
	Filling stone		10	"		256	"
	Sub-total					6,511	
3	Reinforced concrete work						
	Concrete for sub-slab	Ready mixed concrete 90 kg	10	M^3	46.2	462	Local
	Ready mixed concrete	180 kg	140	"	47.0	6,581	"

No.	Description	Dimensions & shape	Quantity	Unit	Unit Price	Amount	Remarks
	Concrete form		170	M^3	3.8	654	Local
	Placement of concrete form		170	"	4.3	726	"
	Miscellaneous materials for concrete work	Hardware and supplies	420	M^2		323	"
	Reinforcing bar		12	t	385	4,615	
	Additional work and placement of reinforcing bars		12	t	150	1,795	Local
	Marking		420	M^2		108	"
	Sub-total					15,264	
4	Steel works						
	Cost of steel materials		53	t	512.8	27,179	
	Cost of fabrication		53	"	256.4	13,590	
	Rust proof painting		53	"	17	906	
	Packing charge		53	"	25.6	1,359	
	Transportation charge		53	"	17.0	906	
	Shipping charge		53	"	42.7	2,265	
	Incidental expenses		1	Comp.		4,552	
	Field assembly and additional work		53		256	13,590	
	Sub-total					64,347	
5	Concrete block work (Control room)						
	Concrete block	15 cm thick	30	M^2	6.8	205	
	Placement of concrete block	Decorative placement	30	"	4.3	128	Local
	Sand, cement and reinforcing bars		30	"	3.4	103	"
	Sub-total					436	
6	Carpentry						
	Cost of lumber	Control room	3	M^3	512.8	1,538	Local
	Miscellaneous materials		1	Compl.		171	"
	Wage of carpenters		12.25	M^2	85.5	1,047	"
	Wage of carpenter helpers		1	Compl.		171	"
	Cost of hardware	Nails & bolts	12.25		8.5	105	
	Sub-total					3,032	
7	Wooden fixture work						
	Screen door for control room	Polyvinyl fence	10	each	51.2	512	
	Screen door for entrance		1	"	85	85	
	Installation of doors		11	set	43	470	Local

No.	Description	Dimensions & shape	Quantity	Unit	Unit Price	Amount	Remarks
	Hardware		1	Compl.		171	
	Sub-total					1,239	
8	Metal works						
	Colored corrugated iron sheet	Roof, down wall #28 One side colored long pitch corrugated iron sheet	770	M^2	2.6	1,974	
	Hook		770	"	0.4	329	
	Placement of roofing	Punching, OP (oil point) coating	770	"	4.3	3,291	Local
	Ridge coping	#28 colored	30	M	8.6	256	
	Ascending coping	#28 colored	45	"	6.8	308	
	Placement of above coping		75		2.6	193	Local
	Sub-total					6,350	
9	Plaster work						
	Floor face troweling		500	M^2	1.7	855	Local
	Cement	For one lot	20	Bag	3.2	65	"
	Sub-total					920	
10	Painting						
	Two coats of OP (oil paint) on steel frame		53	t	25.6	1,359	
	OP (oil paint) coating of room		60	M^2	8.5	513	Local
	Sub-total					1,872	
11	Miscellaneous works						
	Exterior works						
	Land grading	2 m from struct.	180	M^2	2.1	385	Local
	Excavation for U-shape drainage pipe		90	M	8.5	77	"
	Placement of gravel		90	"	42.7	385	"
	Placement of U-shape drainage pipe		90	"	2.6	231	"
	Filling gravel		4.5	M^3	25.6	115	"
	U-shape drainage pipe	JIS 300A 40 x 30 x 24	140	each	5.1	718	"
	Sand		2	M^3	25.6	51	"
	Cement		10	Bag	3.2	32	"
	Sub-total					2,686	
12	Piling						
	Cost of wooden pile	ϕ10cm x L 10.00m two piles joined	20	each	51.3	1,026	Local

No.	Description	Dimensions & shape	Quantity	Unit	Unit Price	Amount	Remarks
	Pile driving		20	each	25.6	513	Local
	Pile head cutting		20	"	2.6	51	"
	Metal joints	ø 10cm, L30cm	20	"	8.5	171	
	Sub-total					1,761	
II	CONSOLIDATED TABLE FOR WAREHOUSE						
1	Temporary works		1	Compl.		5,402	
2	Banking		1	"		8,470	
3	Reinforced concrete work		1	"		22,931	
4	Steel works		1	"		145,726	
5	Concrete block work		1	"		5,085	
6	Carpentry		1	"		154,871	
7	Steel sash work		1	"		14,821	
8	Wooden fixtures		1	"		530	
9	Metal works		1	"		10,091	
10	Painting & miscellaneous works		1	"		5,641	
11	Piling		1	"		22,308	
	Total					395,877	
II	BREAKDOWN OF ESTIMATED COST AND QUANTITY OF WORK FOR WAREHOUSE						
1	Temporary works						
	Cost of leveling stake materials		460	M^2	0.9	393	Local
	Cost of exterior scaffolds		1,000	"	1.7	1,709	"
	Cost of hanging scaffolds		460	"	1.3	590	"
	Cost of interior scaffolds		460	"	1.3	590	"
	Cost of scaffolding board		600	each	2.1	1,282	"
	Cost of protection materials		460	M^2	1.7	786	"
	Full-size sectional details		1	Compl.	1.7	51	"
	Sub-total					5,402	
2	Banking						
	Excavation		130	M^3	4.3	556	Local
	Disposition of surplus earth		60	"	2.6	154	"
	Macadam foundation		80	"	4.3	342	"
	Placement of concrete sub-slab		23	"	8.5	197	"

No.	Description	Dimensions & shape	Quantity	Unit	Unit Price	Amount	Remarks
	Concrete placing		190	M^3	6.8	1,299	Local
	Erection and dismantling of scaffolds		1,000	M^2	1.7	1,709	"
	Erection and dismantling of hanging scaffolds		460	"	1.7	786	"
	Erection and dismantling of interior scaffolds		460	"	1.7	786	"
	Rubble		80	M^3	25.6	2,051	"
	Filling gravel		23	"	25.6	690	"
	Sub-total					8,470	
3	Reinforced concrete work						
	Material of concrete sub-slab	Ready mixed concrete 90 kg	23	M^3	46.2	1,062	Local
	Ready mixed concrete	Ready mixed concrete 180 kg	190	"	47.0	8,932	"
	Concrete form		880	M^2	3.8	3,385	
	Reinforcing bar		17	t	384.6	6,538	
	Additional work and placement of reinforcing bars		17	t	149.6	2,543	Local
	Miscellaneous materials for concrete work	Hardware and supplies	460	M^2	0.8	354	Local
	Marking		460	"	0.3	118	"
	Sub-total					22,931	
4	Steel works						
	Cost of steel material		120	t	512.8	61,538	
	Cost of fabrication		120	"	256.4	30,769	
	Field assembling and additional work		120	"	256.4	30,769	
	Rust proof painting		120	"	17.1	2,051	
	Packing charge		120	"	25.6	3,077	
	Transportation charge		120	"	17.1	2,051	
	Shipping charge		120	"	42.7	5,128	
	Overhead		1	Compl.		10,342	
	Sub-total					145,726	
5	Concrete block work						
	Heavy foundation block	Decorative placement 15 cm thick	350	M^2	6.8	2,393	Local

No.	Description	Dimensions & shape	Quantity	Unit	Unit Price	Amount	Remarks
	Sand		350	M^2			Local
	Cement		350	"	3.41	1,197	"
	Reinforcing bar		350				
	Placement of above concrete block		350	"	4.3	1,496	Local
	Sub-total					5,085	
6	Carpentry						
	Cost of lumber	(Local lumber)	200	M^3	512.8	102,564	Local
	Cost of miscellaneous materials		10	"	512.8	5,128	"
	Installation of wood works and fixture		460	M^2	85.5	39,316	"
	Wages of carpenter helpers		460	"	8.5	3,932	"
	Cost of hardware	Nails	460	"	8.5	3,932	
	Sub-total					154,871	
7	Steel sash work						
	Steel wire door	1,500 x 1,500	102	each	128.2	13,077	
	Installation of door	(Welding of metal part and screws)	102	"	8.5	872	Local
	Hardware		102	set	8.5	872	
	Sub-total					14,821	
8	Wooden fixtures						
	Door for entrance		4	each	85.5	342	
	Hardware		2	set	85.5	171	
	Installation of doors		4	each	4.3	17	Local
	Sub-total					530	
9	Metal works						
	Long colored corrugated iron sheet	Roof, gable side, long pitch colored corrugated iron sheet, one side colored	750	M^2	2.6	1,923	
	Hook		750	"	0.4	321	
	Ridge coping	#28 colored iron sheet	40	M	8.5	342	
	Ascending coping	"	32	"	6.8	219	
	Water drip	Around sash	300	"	2.6	769	
	Rodent stoppage		110	"	4.3	470	
	Colored iron sheet	One side colored #28 iron sheet for flooring	400	M^2	2.6	1,026	
	Miscellaneous hardware		1	Compl.		427	
	Placement of colored iron sheet	Punching and OP coating	750	M^2	4.3	3,205	Local

No.	Description	Dimensions & shape	Quantity	Unit	Unit Price	Amount	Remarks
	Installation of coping, water drip and rodents stoppage		542	M	2.6	1,390	Local
	Sub-total					10,091	
10	Painting and miscellaneous works						
	Painting of steel portion	Two coats of OP	120	t	25.6	3,077	Local
	Fixtures	OP coating	200	M2	4.3	855	"
	Mortor plastering of base board	(Materials included)	200		8.5	1,709	"
	Sub-total					5,641	
11	Piling						
	Cost of piles	φ 10cm, L-10,000 m 2 piles joined	261	each	51.3	13,385	Local
	Pile driving		261	"	25.6	6,692	"
	Metal joints	∅ 10cm, L-30cm pipe	261	"	8.5	2,231	
	Sub-total					22,308	

III	CONSOLIDATED TABLE FOR GENERATOR HOUSE				
1	Temporary works	1	Compl.	354	
2	Foundation works	1	"	846	
3	Roofing	1	"	296	
4	Carpentry	1	"	5,726	
5	Painting and miscellaneous works	1	"	427	
	Total			7,650	

III	BREAKDOWN OF ESTIMATED COSTS AND QUANTITY OF WORK FOR GENERATOR HOUSE					
1	Temporary works					
	Cost of leveling stake materials	24.5	M2	0.9	20	Local
	Cost of exterior scaffolds	70	"	1.7	120	"
	Cost of scaffolding board	1	Compl.		85	"
	Transportation cost	1	"		128	"
	Sub-total				354	

No.	Description	Dimensions & shape	Quantity	Unit	Unit Price	Amount	Remarks
2	Foundation works						
	Excavation	(Separate work)	8		4.3	34	Local
	Macadam foundation		3.7	M^3	4.3	16	"
	Placement and removal of concrete form		1	Compl.		85	"
	Concrete placing		4	M^3	8.5	34	"
	Rubble		3.7	"	25.6	95	"
	Filling gravel		12	"	25.6	308	"
	Ready mixed concrete		4	"	47	188	"
	Leveling of surplus earth		1	Compl.		85	
	Sub-total					846	
3	Roofing						
	Long colored corrugated iron sheet	#28 long pitch corrugated iron sheet, one side colored	35	M^2	2.6	90	
	Hook		35	"		9	
	Coping	Colored	7	M	6.9	48	
	Placement of roofing		35	M^2	4.2	150	Local
	Sub-total					296	
4	Carpentry						
	Cost of lumber		6	M^3	513	3,077	Local
	Miscellaneous materials		0.5	"	513	256	"
	Wage of carpenter		24.5	M^2	85.5	2,094	"
	Wage of carpenter's helper		1	Compl.		256	"
	Hardware	Nails, bolts, etc.	1	"		43	"
	Sub-total					5,726	
5	Painting and miscellaneous works						
	Painting of wood portions	OP coating	40	M^2	4.3	171	Local
	Troweling of ramp concrete floor	Materials included	30	"	8.5	256	"
	Sub-total					427	