32524

Portable Blast Freezing — New Technology for the Fishing Industry

D. Lemon, W. D. McDougall, and R. P. Martell[1]

Fisheries Development Branch
Scotia – Fundy Region
Halifax, Nova Scotia B3J 2S7

July 1981

Canadian Industry Report Fisheries and Aquatic Sciences NO. 127

Government of Canada Fisheries and Oceans
Gouvernement du Canada Pêches et Océans

Canadian Industry Report of Fisheries and Aquatic Sciences

These reports contain the results of research and development that are useful to industry for either immediate or future application. Industry Reports are directed primarily towards individuals in the primary and secondary sectors of the fishing and marine industries. No restriction is placed on subject matter and the series reflects the board interests and policies of the Department of Fisheries and Oceans, namely, fisheries management, technology and development, ocean sciences, and aquatic environments relevent to Canada.

Industry Reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report will be abstracted in *Aquatic Sciences and Fisheries Abstracts* and will be indexed annually in the Department's index to scientific and technical publications.

Numbers 1-91 in this series were issued as Project Reports of the Industrial Development Branch, Technical Reports of the Industrial Development Branch, and Technical Reports of the Fisherman's Service Branch. Numbers 92-110 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Industry Reports. The current series name was changed with report number 111.

Details on the availability of Industry Reports in hard copy may be obtained from the issuing establishment on the front cover.

Rapport canadien à l'industrie sur les sciences halieutiques et aquatiques

Ces rapports contiennent les résultats des recherches et des progrès qui peuvent être utiles à l'industrie pour des applications soit immédiates, soit futures. Ils sont préparés à l'intention principalement des membres des secteurs primaire et secondaire de l'industrie des pêches et de la mer. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du Ministère des Pêches et des Océans, notamment gestion des pêches, techniques et développement, sciences océaniques et environnements aquatiques, au Canada.

Les Rapports destinés à l'industrie peuvent être considérés comme des publications complètes. Le titre exact paraît au haut du résumé de chaque rapport, qui sera publié dans la revue *Aquatic Sciences and Fisheries Abstracts* et qui figurera dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros de 1 à 91 de cette série ont été publiés à titre de rapports sur les travaux de la Direction du développement industriel, de rapports techniques de la Direction du développement industriel, et de rapports techniques de la Direction des services aux pêcheurs. Les numéros 92 à 110 ont été publiés à titre de Rapports à l'industrie du Service des pêches et de la mer, Ministère des Pêches et de l'Environnement. Le nom de la série a été changé à partir du rapport numéro 111.

La page couverture porte le nom de l'établissement auteur où l'on peut se procurer les rapports sous couverture cartonnée.

Canadian Industry Report of

Fisheries and Aquatic Sciences No. 127

July 1981

PORTABLE BLAST FREEZING - NEW TECHNOLOGY FOR THE FISHING INDUSTRY

by

David Lemon, W.D. McDougall

and R.P. Martell[1]

Department of Fisheries and Oceans

Fisheries Development Branch

Scotia-Fundy Region

1721 Lower Water Street

Halifax, Nova Scotia

B3J 2S7

[1]Associated Freezers of Canada Ltd.
Burnside Industrial Park
Dartmouth, Nova Scotia B2Y 4A8

Cat. No. Fs 97-14/ 127 ISSN 0704-3694

Correct citation for this publication:

Lemon, David, W.D. McDougall and R.P. Martel. 1981. Portable Blast Freezing - A New Technology for the Fishing Industry. Can. Ind. Rep. Fish Aquat. Sci. 127: iii + 8p.

ABSTRACT

Lemon, David, W.D. McDougall and R.P. Martell. 1981. Portable Blast Freezing - A New Technology for the Fishing Industry. Can. Ind. Rep. Fish. Aquat. Sci. 127: iii + 8 p.

In many areas of Atlantic Canada there are periods during the year when gluts of certain species occur. A major problem in handling these fish is often a lack of sufficient freezing capacity. However, because of the seasonal nature of such gluts, investment in the necessary on site freezing capacity is not economically feasible. After comprehensive study, it was concluded that portable freezing capacity could serve to effectively reduce the problem. In early 1979, a portable blast freezing unit, capable of freezing approximately 25,000 pounds of product per day was constructed under an agreement with Associated Freezers of Dartmouth, N.S. The unit was demonstrated in six locations in the Maritimes during the summer and fall of 1979 and it appears from this experience that such units might well be effectively utilized in Atlantic Canada in the years to come.

Résumé

Lemon, David, W.D. McDougall and R.P. Martell. 1981. Le Congélateur À Air Pulsé Portatif - Une Nouvelle Technologie Pour L'Industrie de la Pêche. Can. Ind. Rep. Fish. Aquat. Sci. 127: iii + 8 p.

Dans de nombreaux secteurs de la région de l'Atlantique (Canada), il y a des périodes de l'année pendant lesquelles il y a surabondance de certaines espèces de poisson. Il arrive souvent que l'on ait alors beaucoup de difficulté à traiter le poisson tout simplement parce qu'on ne dispose pas des installations de congélation voulues. Toutefois, étant donné que cette surabondance ne se produit que de façon saisonnière, il n'est pas économique de construire des installations de congélation fixes. Des études approfondies ont permis de conclure que les appareils de congélation portatifs pouttaient permettre de résoudre le problème. Au début de 1979, le ministère des Pêche et des Océans a fait construire un congélateur à air pulsé portatif capable de congeler environ 25000 livres de poisson par jour par la Associated Freezers, de Dartmouth (N.-E). Au cours de l'été et de l'automne de 1979, des représentants du Ministère ont fait la démonstration de l'appareil dans six localités des Maritimes; cette expérience a semblé démontrer qu'il se pourrait fort bien que de tels appareils soient efficacement utilisés dans la région de l'Atlantique (Canada) au cours des années à venir.

INTRODUCTION

The inshore fishery of the Canadian Atlantic region, with few exceptions, is a seasonal operation. The length of the operating season can be variable and is dependent on such factors such as weather, size of boats and fishing gear utilized, migratory fish and availability of fish processing facilities.

It is well known that certain species tend to be available inshore for relatively short periods of time. This is certainly the case for mackerel, herring, and squid and in the case of Newfoundland capelin. During these glut periods, which are often unpredictable, freezing capacity is usually limited, however, sufficient processing facilities may exist to permit simple processing operations such as weighing, washing and product sorting. It is simply not economical to provide permanent freezing facilities in locations where facilities would be utilized primarily for those inshore fisheries having a limited operating period. Because of inadequate freezing facilities, when fish becomes available at short notice and in abundant quantities, the harvesting capability of inshore fishermen may be severely limited. This results in loss of income to fishermen and to the fishing industry generally.

Many in the industry, have, over the years, suggested that portable or mobile equipment might be of real value in handling such situations. Accordingly, the Department commissioned a study to determine if mobile freezing plants did in fact represent a viable option for the industry to pursue. As part of the study three alternatives were considered:

1. additional permanent freezing facilities

2. portable freezer facilities

3. self contained mobile freezer facilities

On the basis of the positive results of the study and the general interest in the technology, a contract was awarded on a cost shared basis to Associated Freezers of Canada Ltd., Dartmouth, N.S., for the design, manufacture, testing and operation of a self contained mobile freezer unit.

ENGINEERING

The feasibility study suggested double contract horizontal plate freezers be used in preference to other freezing systems. Subsequent analysis and discussions between the contractor and the Department determined that a blast freezer would provide a more versatile operation even though indications were that the initial capital cost of horizontal plate freezers would be somewhat lower than a blast freezer.

Rail, sea and road transportation modes were analyzed in the consultants study, and road transportation was considered to be the most feasible. The capital cost or rental cost of barge transportation was considered to be prohibitively high. Rail transport was considered not feasible because of the lack of potential sites which could be serviced. Consideration was originally given to provision of a completely self contained unit with a diesel generator power source for operation in locations where suitable power is not available. Due to cost factors, the diesel generator option was not included. It was felt that the feasibility of the concept would not be adversely affected by not providing the self contained component.

During the winter of 1979, the unit was constructed. It consists of a blast freezing tunnel with a freezing capacity of approximately 30,000 pounds per 24 hours, built on a single tri-axle chassis, the unit having an overall length of 60 feet, width of 12 feet, and height of 13 feet. Two access doors to the tunnel are located on one side to allow for the sequential loading of product, and for easy access in locations where space is limited to allow for positioning parallel to existing plant walls. (Figures 1,2, and 3)

The refrigeration system generally consists of a conventional two stage compression system, suction accumulator, evaporative condenser, receiver, liquid sub-cooler, finned evaporator, and necessary refrigeration components and controls. The evaporative condenser was chosen because of a high capacity-to-weight ratio. The evaporator fin spacing is 1/2" on the inlet side, and 1/3" on the outlet half to reduce the plugging effect of frost accumulation.

For the sake of simplicity, water defrost was used, but reverse cycle hot gas, electric, or propane heat sources could be readily applied at appropriate additional cost. Naturally it was found that the small water supply required for the condenser needed frost protection during the winter months, to prevent freezing during off cycles. On occasion, some difficulty was experienced by operators not ensuring a complete defrost before starting the system up, especially during cold weather. Of course normal draining procedures should be followed to winterize the unit during off seasons.

The total connected load is approximately 145 H.P., 3 Phase 550 Volts as follows:

Low Stage Compressor	50 H.P.
High Stage Compressor	60 H.P.
Evap Condenser Fan	3 H.P.
Evaporator Fans 3 x 7.5 =	22.5 H.P.
Water Pump	1 H.P.

10 KVA Transformer to supply heaters, ventilation and lights.

The design capacity is approximately 30,000 pounds per 24 hours, however, actual quanities frozen will depend on proper loading techniques, to ensure necessary air circulation in a uniform pattern. Another key factor in freezing efficiency is the ratio of exposed surface to product thickness. Generally, unit thickness should not exceed 2 1/2" with a maximum for some products of 3".

OPERATION

As part of the cost sharing agreement with the Department, Associated Freezers agreed to operate the facility at five different locations in the Maritimes between May 1st, 1979, and January 31st, 1980, it was in fact operated at six locations. In order to adhere to the Fish Inspection Regulations and ensure that product was properly handled before freezing, it was necessary to locate the freezer adjacent to licensed processing plants. Some modifications, such as leveling an area close to the plant or installing a concrete pad were required at each site to accommodate the freezer. The most expensive site preparation involved the provision of power. In three locations it was necessary to install transformer banks to deliver the required 550 volts, In two of the locations it was possible to connect to existing transformer systems while in the final location power was provided by a separate diesel-generator set. Thus, at this last location it was possible to evaluate the unit's operation independent of fixed mains.

The rational for operating the freezer at the various locations chosen was twofold:

(a) to acquire operational data and determine what problems were inherent in operating the unit.

(b) to demonstrate the concept of portable freezing to as wide an audience as possible throughout the Maritime Provinces.

This sometimes meant that the freezer was not always moved to coincide with peak production. Through the use of local media, those in the area were informed of the freezer location. The freezer was available for viewing at any time and was also available to freeze products for anyone wishing to use it within scheduling restraints.

In May of 1979, the freezer was transported to Cocagne, New Brunswick, where it underwent testing. After initial shakedown the unit was used over a twenty day period to freeze approximately 200,000 pounds of mixed product including cold pack lobster. At the end of June, the unit was moved to Middle Pubnico, Nova Scotia. It was anticipated that large quantities of herring would be available from the Bay of Fundy herring fishery as well, the freezer would be utilized to freeze dogfish as an effort was planned to harvest this hitherto unused resource on an experimental basis. Unfortunately herring catches were down substantially and the problem was further complicated by the presence in the catch of a substantial quantity of small fish which made processing difficult. The dogfish project yielded only sporadic catches thus, the expected raw material was not available and the freezer was grossly underutilized at this location.

The unit was moved via road and ferry to Black's Harbour, New Brunswick, where it was immediately pressed into service to assist in the freezing of bulk sardine herring. The freezer averaged between 20,000 and 25,000 pounds per day when in operation.

At the end of August it was moved to Gaspereau, P.E.I., the main product processed there was head on gutted hake and approximately 100,000 pounds of this product was frozen. The presence of the freezer at this plant allowed the firm to become involved in frozen groundfish , a commodity it had not previously processed.

On October 1st, 1979, the unit was moved to Neil's Harbour on Cape Breton Island, where approximately 200,000 pounds of squid were frozen over the next month. The plant at Neil's Harbour had no freezing or cold storage facilities whatsoever pershiable species. Previously the only alternative open to fishermen in the area was to truck their catch some distance to a plant equipped with freezing facilities, this practise is, however, not recommended for squid.

In the middle of November the unit was moved to Mink Cove, Digby County, Nova Scotia. Again to a plant without existing freezing facilities and used there periodically until the end of January. During this period 139,000 pounds of herring fillets were frozen. The freezer was operated using a diesel-generator set with only some minor problems. These problems can, in the future, be avoided by some simple modicications in design.

During the entire project there were no problems of any kind related to moving the freezer, it covered in excess of 3,000 km. during the demonstration period. It travelled at normal highway speed and in fact made three different ferry crossings. All moves from disconnect to repositioning were made in less than 24 hours.

The unit proved to be an extremely good freezer capable of producing at rated capacity providing, as mentioned previously, it was correctly loaded. It is relatively simple to operate, usually novices were able to master its operation after a day or two of instruction.

In order to maximize the utility of any mobile freezer it is necessary that loading and unloading be scheduled in such a way as to take full advantage of equipment capability. Remember too, that once product is frozen it has to be stored. This may mean the provision of mobile cold storage units or reefer transport to central cold storage. This factor must also be worked into any scheduling equation.

ECONOMIC ANALYSIS

A number of different analysis have been conducted on data accumulated and all appear to indicate that such units could be economically feasible. An investment decision to buy or lease such a unit depends on a number of factors, many of which are particular to the specific individual or firm involved. The rate of return will, for example, be dependent on the species frozen, the degree of usage, the power costs in particular area and so on, as well as being dependent on traditional exonomic factors such as the cost and availability of funds.

In the analysis that is highlighted here, an attempt has been made to avoid some of these problems. Using data accumulated from the demonstration phase of project and making adjustments or projections where necessary, an attempt has been made to calculate the break-even point for freezing using the mobile freezer. That is, the increase in the price per pound of frozen material that must be realized to cover the cost of freezing irrespective of other costs such as handling, transportation and storage. The particular scenario outlined here is based on the following assumptions:

(1) The freezer operates at five locations per year, spending six weeks at each location.

(2) The freezer operates five days per week at 85% capacity.

(3) All costs are in 1979 constant dollars.

(4) The capital cost of the freezer is assumed to be $190,000, the unit has a useful life of 15 years with no scrap value.

(5) Racks and pans are replaced every five years at a cost of $40,000.

(6) Insurance, transportation and personnel costs do not vary. Energy costs are assumed to rise dramatically over the first five years at a rate of 14% per year and thereafter 5% per year.

(7) Maintenance costs are assumed to total 40% of the capital cost over the life span of the unit and are applied on a periodic basis from year 6 through year 14.

(8) Depreciation, interest and like expenses are not included.

The approach taken here is a very conservative one, for example, the maintenance costs may be arbitrarily high and energy costs which are by far the largest operating expense are assumed to rise dramatically. Some might argue, as well, that the 85% capacity figure used in the calculations is too high. (Table I)

Be that as it may, the break-even point calculated by discounting at 10% is 2.85 ¢/lb. and at 15% is 3.04¢/lb. both of which are acceptable values. Other scenarios, not included here, in which a number of the variables have been altered yield similar results.

CONCLUSIONS

The concept of mobile blast freezing was more than adequately demonstrated during this project. Although the unit tested had a capacity of 30,000 pounds/24 hours, for smaller plants one might consider a smaller unit. Although the cost per pound frozen probably would not decrease with a smaller unit, if anything it might be higher, there might be advantages in terms of ease of operation and a lower voltage requirement, such as 220 volt, 3 phase which is more readily available than 550 volt in rural areas.

Blast freezing was utilized in this case for reasons of versatility and in fact it would not have been possible to freeze all the product types that were frozen in this demonstration in anything but a blast freezer. However, if freezing requirements were specifically known there is no reason that other types of heat exchange apparatus, such as vertical or horizontal plates or belt/conveyor type freezers could not be constructed. Similarly the concept of a portable engine room has been discussed. A unit could be attached to a reefer trailer or simply added for a specific period to a free standing structure. Portable freezing may also have some application in other industries, notably agriculture. This technology represents a viable option for consideration in any future operational planning. (Figures 4-8)

TABLE I

MOBILE FREEZER

BREAK-EVEN ANALYSIS IN 1979 CONSTANT DOLLARS

Year	Maintenance	Energy	Total
1		$27,625	$266,915
2		31,493	40,783
3		35,901	45,191
4		40,928	50,218
5		46,658	55,948
6	$ 8,550	53,190	111,030
7		55,849	65,139
8	12,825	58,642	80,757
9		61,574	70,864
10	17,100	64,652	81,752
11		67,885	117,175
12	21,375	71,279	101,944
13		74,843	84,133
14	25,650	78,585	104,235
15		82,514	91,804

OTHER COSTS

Personnel costs are assumed to be $4,500 per year. Transportation costs are assumed to be $3,270 per year. Racks and pans are replaced in year 6 and year 11 at a cost of $40,000 in each of those years.

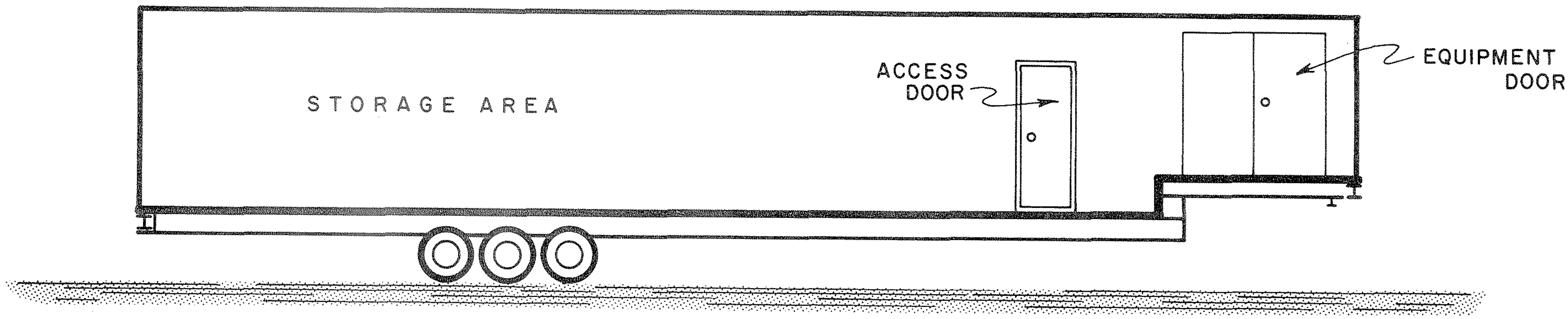
Present value of costs at 10%: $794,249
Break-even point at 10%: $ .0285/lb.

Present value of costs at 15%:	$658,201
Break-even point at 15%:	$ .0304/lb.

Figures 1 & 2

MOBILE BLAST FREEZER

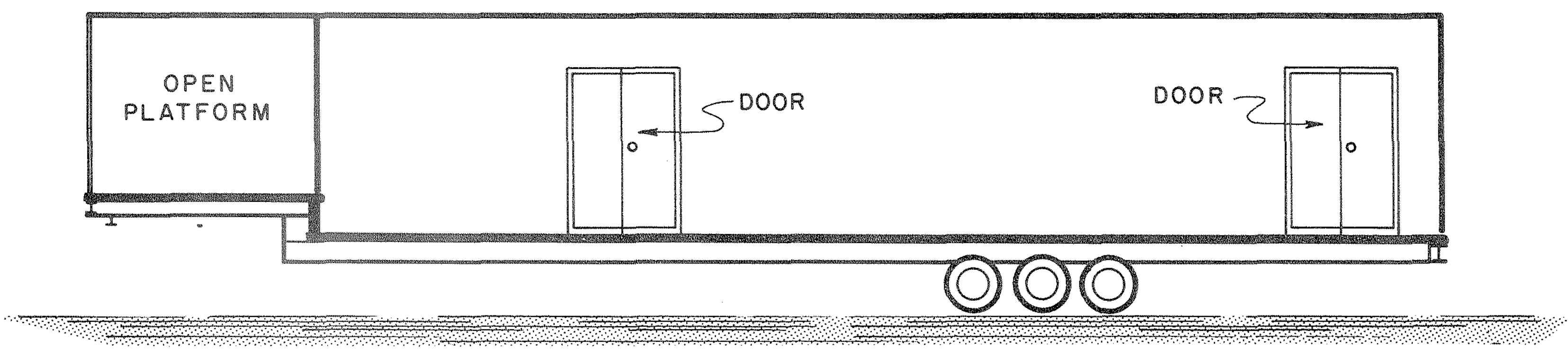
OVERALL LENGTH 60 FEET



CURB SIDE

MOBILE BLAST FREEZER

OVERALL HEIGHT 13.1/3 FEET

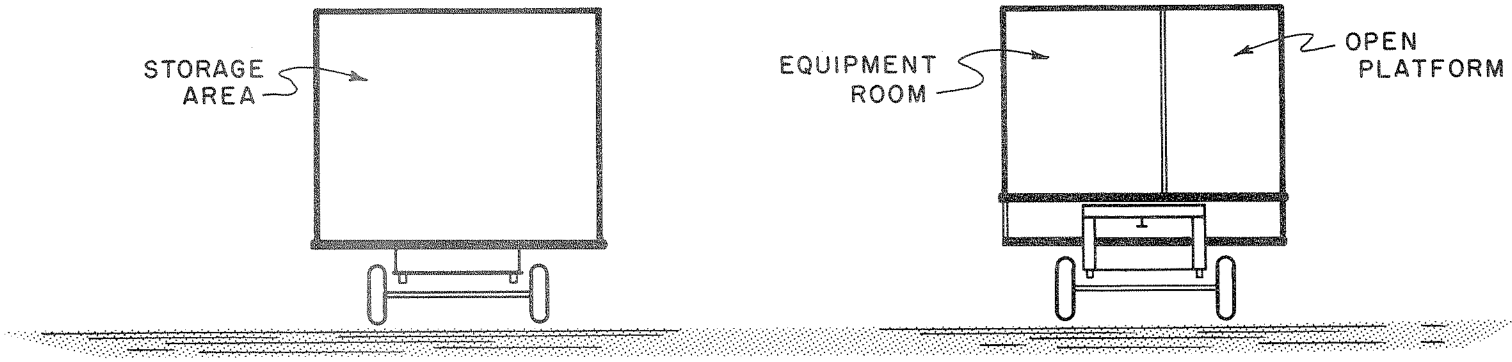


STREET SIDE

Figures 3 & 4

MOBILE BLAST FREEZER

WIDTH 12.1/4 FEET

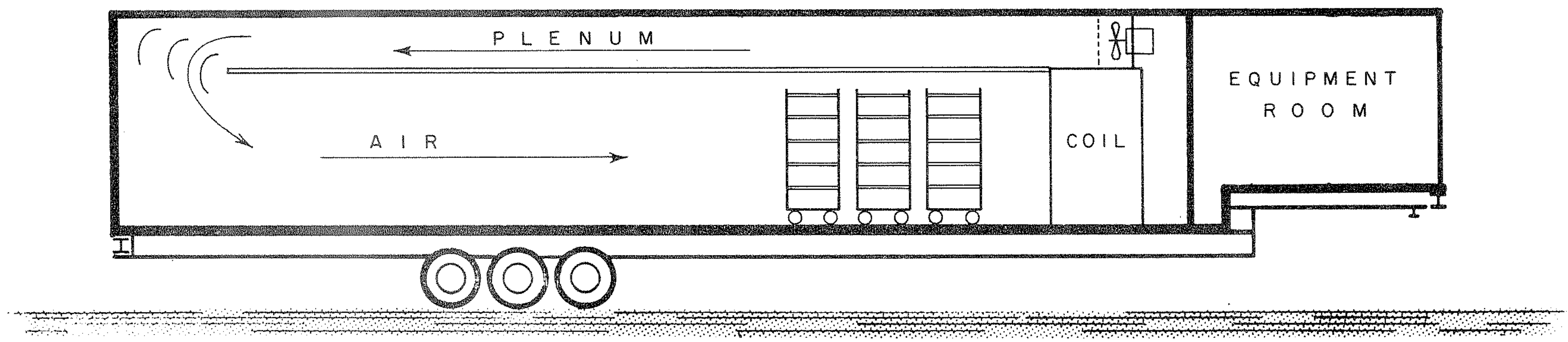


REAR FRONT

MOBILE BLAST FREEZER

OVERALL LENGTH 60 FEET

Nº 1. ALTERNATE ARRANGEMENTS OF EQUIPMENT.
BATCH BLAST FREEZING ON RACKS



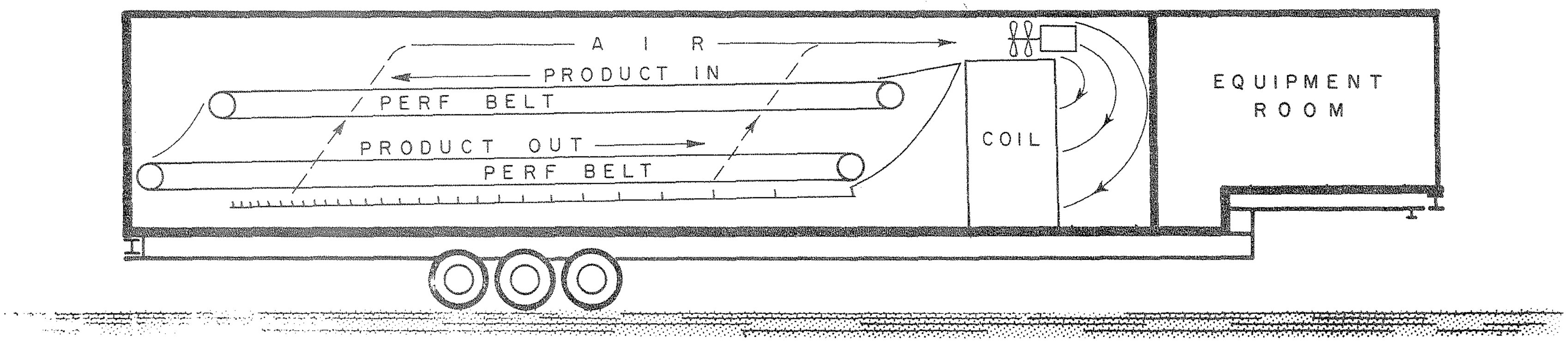
CURB SIDE

Figures 5 & 6

MOBILE BLAST FREEZER

OVERALL LENGTH 60 FEET

Nº 2. BELT OR CONVEYOR
CONTINUOUS I.Q.F., USING REMOVABLE CONVEYOR UNIT

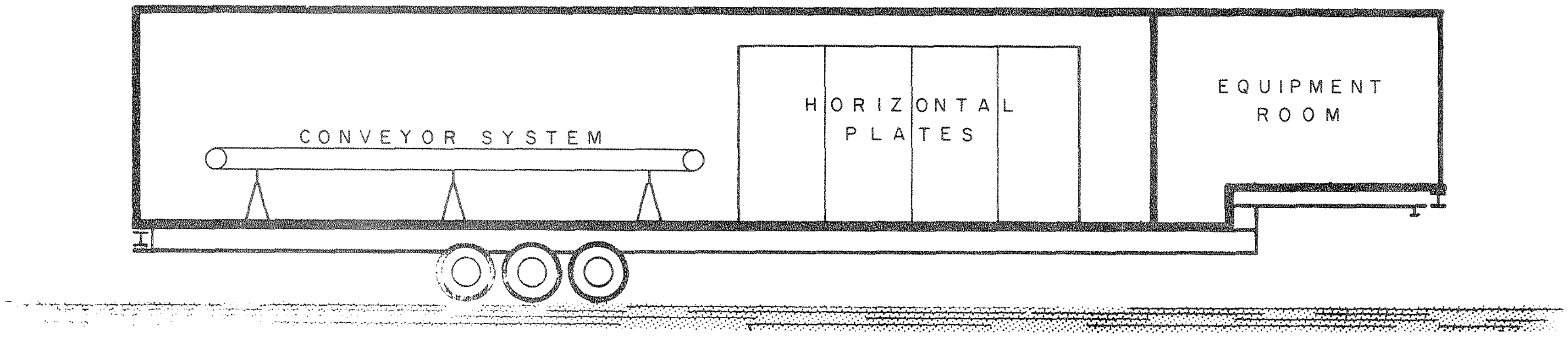


CURB SIDE

MOBILE BLAST FREEZER

OVERALL LENGTH 60 FEET

Nº 3. HORIZONTAL PLATES,
CONVENTIONAL BLOCKS AND LIMITED I.Q.F.



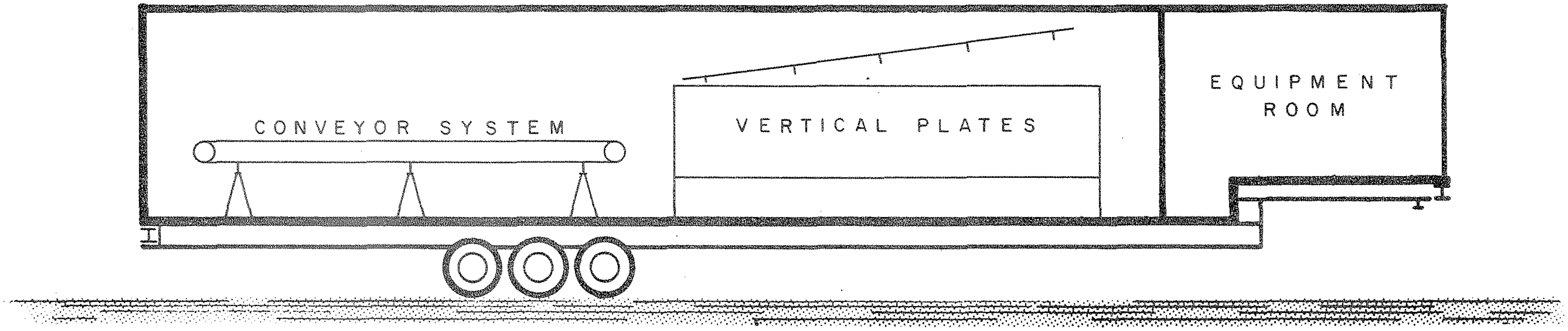
CURB SIDE

Figures 7 & 8

MOBILE BLAST FREEZER

OVERALL LENGTH 60 FEET

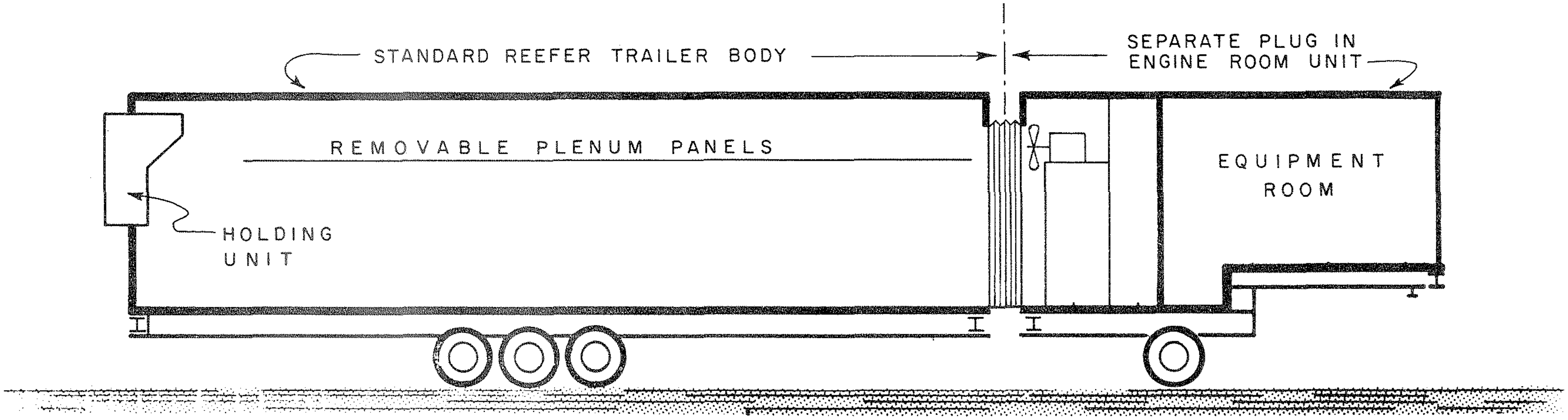
Nº 4. VERTICAL PLATE,
BULK BLOCK FREEZING FOR FURTHER PROCESSING ETC.



CURB SIDE

MOBILE BLAST FREEZER

Nº 5. OVERALL LENGTH 60 FEET



CURB SIDE