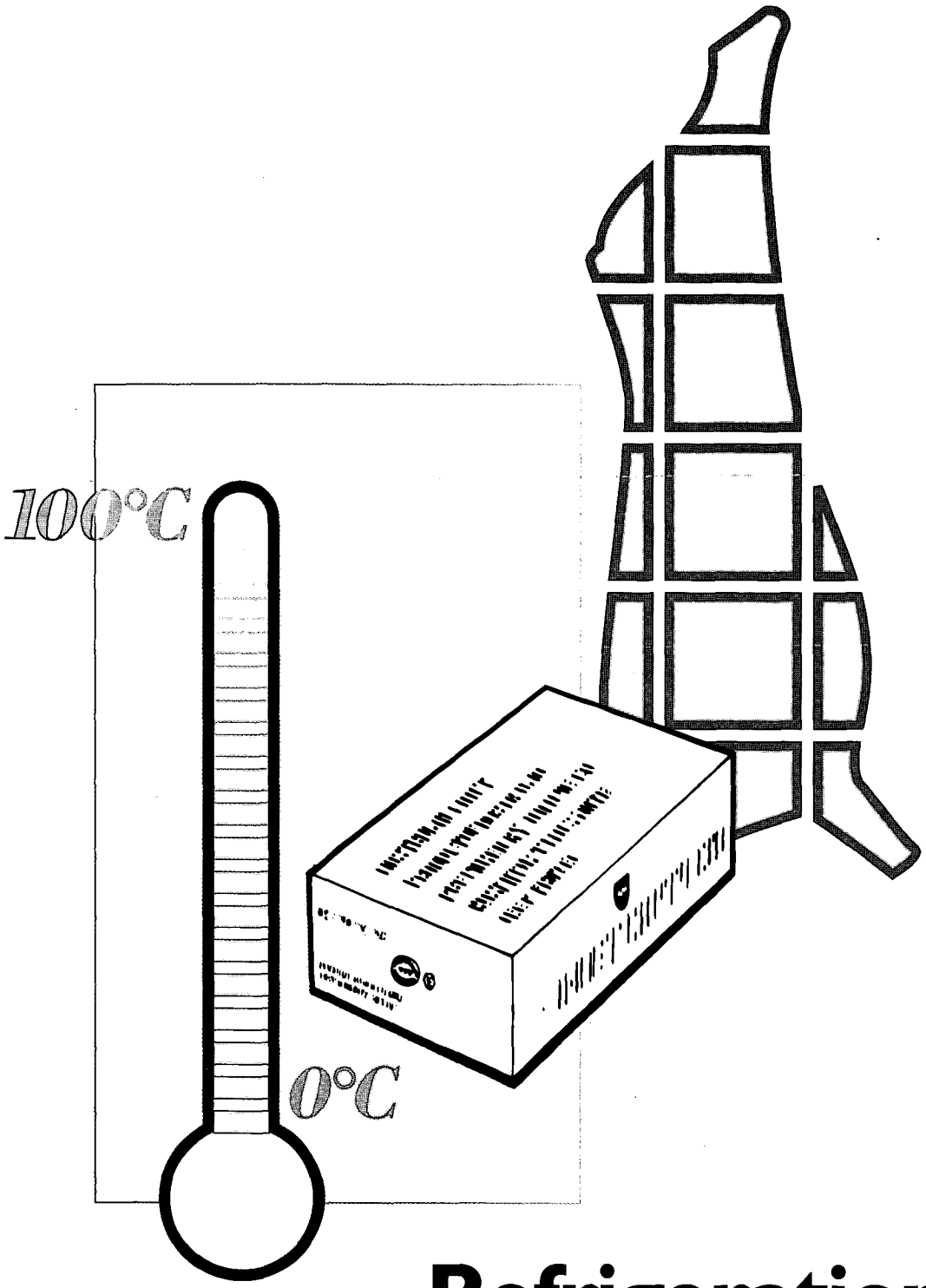

Refrigeration of Hot-Boned Meats

1997

Meat Research Corporation

AMT
AUSTRALIAN MEAT TECHNOLOGY

additional handling and control is required. Primals packed at initial temperatures up to 30°C with lids off and about 28°C with cartons lidded could meet the time/temperature requirements.

Air blast chilling with spacers between cuts – To allow air flow over the surfaces of the cuts, the use of removable spacers between cuts has been investigated. The spacers of fibreboard or plastic would be inserted at, or after, packing and removed at lidding. These aid chilling, but increase handling and material costs.

Chilling individually in air – Provided the air temperature is not below -1°C, individual chilling has the advantage of rapid chilling without the danger of freezing – and the product is available for shipping the next day. Although a conveyorised system could be installed in existing chiller space, or purpose built chillers used, capital cost could be high, product handling may be complicated and care must be taken with cut and grade identification. This method would allow primals to be packed from beef sides boned immediately after slaughter.

Immersion chilling – Immersion chilling is presently carried out on a small scale. Vacuum-packed cuts pass through chilled or ice water for a minute or two after the shrink tunnel. When the meat is packed in cartons, the overall cooling rate is not greatly affected.

To effectively cool hot-boned cuts, they need to be immersed for 60 minutes or more. In larger plants, this requires very large tanks with ancillary water refrigeration and pumping equipment. The same comments regarding product handling with air chilling apply here. Time/temperature requirements could be met for primals from true hot-boned beef.

Additional information

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AQIS Notice No. 94/2, "Hot-Boning Approved Programs"

"Meat Quality Aspects of Hot-Boning", in Proceedings of Meat 95, The Australian Meat Industry Research Conference, Gold Coast, Qld, September 1995 pp 12B1-3

Meat Research Report No. 3/96, "Hot-boning of Beef for Primal Cuts", Australian Meat Technology Pty Ltd

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:

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Air velocities range from less than 1m/s to more than 10 m/s. Ideally, air velocity of at least 3m/s should be used. To aid air movement, all stillage shelves should be the same height and pallets of block-stacked product should not be placed in the freezer. The stillage shelf spacing should allow at least 50mm for air movement above the cartons.

Care should be taken in the design of the blast freezer to ensure air flows through the stow and not around the sides.

Automatic air blast freezers – For hot-boning, continuous freezers have the advantage over batch freezers because cartons are loaded immediately after packing and air distribution is generally more even.

Shelving design can effect the cooling rate, with freezers with corrugated shelves having a 10% advantage over freezers with flat shelves. The carton orientation on the shelves also has a small effect on the freezing rate. Cartons with the ends pressed together will cool faster than cartons arranged so the long sides are pressed together.

Blast freezer air temperature and velocity

The rate at which a carton of meat cools in a blast freezer is dependent on air temperature and velocity. Although a combination of lower temperatures and higher velocities will produce faster cooling, both have practical and economic limits.

Because an increase in air velocity consumes more fan power and produces additional heat that must then be removed, increasing air velocity above 5m/s provides little gain.

Reducing ammonia suction temperatures much below -40°C will incur rapidly increasing compressor power costs.

A comparison of calculated cooling times for different air temperatures in a blast freezer shows that reducing air temperature from -20°C to -30°C reduces cooling time to 7°C by 16%. (Table 4)

TABLE 4 **Cooling times to 7°C using different blast freezer air temperatures (155mm deep box & lid carton at an initial temperature of 30°C, 3 m/s air velocity)**

Blast freezer air temperature	Time to cool to 7°C
-20°C	12.2h
-30°C	10.2h

Optimum blast freezer air temperature should be set for a particular application. If the time/temperature requirements can be met for warm-boned meat with an air temperature of -22°C, lower temperatures are not necessary. Cooling true hot-boned meat (under the alternate protocol) still requires low temperatures of -30°C or below, but an operating cost penalty will be incurred.

True hot-boning

Few plants carry out true (ie straight off the slaughterfloor) beef or mutton hot-boning. Plants that have true hot-boning either operate to the alternate protocol or employ plate freezers. Even with plate freezers, it can be difficult to reduce large beef primal cuts, packed at initial temperatures up to 36°C, to 7°C within the time allowed (7.17 hours). Bulk-packed product at average temperatures of 28°C - 30°C can normally be cooled in time using plate freezers.

Boneless mutton, whether bulk-packed or packed as primals, will have a lower initial temperature than beef but, in practice, time/temperature requirements are still difficult to meet using blast freezers.

The alternate time/temperature protocol

True hot-boning will often be carried out under an approved alternate time/temperature protocol. To obtain approval for an alternate protocol, processors must seek advice from an independent "expert authority" to assess cooling rates and collect samples from frozen or chilled cartons for microbiological analysis.

The product must be microbiologically comparable to product processed using the conventional boning technique. The results of the baseline study will provide the guideline to product acceptability.

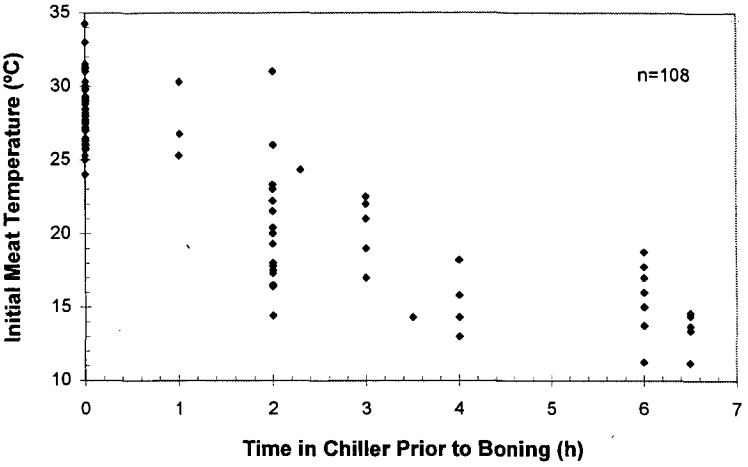
The parameters, such as carton size and type, cooling air temperatures and velocities, carcase type, initial meat temperatures and time intervals used and measured during the hot-boning trial, must be written into a Quality Assurance program for approval and adhered to during commercial production.

Warm-boning

Warm-boning allows for an increase in throughput on the slaughter floor without increasing chiller space. The chilling times prior to boning range from one to six hours.

A number of hot-boning trials for bulk-packed and some beef primal cuts indicate a relationship between initial temperature at packing and the carcase chilling time for any given carcase weight. (Figure 1)

FIGURE 1 Initial temperature of bulk-packed beef after various side chilling periods



This is useful for predicting the minimum side-chilling time for production of manufacturing meat and primal cuts. If, for example, a blast freezer operating at -25°C is available and a carton of certain depth and type is used, the time to cool to 7°C can be calculated or estimated based on various initial temperatures. A chilling time can be predicted and cooling rates can be confirmed by measurement and written into a hot-boning program.

Warm-boning allows time/temperature parameters to be met using air blast freezers.

At packing, meat temperature depends on the length of the carcase or side pre-chill, chiller temperature and carcase size. Using a normal 155mm deep carton, meat can generally be packed and meet the existing ARMCANZ/AQIS time/temperature requirements at a maximum initial temperature of 25°C. Bulk-packed beef requires a side pre-chill of one to two hours while large primal cuts need a side pre-chill of three to four hours.

Mutton carcases can generally be boned, and the time/temperature requirements achieved in conventional blast freezers, after pre-chill periods of one to two hours.

Chilled vacuum-packaged cuts

The emphasis for hot-boning has traditionally focused on producing frozen manufacturing meat. To maximise returns, plants are recovering primal cuts, mainly for freezing, but also for vacuum packing and chilling. One of the main impediments to wider application of hot-boning is the cooling of chilled vacuum-packaged cuts.

MRC-funded projects on beef hot-boning demonstrate that, provided carcases are effectively electrically stimulated, the tenderness of chilled cuts is not affected by hot-boning. However, chilling the cuts could require novel approaches.

The alternate protocol is an option, and some plants are producing chilled primals under hot-boning programs using approved alternate cooling protocol. Stepping too far beyond the existing time/temperature requirements, however, can result in a microbiologically unacceptable product.

Available options for rapidly chilling cuts in order of severity and complexity:

- Air-blast chilling in cartons with lids off
- Two-stage chilling in air blast freezers in cartons
- Air-blast chilling in cartons with lids off and spacers between cuts
- Chilling cuts individually in air
- Immersion chilling of cuts in chilled water or brine

Air blast chilling in cartons with lids off – This is common practice for both warm-boned and conventionally-boned meat. Cartons are cooled in continuous or batch blast chillers operating at -1°C to -5°C. The cartons are labelled on the base after packing and cap-style lids manually applied after chilling. The time/temperature requirements can be met for initial temperatures of 23°C - 25°C.

Two-stage chilling in air blast freezers in cartons – This practice is only suitable for batch blast freezers where the cartons are either transferred to a chiller after several hours or the blast freezer temperature is raised to prevent crust freezing. It can still be difficult to meet the time/temperature requirements for large cuts without freezing the surfaces of smaller cuts. This system has the obvious disadvantage that