

# Blast Freezing of Cartoned Meat

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Meat  
Research  
Corporation



**AMT**  
AUSTRALIAN MEAT TECHNOLOGY

**A**ir blast freezing in batch or continuous units is the most common method of freezing meat in Australia. To meet regulatory requirements while operating the plant under the most economic conditions, processors must be able to estimate the time taken for meat to freeze in blast freezers and understand factors affecting freezing rate.

Freezing time can be estimated from the nomogram (Figure 1) or by using computer programs such as MIRINZ Food Product Modeller.

higher due to the decreased co-efficient of performance (COP) of the refrigeration system.

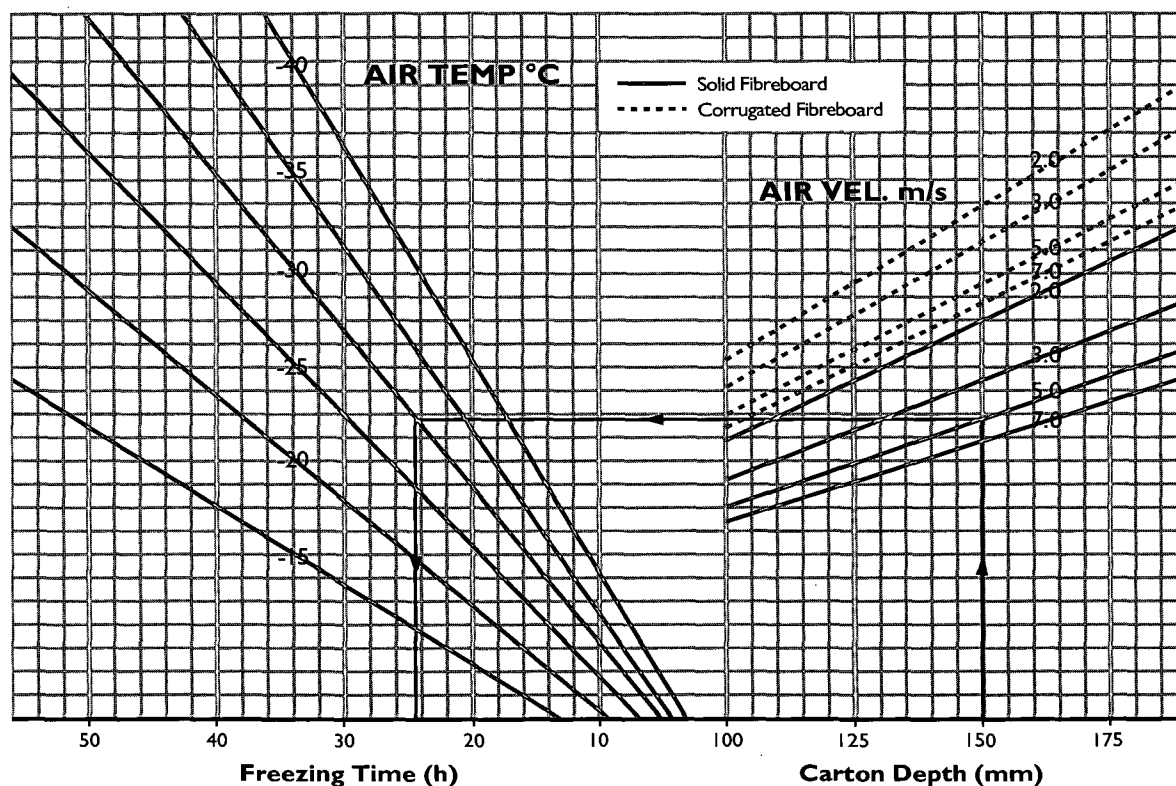
Air movement over the surface of the carton assists in the removal of heat from the product. The surface heat transfer co-efficient increases as the air velocity increases.

Higher air velocities require a greater input of fan power, producing heat which must be removed. Increasing air velocity above about 5m/s has little effect on freezing rate and increases operating costs.

### Cartons

In commonly used cartons, with depths ranging from 152mm to 178mm, the effect on freezing time of the depth of the carton is only 10%.

**Figure 1: Effect of carton depth, air velocity and air temperature on freezing time**



The rate at which cartoned meat is frozen in air blast freezers depends on several factors including air temperature and velocity, carton depth, carton style and fibreboard type, product composition, carton orientation and defrost timing.

### Air temperature, velocity

Lower air temperatures will result in more rapid freezing. Reducing the air temperature from -20°C to -30°C, for example, will reduce the freezing time of a 150mm deep carton by 35%. Although air temperatures can be reduced to -40°C or below, the operating cost will be much

However, if hot-boned meat is being handled, the effect on freezing time may be more significant, and shallower cartons should be considered.

Freezing time predictions from the nomogram are based on box and lid style cartons. When the more commonly used one-piece cartons - with extra layers of fibreboard - are used, freezing time increases by 15%.

The use of the thinner E-flute board as opposed to corrugated B-flute board results in a 15% decrease in freezing times.

## Product Composition

The freezing time of the carton is dependent on the rate of heat transference through the carton contents. Cartons of individually wrapped cuts may take 10% longer to freeze due to the insulating effect of layers of trapped air.

Variations in fat content have little effect on freezing time because, while fat distributed evenly through the carton also tends to lower thermal conductivity, this is offset by the reduced water content.

## Carton Orientation

Theoretical freezing times are calculated on the basis that cooling air flows over all surfaces of the carton. In practice, sides or ends of cartons are normally pressed together. If the sides are pressed together, freezing times are increased

by up to 15%, compared with an increase of 5% if the ends are pressed together.

## Defrost Timing

Blast freezers require defrosting. In the case of batch blast freezers, defrosting can take place during unloading. In continuous units, defrosting should be scheduled for weekends when its effect on freezing time is unimportant.

When freezing cartoned product, there is little evaporation from the product. Water vapour forming as frost on the evaporators will have entered through doors or leaks in the building structure. Adequate sealing will reduce the need to defrost Automatic Air Blast Freezers (AABFs) to once a week.

The effects of these factors and others on the freezing time of cartoned meat are summarised in Table 1.

Table 1: The effect of various factors on the freezing time of cartoned meat.

FACTOR	CORRECTION
<b>1. Restriction of Air Flow</b>	
Cartons supported on flat sheet metal shelves	Add 10%
Cartons supported on corrugated metal shelves	No correction
Cartons have long sides pressed together	Add 15%*
Cartons have long sides adjacent, but spaced (~150mm)	Add 10%*
Cartons have short ends pressed together	Add 5%
Defrost occurs during freezing period	Add number of hours fans are turned off
<b>2. Carton Style</b>	
Overlap slotted container, solid fibreboard (spec. 293/244-342/2 or 244/117-448/2)	Add 15% to solid board prediction
Overlap slotted container made of E-flute (spec. 293/293-117/1)	Deduct 15% from corrugated
<b>3. Carton Contents</b>	
Primal cuts individually wrapped in polythene film:	
i) Fat randomly distributed	Add 10%
ii) Fat located near carton centre	No correction
iii) Fat located near carton periphery	Add 15%
All bulk packs including those with large pieces and with visual fat content in the range 15-25%	No correction
Livers individually wrapped in polythene film and frozen immediately after removal from slaughter floor	Add 15%
<b>4. Frozen Meat Temperature</b>	
Freezing to a centre temperature of -12°C	Add 5%
Freezing to a centre temperature of -2°C	Deduct 10%

\* Maximum correction, applicable to 1 or 2 cartons towards the end of the shelf away from the cold air entry end.



There is little doubt that AABFs are more energy-efficient than batch blast freezers because cartons are moved directly into the freezing area, eliminating the loss of cold air through doors during loading.

No delay during loading means more time is available for freezing so the refrigeration plant may be operated at a slightly higher, more efficient temperature.

AABFs also have lower labour costs and require less floor space.

Although most larger plants use AABFs, batch freezers are often the only viable option for smaller meat plants due to a lower capital cost.

### **Batch Blast Freezers**

In most plants a minimum of two blast freezing rooms are required to accommodate a two-day freezing cycle. If the product is to be removed after 40 hours to reload the blast with fresh cartons, processors must ensure the product is fully frozen before removal.

Attaining even airflow of at least 3m/s over all cartons in batch blast freezers can be challenging. The following points should be taken into consideration when designing and operating blast freezers:

- There should be no large gaps that allow air to bypass the stow between or above stillages or between stillages and walls.
- All stillage shelves should be the same height, as variations in height will block air flow.
- The shelf spacing on stillages should allow at least 50mm space above the cartons, allowing for bulging of the carton during packing and freezing.
- Pallets of block-stacked cartons, or cartons separated by dunnage, should not be placed in the same air flow as cartons on stillages.

### **Automatic Air Blast Freezers**

A more consistent airflow pattern can usually be achieved in AABFs, although considerable variation will occur. Often the lower air velocity occurs over cartons on the bottom shelves and

along shelves located between fans.

The design of the shelf on which the cartons rest may affect freezing times. Cartons on flat shelves take 10% longer to freeze than those on corrugated shelves.

Cartons on the carrier that remains in the loading annex overnight will not be subjected to the same air velocity as those within the freezer, and processors must extend freezing times for these cartons.

### **Blast Freezing Cartoned Offal**

Cartoned offal can often be a difficult product to freeze adequately because it is packed at a higher temperature than conventionally boned meat. If the temperature is not rapidly decreased, shelf-life will be reduced and food safety can become an issue.

“Best practice” in cooling offal can be achieved via several options:

- **Pre-chill offal prior to packing into cartons**  
Either in air or by immersion in chilled water.
- **Pack offal into cartons no deeper than 90-100mm**  
The delay while stacking cartons onto stillages extends cooling times. If a continuous freezer is not available, then an option is to use a dedicated “first-in first-out” trolley freezer. Large beef livers may be difficult to fit into such thin cartons and freezing space requirements will need to be extended.
- **Pack offal into thin inner packs**  
Work by MIRINZ has shown offal can be packed into 40mm and 80mm inner packs and successfully frozen prior to packing into standard cartons. However, bulging of frozen inner packs makes subsequent packing difficult.

### **Additional information**

CSIRO Meat Research Report 12/78  
"Design Methods for Carton Freezers"

CSIRO Meat Research Report A/78  
"Measurement of Freezing Times of  
Cartoned Meat in Automatic Air Blast  
Freezers and Plate Freezers"

Australian Meat Technology Pty Ltd  
Training Manual, "Food Safety --  
Hygienic Meat Made Even Better!", 1996

### **Additional information**

Additional help and advice are available from Food  
Science Australia, Meat Industry Services Section:

	Phone	Fax
Ian Eustace	(07) 3214 2117	(07) 3214 2103
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**Or contact:**

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