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FISHING PORTS
REFRIGERATED STORES DESIGN
GUIDELINES*

Prepared by

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UNIDO Consultant

*The views expressed in this document are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

**Fishing Ports - Refrigerated Stores Design Guide, 74 Rue de Rome, Paris 75008, France.

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INTRODUCTION

The purpose of this study is to contribute to the follow-up to the First Consultation on the Fisheries Industry held in Gdańsk, Poland, from 1 to 5 June 1987.

The main aim of the study is to establish guidelines for cold-stores in small fishing ports.

The study deals with standardisation of cold-stores applicable to the requirements of the fishing ports, these stores being able to handle the daily catch on transient or long term basis.

The storage design is to be laid out to address manual and mechanical approaches.

Catch at sea preservation will be addressed with the intent of keeping the quality of the fish as fresh as possible. This will be applied where the climatic conditions call for food-quality ice, in block or chip form. In short, addressing catch waste reduction due to lack of in-fresh-state conservation methods.
The concept of the need to preserve perishable food is to allow adaptation of irregular supply to constant demand and to create a dependable source of fresh protein supply, thus improving the local diet and giving impetus to the growth of the fishing industry.

Proper preservation will not only have a beneficial effect on consumption patterns, as mentioned above, but is essential to guarantee the consumer reasonable price stability throughout the year. It will also assure the fisherman a fair market value for his catch, at all times.

Addressing this problem is bound to have beneficial fall-out for the local economy and hinterland. It will improve the availability and quality of other food supplies, such as meats, poultry and vegetables, as these find their way into the cold store system. This in turn will enhance the return on the investment.

In the case under consideration, the catch is sold fresh upon arrival at the dockside, for immediate consumption. This is most true for the more sought-after varieties with the unsold catch being smoked, (lightly smoked for consumption within a few days, strongly, for consumption within a month, and dry smoked for long term conservation).

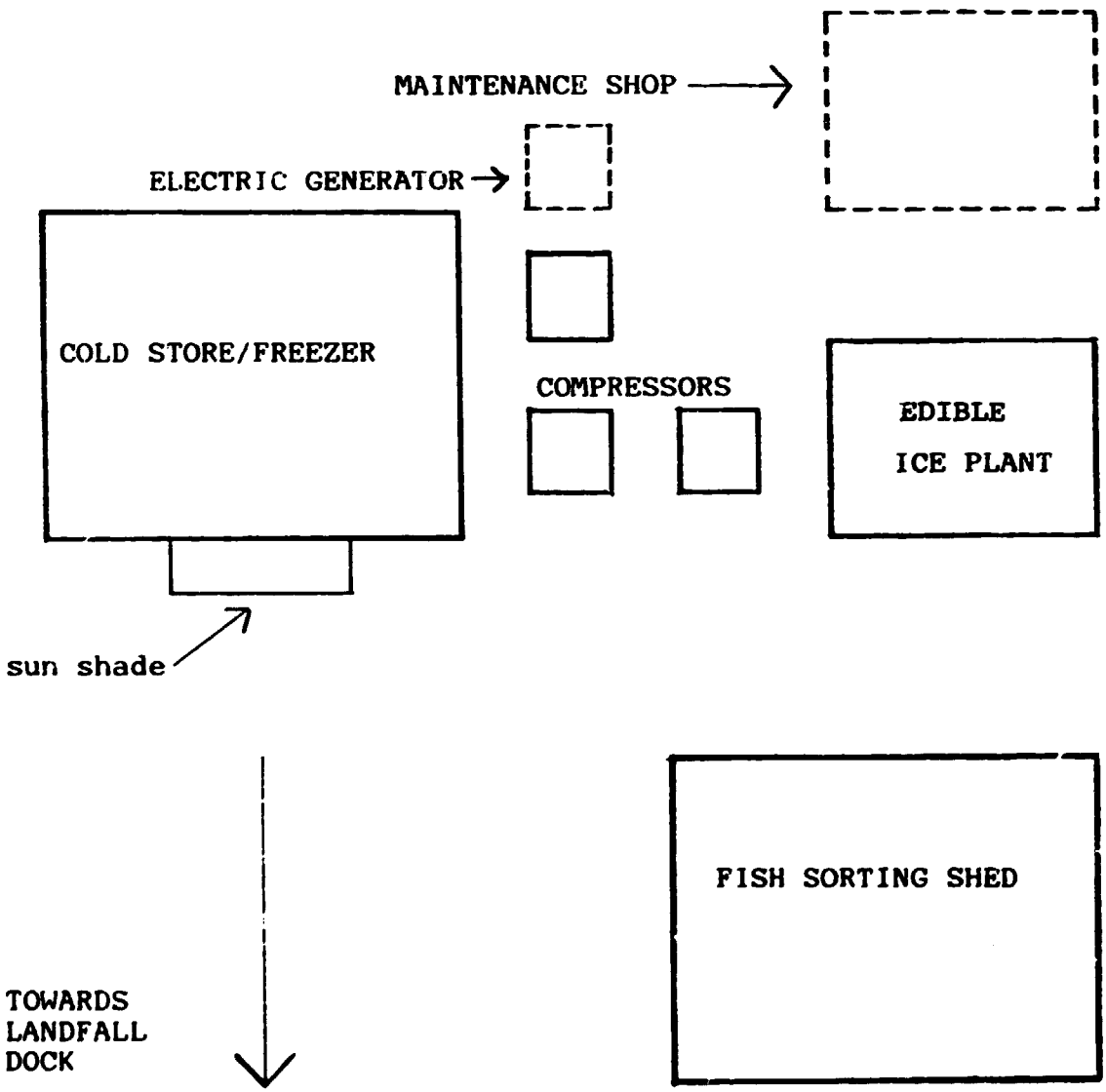
It is evident from the above that the hinterland depends on smoked fish products. This hardly augurs for a change in the present consumption pattern of what essentially is an inexpensive form of protein.

Refrigeration of unsold fish will not only permit stabilising availability on the local market, but it will permit replacing the lightly smoked fish with fresh one. Furthermore a steady supply of the local market will reduce consumer price fluctuations to a minimum. Adding to the refrigeration plant a chipped-ice/block-ice facility will increase the delivery range of fresh fish further inland. Should a freezer be justified, and added, then this more appetizing form of fish could replace the more intensely smoked varieties sold to the hinterland.

The refrigeration company could be operated as a private, public or fishermen-cooperative venture. It would buy up the excess catch not sold on the local market, and would release it as locally needed, while developing new clients further inland.

This report outlines a step by step method to be followed to establish the parameters, collect the data, analyse and decide which combination of solutions is best suited to the specific problem. It further includes, drawings, equipment sizing and specifications set up to permit far ranging questioning of the manufacturer market.

SCHEMATIC, AREA LAYOUT



PLANNING PROCEDURE

GUIDE LINES TO ESTABLISHING OF A COLD STORAGE SYSTEM

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B. Base guide lines.

C. Objectives.

D. Project location.

E. Technical construction data:
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J. Return on investment.

K. Economic and social fall-out.

L. Project schedule.
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SPECIFICATIONS

The following pages include general and specific comments applicable to the cooler and freezer stores, tabulation of suggested store sizes, and their applicable equipment. Furthermore, notes refering to block/chip-ice manufacturing, as well as fish storage lay-out considerations.

The cold/freezer store is to be located as close as feasible to the catch arrival area. This might be a dock or a beach area, benefitting, or not, from the existance of an adjacent local market. The fish that are first to be offered to the public for sale, should be set for sale under a shed and packed in ice. This will reduce spoilage of the unsold part, which eventually will end up in the refrigerated store.

The site chosen for the store should be naturally well drained.

As a first step in site preparation, all vegetation and top soil should be removed. The building site itself levelled and compacted, and drainage ditches dug to remove roof rain run-off. In the particular case for the freezer, if available, a gravel layer, 20 cm thick, should be laid under the building. This will permit natural ventilation of the foundation, rather then require electrical heating of same, to prevent potential frost formation, and eventual frost heave.

COLD STORE COOLER 0°/+2°C

Type No.	Area m^2.	Length m.	Width m.	Height m.	No.Door leaves
287/1	20	5	4	3	1
287/2	40	8	5	4	1
287/3	60	10	6	4	1
287/4	100	12	8	5	1
287/5	150	15	10	5	1
287/6	200	15	13.3	6	2
287/7	400	20	20	6	2
287/8	600	30	20	6	2
287/9	1000	40	25	7	2
287/10	2000	50	40	7	2

Construction Specifications

a. Concrete floor, 12 cm. thick B 30 or better.

b. Precast concrete curbs, 40cmx15cmx100cm, for interior protection of walls.

c. Steel structure, either hot-dip-galvanised, or rust inhibitive paint, one factory, one field applied coat.

d. Walls and ceiling of 10cm (4") insulated, hot-dipped-galvanised, or aluminium metal faced panels.

e. Refrigerator door, manually operated, plus PVC curtain:
-up to 150sm area, hinged door, single leaf, 2.10mx1.20m;
-above 200sm area, sliding door, double leaf, 3mx2.40.

f. Appropriate gutters and down spouts.

g. For required lighting, refrigeration-equipment and stand-by power, see electro-mechanical specifications.

FREEZER -25°C

Type No.	Area m^2	Length m.	Width m.	Height m.	No.Door leaves
2587/1	20	5	4	3	1
2587/2	40	8	5	4	1
2587/3	60	10	6	4	1
2587/4	100	12	8	5	1
2587/5	150	15	10	5	1
2587/6	200	15	13.3	6	2
2587/7	400	20	20	6	2
2587/8	600	30	20	6	2
2587/9	1000	40	25	7	2
2587/10	2000	50	40	7	2

Construction Specifications

a. Bottom concrete slab, 10 cm. thick B 30 or better, including conduits for floor heating system.

b. Insulation panels, polyuretane 12.5 cm (5") thick.

c. Upper concrete slab, 12 cm. thick B 30 or better.

d. Precast concrete curbs, 40cmx15cmx100cm, for interior protection of walls.

e. Steel structure, either hot-dip-galvanised, or rust inhibitive paint, one factory, one field applied coat.

f. Walls and ceiling of 15cm (6") insulated, hot-dipped-galvanised, or aluminium metal faced panels.

g. Freezer door, manually operated, plus PVC curtain:
-up to 150sm area, hinged door, single leaf, 2.10mx1.20m;
-above 200sm area, sliding door, double leaf, 3mx2.40m.

h. Appropriate gutters and down spouts.

i. For required lighting, heating cables for floor and door, refrigeration equipment and stand-by power, see electro-mechanical specifications.

REEFER DESIGN CRITERIA

- Average outside design temprature: 40° C.

- Design relative humidity: 88%.

- Number of air changes per hour:
  10 for coolers
  15-20 for freezers.

- Daily storage design turn-over: 1/4 of storage volume.

- Storage capacity design basis: 160 Kg/m³.

- Manual storage access alley dimensions: 1.20 m wide.

- Maximum allowable storage height: 1 m from ceiling.

- Manual storage range: 1.5 - 1.7 m off the floor.

- Sample store of 100 sm utilised in sample calculations.

- Compressor-evaporator tandems in separate units, smallest size being equal to 2/3 design capacity, for a two assembly store, and 1/2 for a three assemblies and less for above, assuring in the case of a break-down, at least 2/3 design capacity.

EQUIPMENT SPECIFICATION CHECK LIST

-Compressors, air-cooled, semi-hermetic tropicalised
-Compressor capacity
-Oil level indicator
-Oil separator
-Controls
-Air cooled condensor
-Coolant liquid
-receiver
-dehydrator
-Expansion valve

-Evaporators, extra-flat, tropicalised, with automatic electric defrosting

-System insulated piping

-PVC 40 condensate removal piping

-Condensate pressure regulating valves

-HP, LP manometers

-Liquid level indicator

-Control panel
-Power On-off, indicator light
-Defrost, indicator light
-Breakdown, indicator light

-Electric thermostat

-Store room electric panels and lights

-Freezer, only, floor and door heating cables.

COLD STORE COOLER 0°/+2°C

COMPRESSOR CAPACITIES

Type.No.	Area m^2	Volume m^3	Refriger. load Fg/H	Number of compress.	Comp.capac. Fg/H/unit
287/1	20	60	16 500	2	10 000
287/2	40	160	32 500	2	18 000
287/3	60	240	38 600	2	20 000
287/4	100	480	68 500	2	35 000
287/5	150	750	78 000	3	26 000
287/6	200	1200	113 000	3	40 000
287/7	400	2400	208 000	3	70 000
287/8	600	3600	299 400	3	100 000
287/9	1000	7000	538 000	4	140 000
287/10	2000	14000	1 050 000	4	250 000

COLD STORE COOLER 0°/+2°C

EVAPORATOR CAPACITIES

Type No.	Number of evaporators	Fvap.capac. Fg/H/Unit	Daily load entry kg/day	Storage m³
287/1	2	10 000	1 200	30
287/2	2	18 000	5 560	140
287/3	2	20 000	6 400	160
287/4	2	35 000	14 000	350
287/5	3	26 000	24 000	600
287/6	3	40 000	41 200	1 030
287/7	4	70 000	89 400	2 240
287/8	4	75 000	135 000	3 400
287/9	6	94 000	265 000	6 650
287/10	6	167 000	550 700	13 800

FREEZER -25 °C

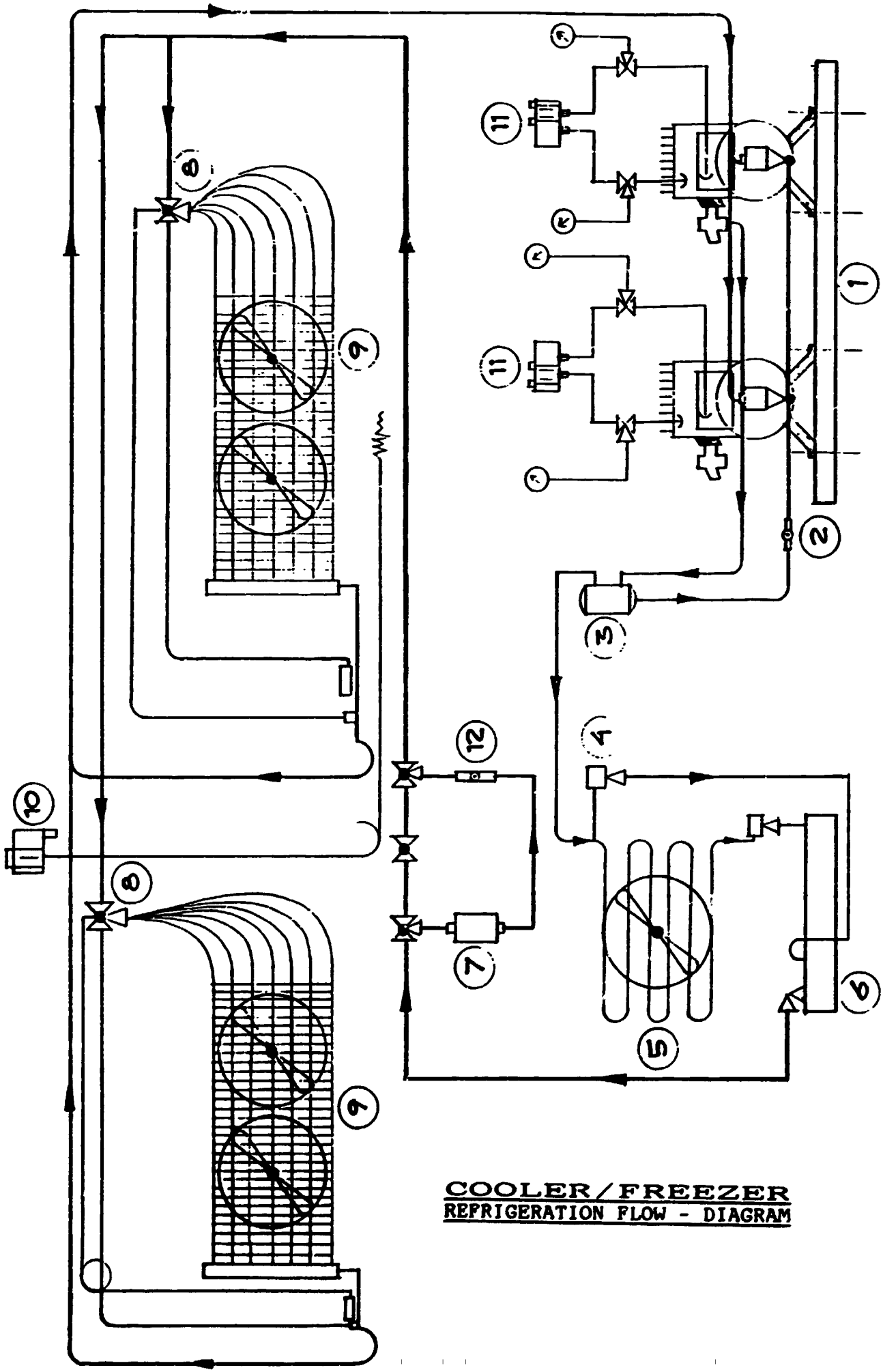
COMPRESSOR CAPACITIES

Type.No.	Area m²	Volume m³	Refriger. load Fg/H	Number of compress.	Comp.capac. Fg/H/unit
287/1	20	60	26 800	3	9 000
287/2	40	160	42 100	3	15 000
287/3	60	240	50 200	3	17 000
287/4	100	480	87 500	3	30 000
287/5	150	750	131 100	4	34 000
287/6	200	1200	197 000	4	50 000
287/7	400	2400	380 000	5	76 000
287/8	600	3600	644 000	6	110 000
287/9	1000	7000	1 056 000	8	132 000
287/10	2000	14000	2 120 000	10	212 000

FREEZER -25°C

EVAPORATOR CAPACITIES

Type No.	Number of evaporators	Evap.capac. Fg/H/Unit	Daily load entry kg/day	Storage m^3
287/1	3	9 000	1 200	30
287/2	3	15 000	5 560	140
287/3	3	17 000	6 400	160
287/4	4	30 000	14 000	350
287/5	4	34 000	24 000	600
287/6	4	50 000	41 200	1 030
287/7	6	64 000	89 400	2 240
287/8	6	110 000	135 000	3 400
287/9	8	132 000	265 000	6 650
287/10	10	212 000	550 700	13 800



COOLER/FREEZER
REFRIGERATION FLOW - DIAGRAM

COOLER/FREEZER

REFRIGERATION FLOW-DIAGRAM LEGEND

1. Compressors
2. Oil level indicator
3. Oil separator
4. Control
5. Air-cooled condenser
6. Receiver
7. Dehydrator
8. Expansion valve
9. Evaporator
10. Thermostat
11. HP, LP manometer
12. Liquid level indicator.

MANUFACTURING BLOCK AND CHIPPED ICE

To optimise fish conservation it is adviseable to pack it in chipped ice as soon as received. This applies to the fish to be sold upon arrival in the market, as well as the fish to be stored in the cooler, for local resale or shipment to other markets.

Chip-ice can be produced in two fashions: either by crushing block-ice, as needed, or by a chip-ice equipment and siloed storage. The direct chip-ice manufacturing and siloing can be economically justified only where industrial fishing boats take on a large load prior to going out to sea. On the other hand the crushing of ice-blocks is recommended for small fishing ports for number of reasons:

--Ice-blocks can be manufactured to meet a need beyond the one of fish conservation only, for example for domestic use. This would increase subtantially the return on this investment.

--crushing can take place in small amounts on an as needed basis, where-as siloed chips would either require large equipment or large storage to flexibily face the varying needs.

--Ice-blocks can be stored, in a segregated space within the cooler; where-as chip-ice would require an additional silo structure.

--Lastly the crusher is a less sophisticated equipment requiring less follow-up maintenance then the chip-ice unit.

ICE - BLOCK PLANT

Type No.	No.cakes /10 hrs.	weight kg	power kw	storage per day m³
IB-187	20	10	3	1
IB-287	32	10	5	1
IB-387	60	10	14	1.5
IB-487	60	15	14	2
IB-587	40	25	18	2
IB-687	64	25	24	4
IB-787	96	25	35	5

Comments to above tabulation:

When properly operated two shifts per day can be carried out, leaving time for maintenance and upkeep. Each shift will require, depending on manufacturer's specification an approximate 10 hour time span.

The required block-ice storage volume was based on a two shift day. The actual storage needs can be determined only within the framework of the project, and could go substantially beyond the tabulated figures.

Should a minimal solution at the port call for the installation of ice manufacturing facility only, and for no fish refrigerated storage at all, then, the minimal storage volume to be installed should be approximately 14 m³, i.e. —— 2.4x2.4x2.4 m, allowing for a usefull 10 m³ of storage.

The power requirements reflect the need for ice-manufacturing only. Not included are lighting, motorised hoists etc. The motorised hoist is recommended as of the IB-387 model.

The economics of the plant call for:
-2 men per shift
-appx. 1 kwh/kg of ice
-fresh water.

DOCK/LANDFALL AREAS

Neither in large, nor in small ports are there normally any fish off-loading facilities., in the sense of specialised equipment. The boats used by coastal water, etc. fishermen, do not require any off-loading equipment; and trawlers have on board cranes, i.e. are self unloading.

On the other hand, while in larger ports the docks and wharves do serve as a proper working area, for catch sorting and ice-packing; small fishing ports have no such work area. It is therefore mandatory for sanitary and effective catch-sorting to have a cleanable concrete slab, prefereably partly if not completely covered by an open air shed, to allow for catch processing..

Fresh water for area wash-down should be provided for, as should be proper drainage and waste removal.

CATCH PRESERVATION AT SEA

Where climatic conditions call for it, ice in form of chip or block should be taken aboard the boats, to preserve the fish in a as fresh a state as possible. This implies that the boats' volumes and dimensions are such as to allow adaptation of insulated containers, or custom formed storage areas into them.

There is no rational way in which a generalised solution can be approached in this report. It has to be studied on case by case basis, keeping in mind the adaptability of insulated material to existing shapes, as it can be installed by cutting up pannels, or by foaming insulation into prepared voids.

STORAGE

Storage will be either manual or mechanical, i.e. forklifts, means. Access alleys within the store have to be laid out to allow easy circulation of store personnel. Their presence whithin the store, particularily in the case of freezers should be kept to a minimum. This is for their own health and to reduce the open door time (reminder the doors are manually operated), thus reducing refrigeration loss to a minimum.

Storage lay-out should not inhibit proper circulation of air, as this would reduce the stores effectiveness. Minimal clearance from wall (0.5 m) and ceilings (1.0m) have to be respected.

Evidently in the first phase manual storage should be resorted to. this limits stacking to a height of 1.5 - 1.7 meter. Beyond that height, storing on shelves and mechanical stacking are called for. This will not only call for additional investment but properly trained operators and maintenance staff.

CONCLUSION AND RECOMMANDATIONS

This document has been established to lead the user in a systematic approach to resolving small fishing ports catch preservation problems.

The term "small fishing port" is obviously subjective. This means that not all line items enumerated in the guide-lines are always applicable. Also the terms utilised in the report are not universally applicable. Example, the term "hinterland" is meaningless in the West Indies, where small fishing ports do exist. Yet the term finds full applicability on the African and other third world continents.

The three levels of fish preservation are:

---Chipped ice, to satisfy the day's market preservation needs, the market being at or near the boats' landfall.

---Chipped ice and cooler refrigerated store, to satisfy the local day's market as well as the following days when no fish are available, and, nearby markets.

---The freezer, which will preserve fish for far-inland shipment, as well as prolonged local storage to regulate supply and demand, thus reducing price fluctuations.

Where a number of small ports are within easy trucking distance from each other, and the roads are allweather roads, a single central store, with chipped ice facilities at each port, should be considered.

Storing in coolers should at first be on a manual basis, expanded to mechanical storage once increased demand increases available supply.

Equipment lay-out should be designed as a series of independent compressor-evaporators tandems, sizing to be such that in the worst case scenario of equipment failure, (for plants up to 200 sm rea) one tandem would supply 2/3 of the required refrigeration capacity.

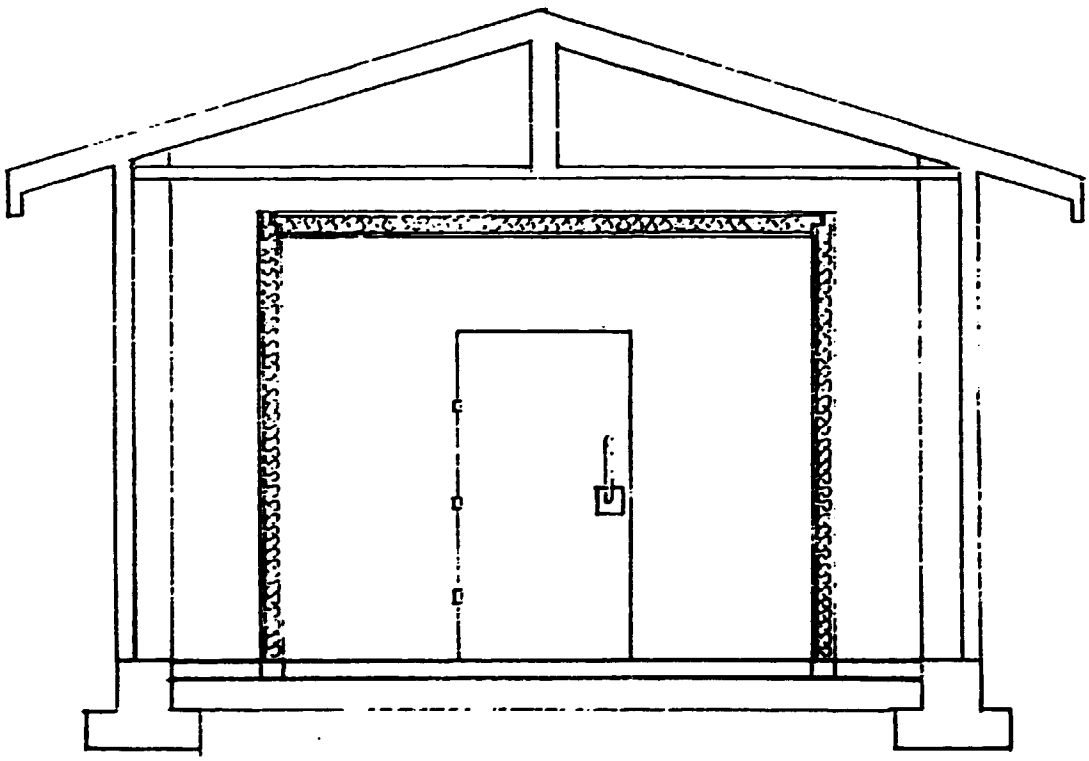
Stand by power requirements should be considered where local power outage statistics indicate down-time beyond reasonable storage preservation under closed-door conditions.

Consultant should be called in even for very small projects, to assure for proper, up to date and not over-designed approach.

ANNEX A

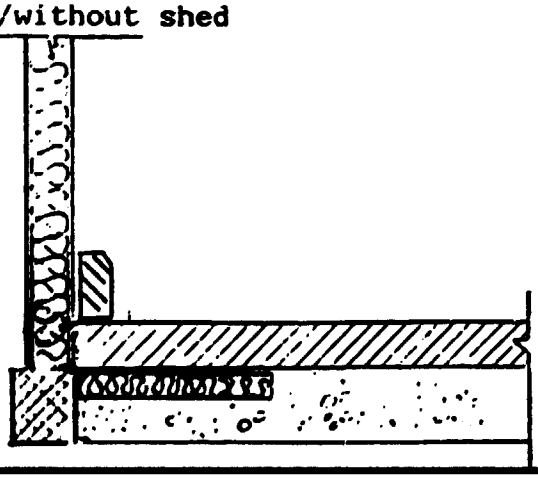
GUIDE-LINE CONSTRUCTION PLANS AND DETAILS

COOLER FACADE/FLOOR DETAILS

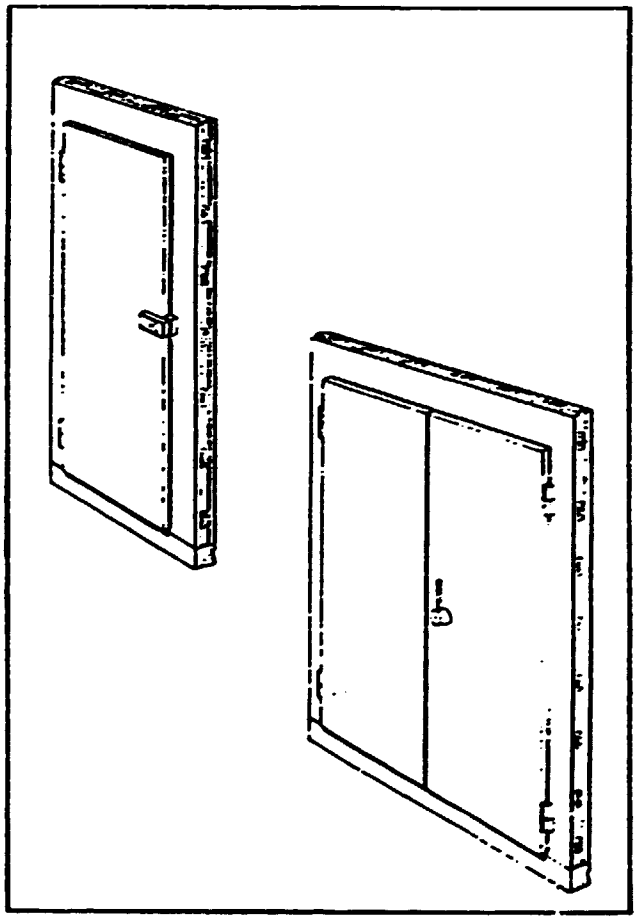


Facade/cut/building sun shade

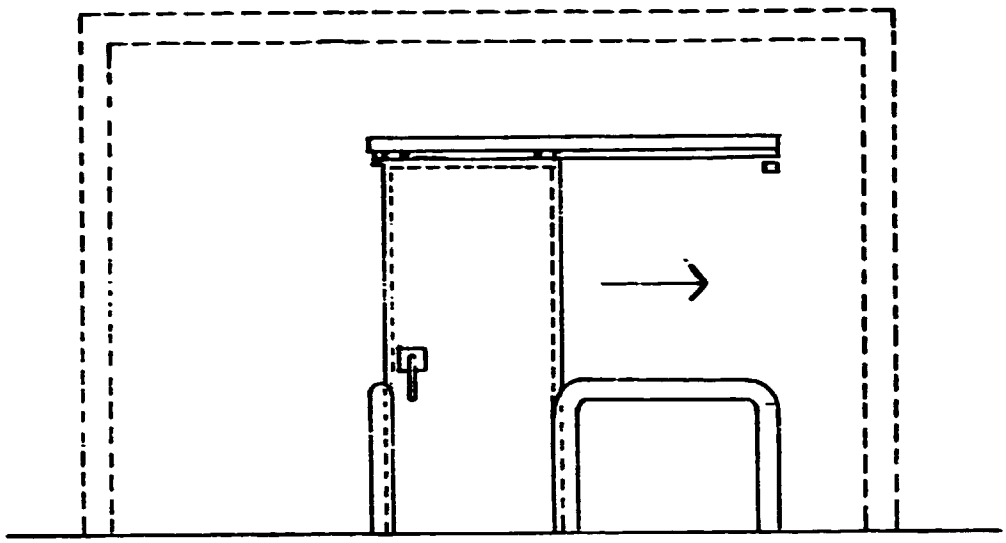
Building can be with/without shed

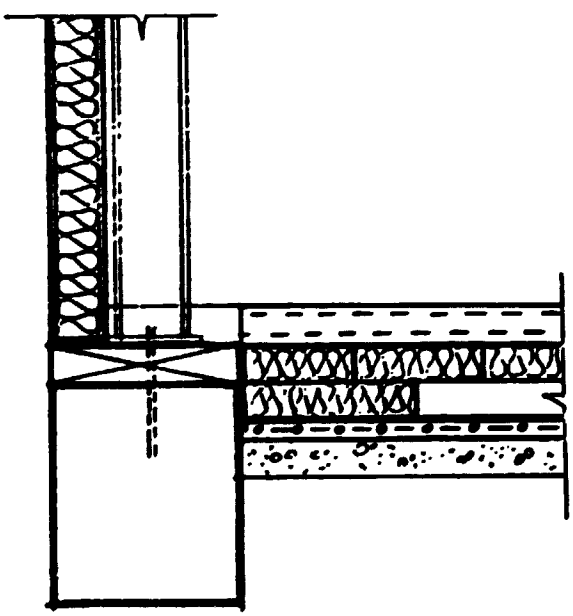


TYPICAL REEFER DOORS



FREEZER FLOOR/DOOR DETAILS





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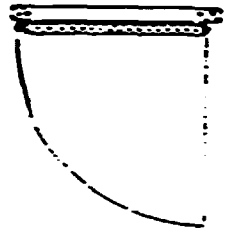
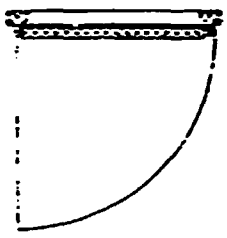
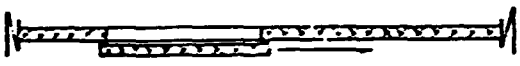
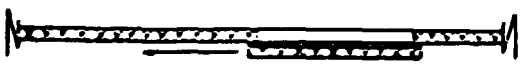
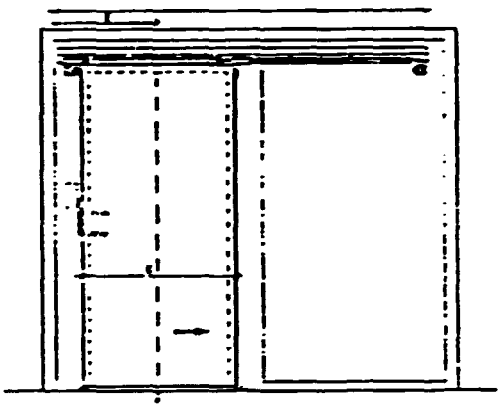
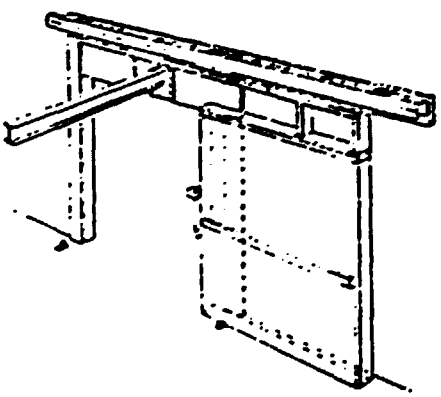




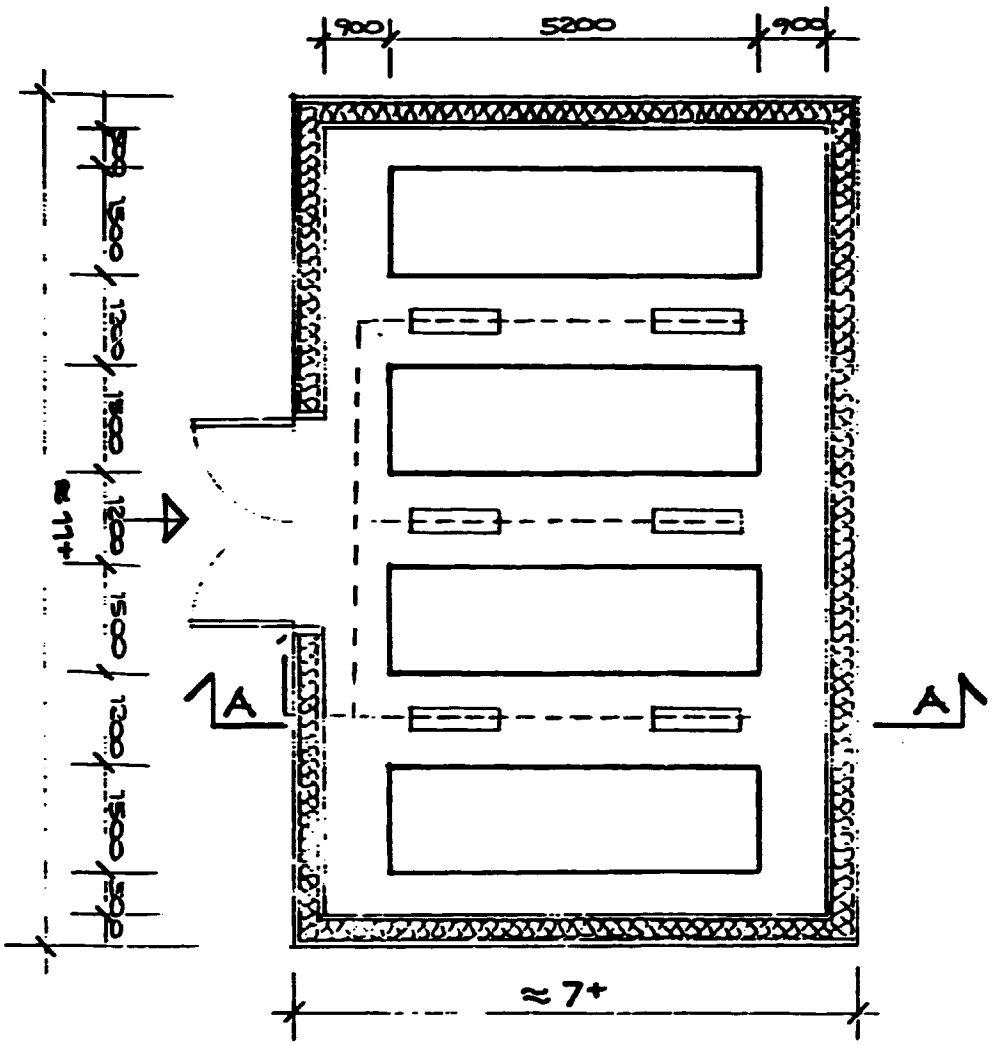


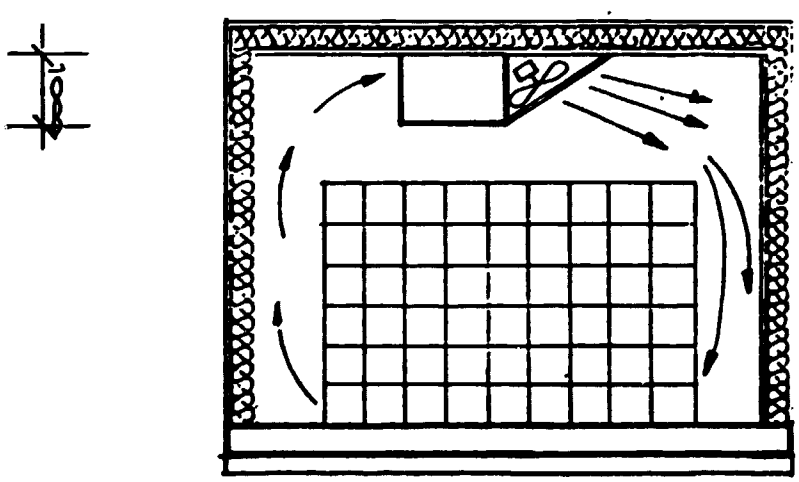






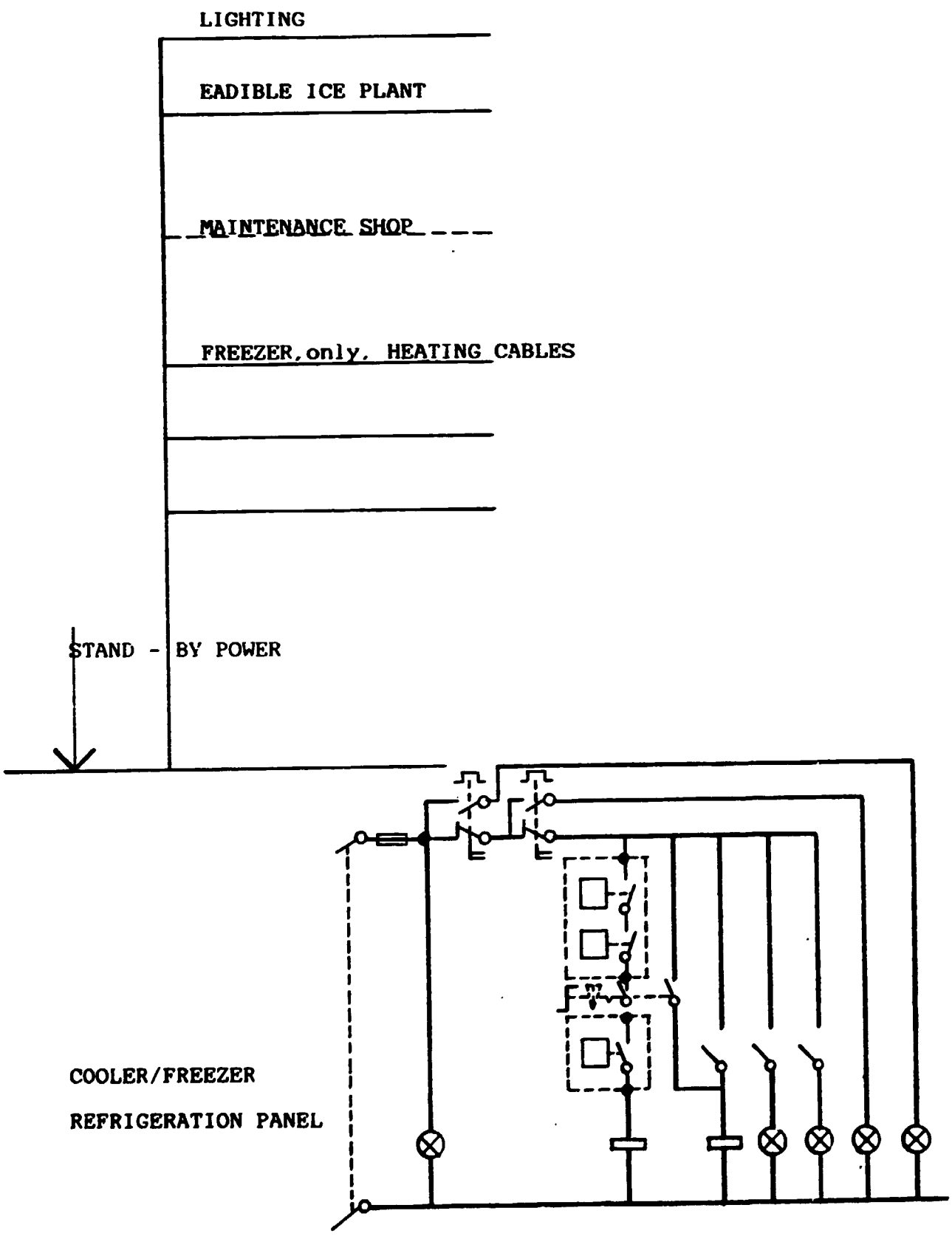
STORAGE/LIGHTING LAYOUT, not to scale.





A-A

ELECTRIC SCHEMATIC



ANNEX B

SAMPLE CALCULATION

100 SM COOLER

This french language refrigeration design computer program will be issued in english for use whenever this study will be applied to a project in an english speaking country, or in spanish, etc....

S.C.SCHIFF/A.TISBA	BILAN FRIGORIFIQUE		
DATE	7/12/87		
NOM DU PROJET			
N de PROJET	TYPE 287/10		
Temperature exterieure	40		
Temperature interieure	-1		
Temperature sol	30		
Temperature plafond	35		
HR ext	88		
HR int	85		
DIMENSIONS DU LOCAL			
Longueur	12		
Largeur	8		
		Surface :	96
Hauteur :	5	Volume :	480
1 REFROIDISSEMENT DES DENREES			
Entrees journalieres	14000	Kg/Jour	
Chaleur massive	0,86	Kcal/Kg c	
Temperature d'introduction	20	c	
Temperature de chambre	-1	c	
Chaleur a evacuer	252840	Fg/Jour	

2 EMBALLAGES ET PALETTES		
Chaleur mass. de l'emballage	0,27	
Temperature d'introduction	25	
Temperature de la chambre	-1	
Masse de l'emballage	1750	
Chaleur a evacuer	12285	
3 METABOLISME DU PRODUIT		
Chaleur de respiration/24h	0	Kcal/Kg 24
Masse du produit	0	
Chaleur a evacuer	0	
4 ECHANGES THERMIQ DES PAROIS		
Parois laterales	200	
Coefficient K1	0,22	Kcal/m2*c
Chaleur a evacuer	1804	
Sol	40	
coefficient K lineique	1,5	
Chaleur a evacuer	1860	
Plafond	40	
Coefficient K3	0,22	
Chaleur a evacuer	316,8	
Total Echanges Parois/Jour	95539,2	

5 RENOUVELLEMENT D'AIR	
Volume du local	480
Air de renouvellement m3/24h	9600,00
Volume massif	0,89
h ext	33,11
h int	-7
Chaleur a evacuer	432647,19
6 ECLAIRAGE	
Puissance electrique (W)	120
Nombre	6
Temps d eclairage/jour	2
Chaleur a evacuer	1238,4
7 MOTEURS APPAREILS	
Puissance (W)	0
Nombre	0
Temps h/j	0
Chaleur a evacuer	0
8 PERSONNEL	
Nombre	4
Temps/jour	6
Chaleur degagee Kcal/h pers	70
Chaleur a evacuer	1680

9 VENTILATION INTERNE		
Nombre d'evaporateurs	2	
Puissance Ventilateurs (W)	2500	
Taux de brassage	20	
Debit souffle	9600,00	
Rendement volumetrique	0,8	
Rendement mecanique	0,8	
Puissance ventilateurs	161250,00	
10 DEGIVRAGE		
Puissance (W)	2500	
Nombre	2	
Temps/jour	4	
Chaleur a evacuer	17200	
SOUS-TOTAL	974679,79	
PERTES INCALCULABLES (+10%)	97467,979	
BILAN FRIGORIFIQUE JOURNALIER	1072147,8	Fg/j
Temps de marche compresseurs	16 heures	
PUISSANCE HORAIRE NECESSAIRE	67009,236	Fg/h