

Meat technology – information sheet

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Temperature rises in frozen cartons when pallets are exposed to ambient conditions or transported on non-refrigerated trucks

Pallets of frozen manufacturing meat at -18 °C may be exposed to ambient conditions for 18 minutes on a 35 °C sunny summer day before the temperature 25 mm in from the corners reaches -10 °C and 56 minutes before reaching -5 °C.

Pallets of frozen meat cartons are removed from cold stores for loading out and can be in refrigerated loading docks or, at times, exposed to outside ambient conditions. If they are to be loaded into, or unloaded from, the refrigerated hold of a ship, they may be exposed to ambient conditions on the wharf. Pallets of frozen meat are also, at times, transported short distances in non-refrigerated trucks.

This Information Sheet was developed from the results of trials that were conducted in the container test facility of Food Science Australia at North Ryde, NSW. Models were developed based on the results of the trials and these were used to predict the rise in meat temperature under a range of ambient conditions.

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Pallets exposed to ambient conditions

Three pallets of frozen beef of differing fat contents (65 CL, 85 CL and 93 CL) were instrumented and exposed to temperature conditions typical of a Queensland summer day. Each pallet was fitted with 36 thermocouples positioned in the corners (approximately 25 mm deep) and in the centres of test cartons.

The positions that were the fastest to warm were the bottom corners facing the sun. For meat at

the centres of cartons, the fastest warming positions were on the top layer of the pallet (data not shown). There was negligible difference in rate of warming between cartons of different chemical lean specification. Table 1 and Table 2 show predicted times for the warmest part (bottom corner) of the pallet to rise to -10°C and -5°C when exposed to constant ambient temperature both with and without exposure to full sunshine.

Table 1: Predicted time (h) for meat temperature 25 mm from corner to reach -10°C

Initial meat temperature	Ambient temperature (°C)					
	15		25		35	
	Sun	Shade	Sun	Shade	Sun	Shade
-20°C	0.8	0.9	0.5	0.6	0.4	0.5
-18°C	0.6	0.7	0.4	0.5	0.3	0.4
-15°C	0.3	0.4	0.2	0.3	0.2	0.2

Table 2: Predicted time (h) for meat temperature 25 mm from corner to reach -5°C

Initial meat temperature	Ambient temperature (°C)					
	15		25		35	
	Sun	Shade	Sun	Shade	Sun	Shade
-20°C	2.3	2.8	1.4	1.7	1.1	1.2
-18°C	2.0	2.5	1.3	1.5	0.9	1.1
-15°C	1.6	2.0	1.0	1.2	0.8	0.9

The temperature of -10°C was selected because the International Institute of Refrigeration defines 'frozen food' as product that is stored at a temperature of -10°C or colder. The higher limit of -5°C was selected because at around this temperature meat will start to soften and slow growth of some spoilage bacteria and fungi might begin.

Pallets on a non-refrigerated truck

Twenty-two pallets of frozen manufacturing meat were loaded onto a curtain-sided trailer in a single layer with 11 of the pallets fitted with thermocouples to record the temperature at five-minute intervals. On completion of loading the curtains were closed and the trailer moved into the test facility which was held at 35°C with solar radiation on the top and one side of the trailer.

The corners of cartons on the top layer adjacent to the wall with solar radiation were fastest to

warm. The carton centres to warm fastest were on the top layer of pallets. The centres of cartons on lower layers changed little over the four hours of the trial. The predicted times for frozen manufacturing meat to rise to -10°C and -5°C when transported on non-refrigerated trucks or trailers are given in Tables 3 and 4 for conditions of full summer sun and no sunshine.

Table 3: Predicted time (h) for meat temperature 25 mm from corners to reach -10°C

Initial meat temperature	Ambient temperature (°C)					
	15		25		35	
	Sun	Shade	Sun	Shade	Sun	Shade
-20°C	1.4	4.6	1.2	3.1	1.0	2.2
-18°C	1.1	3.2	0.9	2.2	0.8	1.6
-15°C	0.7	1.7	0.6	1.2	0.5	0.8

Table 4: Predicted time (h) for meat temperature 25 mm from corners to reach -5°C

Initial meat temperature	Ambient temperature (°C)					
	15		25		35	
	Sun	Shade	Sun	Shade	Sun	Shade
-20°C	3.1	19.6	2.7	11.7	2.5	7.4
-18°C	2.8	17.0	2.4	10.2	2.3	6.5
-15°C	2.4	13.4	2.1	8.1	1.9	5.2

