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# SISTEMAS DE ENFRIAMIENTO POSCOSECHA PARA PRODUCTORES DE ESCASOS RECURSOS EN CENTRO AMERICA

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## I. INTRODUCCION

Durante los últimos 10 años, ha habido un desarrollo significante de la industria de exportación de productos no tradicionales de Centro América. Muchos cultivos han ido de poca o ninguna producción comercial para la exportación en 1984 hasta volúmenes muy altos exportados en 1993-94. Ejemplos notables de productos hortícolas que se han expandido en forma dramática durante la década pasada en Centro América y que ahora son productos principales de exportación son: melón cantaloupe y honeydew, piñas, arveja china, esparragos, moras, frambuesa, cebollas, mini-vegetales y flores de corte. También hay proyecciones favorables para mangos, ciertas frutas tropicales, alcachofas y flores tropicales. Hay indicativos de que la industria de Exportaciones Agrícolas No Tradicionales continuará expandiendose a través de la próxima década.

Los productos de Exportación Agrícola No Tradicional (EANT) consisten casi enteramente de productos hortícolas altamente perecederos (i.e., frutas, vegetales, flores de corte). A casi todos estos cultivos es necesario remover el calor del campo inmediatamente después de su cosecha para poder mantener la calidad del producto y su vida en el mercado. Así mismo, es esencial el no romper la cadena fría durante el almacenamiento y el transporte.

Muchos productores de EANT en Centro América no usan procedimientos de enfriamiento poscosecha y almacenaje apropiados. El resultado es, producto de menor calidad que la óptima a su llegada al mercado de destino, y en algunos casos, envíos rechazados o degradados. La falta de infraestructura de poscosecha es particularmente evidente entre productores de poco volumen y pocos recursos. Muchos no entienden los requisitos del mercado de exportación para productos de extrema alta calidad, al contrario de aquellos encontrados en los mercados locales.

La competencia para los mercados lucrativos de Norte América y Europa es intensa. Cada año más productores dentro de un país y países adicionales, exportan productos hortícolas. Los compradores demandan el abastecimiento consistente de producto de alta calidad.. Si ellos no pueden obtenerlo de un país (o proveedor), lo obtendrán de algún otro.

La inversión en infraestructura poscosecha es comúnmente no considerada como un componente esencial para los negocios de exportaciones de agricultura no tradicional. Consecuentemente, se pierden considerables ganancias de mercado y ocurren pérdidas económicas significantes. Para poder desarrollar una industria de EANT más sostenible y provechosa en Centro América se necesita un esfuerzo continuo para convencer al productor/exportador que la inversión en infraestructura de enfriamiento y almacenaje es tan importante como cualquier otro aspecto del negocio. Las inversiones para guardar la calidad en la comercialización de las frutas, vegetales y flores después de su cosecha no son gastos. Estos se pagarán

así mismos en repetidas veces. Hasta una reducción parcial en perdidas de poscosecha pueden mejorar significativamente el retorno neto al productor. El dicho "uno debe de gastar dinero para hacer dinero" suena muy cierto en este negocio de perecederos. No obstante, para muchos productores de escasos recursos, la inversión no parece ser justificada debido al poco volumen de producto cosechado. Hay sistemas de enfriamiento de bajo volumen y bajo costo disponibles que pueden ser construidos fácilmente. El objetivo principal de este seminario es compartir esta información con ustedes con la confianza de que el manejo mejorado y las tecnologías de poscosecha serán adquiridas.

## II. RESUMEN DE BIOLOGIA DE POSCOSECHA

Es necesario tener un entendimiento básico de la biología de poscosecha para que sistemas de enfriamiento apropiados puedan ser integrados a la operación general. Productos hortícolas frescos son organismos vivos que continúan respirando después de su cosecha y padecen todo el proceso fisiológico asociado con la vida. Ellos son susceptibles a podredumbre patológica y están en un estado continuo de deterioro.

La vida de almacenamiento de los productos varia al inverso con el grado de respiración. La vida de almacenamiento de productos como el brocoli, arveja china, moras, alcachofa, esparrago y elotillo, los cuales tienen alto grado de respiración, es corta; y aquella de cebollas, calabaza, ñame y cítricos, los cuales tiene corto grado de respiración, es larga (Tabla 1). El mercadeo exitoso en la exportación depende de la reducción del grado de deterioro y podredumbre. Manejo apropiado de temperatura es el factor único y más importante que influye en la vida poscosecha y calidad de mercado de un producto. La remoción rápida de la temperatura del campo del producto es esencial para preservar la calidad de mercado de los cultivos hortícolas altamente perecederos. Unas pocas horas de demora antes de iniciar el enfriamiento puede resultar en deterioro irreversible y perdida de calidad del producto. Un viejo dicho dice que uno pierde 10 horas de vida poscosecha por cada hora que el producto permanece a temperatura ambiente después de haber sido cosechado. Cada 10°C de reducción de temperatura disminuye la actividad respiratora de un producto por un factor de 2 a 4. Los productos difieren por su grado respiratorio y vida potencial de mercado. No obstante, con todos los productos, mientras más larga sea la demora en el enfriamiento después de cosecha, más grande será el deterioro.

La cosecha debe de realizarse en horas tempranas de la mañana para minimizar el calor de campo y la carga de refrigeración requerida. Los productos cosechados también deben de ser ocultos del sol hasta que sean llevados a las instalaciones de enfriamiento. Producto expuesto al sol puede calentarse más de la temperatura del aire y exposición directa con el sol puede causar quemadura de sol.

Inmediatamente después de enfriarse, es esencial almacenar y transportar el producto a su temperatura y humedad optima (Tablas 2 y 3). Los beneficios de enfriar se perderán si el producto no es refrigerado apropiadamente después de su enfriamiento.

El componente principal de todas las frutas, vegetales y flores frescas es el agua. El contenido de agua en cultivos hortícolas tiene un rango de entre 70% y 95%. La marchitez y decaimiento causado por la perdida de agua daña seriamente la apariencia y aceptación del producto en el mercado. La mayoría de productos hortícolas pierden su aceptación de mercado de exportación después de una perdida de agua de solo 5% de su peso original. Así mismo, pérdida de agua también representa perdida de dinero, debido a que la mayoría de los productos se venden en base de su peso. Humedad relativa apropiada (HR) es importante en minimizar la perdida de agua de productos frescos. La mayoría de productos deben de almacenarse entre 90-95% de HR (excepto cebollas y ajo). De igual forma, la temperatura de producto y velocidad del movimiento de aire sobre el producto afectan la cantidad de perdida de agua.

El grado de perdida de agua esta relacionado directamente con la diferencia de presión de vapor entre la fruta y su ambiente. La temperatura y HR controlan esta diferencia de presión de vapor. A temperatura tibia de producto (i.e., 30°C) y HR baja (i.e., 30%), el grado de perdida de agua puede ser de 25 a 50 veces mayor que a 0°C y 95% de HR, respectivamente.

## III. ENFRIAMIENTO Y ALMACENAJE

El primer paso en el manejo apropiado de temperatura después de la cosecha es remover rápidamente el calor de campo del producto. Comúnmente se refiere a este paso como pre-enfriamiento, aunque el término enfriamiento es suficiente. Los productos perecederos son muy susceptibles a marchitarse, decolorarse, aguadarse, cambios adversos de sabor y podredumbre patológica a temperaturas altas. Varios métodos de remoción de calor de campo pueden ser usados, dependiendo del producto. Los dos tipos de métodos de enfriamiento mejor adaptados para cultivos perecederos de EANT son enfriamiento por aire forzado e hidroenfriamiento. El enfriamiento de cuartos es generalmente muy lento para la preservación efectiva de la calidad del producto. Otros métodos de enfriamiento tales como, hielo y enfriamiento por aspirador (succión) no son generalmente tan económicos o prácticos. Después de que el producto ha sido enfriado, es esencial mantener la cadena fría durante almacenamiento, tránsito y distribución.

Enfriamiento y almacenaje son dos operaciones separadas que tienen muy diferentes requisitos. Los requerimientos específicos para adquirir enfriamiento rápido y uniforme debe de ser considerado independientemente de los requerimientos para almacenar en frío. La capacidad de refrigeración necesaria

para un enfriamiento rápido es sustancialmente mayor que para almacenamiento en frío. Existen otras diferencias entre enfriamiento y almacenaje en frío. Durante el enfriamiento rápido, la velocidad alta de aire no incrementa significativamente el total de perdida de agua del producto si ocurre únicamente mientras el producto se esta enfriando. No obstante, durante almacenamiento en frío consecutivo, la velocidad alta de aire reseca los productos hortícolas sobre el período largo de exposición a aire rápido en movimiento. La humedad relativa alta es esencial para prevenir perdida excesiva de agua durante el almacenamiento en frío, pero es de menor importancia durante el período corto de enfriamiento. Generalmente el control de etileno no es necesario durante el enfriamiento, pero para algunos productos puede ser esencial durante el almacenaje. Una combinación de enfriamiento rápido, almacenaje y transporte subsecuente del producto a su temperatura baja y humedad relativa óptima maximizará el potencial de vida de mercado para ese producto.

## A. Determinación de Requerimientos de Refrigeración

Refrigeración es el proceso de remoción de calor de un producto y no de introducir frío en el mismo. Varias fuentes de calor deberán ser removidas por medio de refrigeración durante los períodos de enfriamiento y almacenaje. La fuente principal de calor que debe ser removida después de la cosecha es el calor del campo de un producto. Esto se determina mediante la siguiente fórmula:

*Btu (calor) = peso (lbs) del producto x calor específico (del Producto) x T° (temperatura) diferencia entre T° pulpa y la T° de almacenaje deseado final.*

La proporción de calor requerido para elevar la temperatura de un peso dado de fruta o vegetal hacia la requerida para causar un incremento equivalente en el mismo peso del agua, se llama calor específico. Es necesario saber el calor específico de un producto para calcular la carga de refrigeración durante el paso de enfriamiento. Puede ser estimado de la siguiente ecuación:

*Calor específico = 0.008 x (porcentaje $H_2O$ en el producto) + 0.20.*

Ejemplo: el calor específico de las moras, con un contenido de humedad del 85%, es 0.008 x 85 + 0.20 = 0.88. El calor específico sobre el nivel de congelamiento para varias frutas y vegetales se da en las tablas 4 y 5.

Fuentes adicionales de calor que necesitan ser tomadas en cuenta cuando se determinan los requerimientos de refrigeración para enfriamiento y almacenaje incluyen el calor de respiración (calor vital).

Todos los organismos vivientes sueltan calor durante la respiración de carbohidratos hacia $CO_2$ y $H_2O$. La cantidad de calor varía con el producto y se incrementa con la temperatura. Los grados aproximados de calor producidos por varios cultivos hortícolas frescos a diferentes temperaturas de almacenamiento pueden calcularse de los grados de respiración que se muestran en la Tabla 1. La evolución del calor se expresa a través de 'joules' en el sistema métrico y en "British thermal units" (Btu) en el sistema inglés. Para cada miligramo de $CO_2$ producido por respiración, 2.55 calorías de calor son generadas, así es que el valor de 2.55 se usa en el computo de la evolución de calor. Una caloría es la cantidad de calor requerida para elevar la temperatura de 1 gramo de agua 1°C, por lo cual, 1 Btu es la cantidad de calor requerida para elevar la temperatura de una 1 lb de agua 0.56°C (1°F). Una caloría equivale 4.187 J, así que la evolución de calor en el sistema métrico es calculado multiplicando cada miligramo de $CO_2$ por un factor de 10.676. El valor 10.676 se deriva de la multiplicación de 2.55 cal/mg $CO_2$ por 4.187J/cal. Una kilocaloría equivale a 3.968 Btu, por lo que la evolución de calor en 'British thermal units' por tonelada por día (24 horas) se calcula por la multiplicación de los grados de respiración en miligramos de $CO_2$ x kilogramo x hora x un factor de 220. El valor 220 se deriva multiplicando 2.55 cal/mg $CO_2$ x 86.3, un factor que convierte calorías por kilogramos por hora hacia 'British thermal units' por tonelada por día.

Otras fuentes de calor que agregan al requerimiento total de refrigeración durante enfriamiento y almacenaje incluyen fuga de calor a través de superficies del cuarto y puertas abiertas y calor generado por motores eléctricos, luces, equipo de manejo mecánico y trabajadores.

Se refiere comúnmente a la carga de refrigeración en toneladas de refrigeración. La tonelada normal de refrigeración es la cantidad de calor absorbida por una tonelada de hielo derritiendose de 0°C (32°F) en 24 horas. Se requiere de 144 Btu para derretir 1 lb de hielo a 0°, ó 288,000 Btu para derretir 1 tonelada de hielo a 0°. (144 Btu x 2,000 lb). Dado a que una tonelada de refrigeración especifica que la tonelada de hielo debe de ser derretida en 24 horas, una tonelada de refrigeración absorbe 288,000 Btu en 24 horas. Esto es equivalente a 12,000 Btu/hora (12,660 kJ/hora).

El requisito de refrigeración durante el enfriamiento deberá basarse en la carga máxima de refrigeración. Esta cumbre ocurre usualmente cuando las temperaturas exteriores son altas y se está enfriando producto tibio.

La carga máxima de refrigeración depende de la cantidad de producto que se recibe cada día, de la temperatura del producto al momento en que se inicia

el enfriamiento, del calor especifico del producto, de la temperatura final alcanzada, y de la infiltración de fuentes de calor ajenas al producto en el medio ambiente de enfriamiento.

## B. Enfriamiento por Aire Forzado

El enfriamiento por aire forzado es adaptable a la mayoría de tipos de productos y es ideal para operaciones donde una gran variedad de productos tienen que ser enfriados. Cultivos de EANT de Centro América ideales para el enfriamiento por aire forzado son: moras, frambuesas, fresas, melones, piñas y flores de corte. El enfriamiento por aire forzado es el método recomendado para operaciones de pequeña escala. Un cuarto frío existente puede ser comúnmente usado para enfriamiento por aire forzado para pequeñas cantidades de producto por medio de la instalación de un ventilador portátil pequeño. Grandes cantidades de producto usualmente requieren la instalación de más capacidad de refrigeración.

El método más común de enfriamiento por aire forzado se logra a través de la alineación paralela de columnas de cajas llenas y ventilados, con las columnas paralelas de producto, separadas por varios pies de espacio abierto (usualmente el diámetro del ventilador). Después, una lona o cubierta plástica es colocada sobre las columnas paralelas (con el centro sobre el espacio abierto entre las columnas paralelas de producto). Esta carpa restringe la dirección en la cual el aire puede escaparse. En efecto, usted ha creado un "túnel" que restringe la dirección del aire. La carpa se extiende hacia un ventilador de gran capacidad colocado en la sección al frente medio y al centro de la columnas paralelas del producto en cajas. El ventilador hala aire fresco a través del producto, removiendo el calor del campo de dicho producto y logra su enfriamiento. Las partes superiores de las columnas están expuestas directamente al aire frío. Los ventiladores desarrollan fluido alto de aire a una presión de estática relativamente alta. Las figuras 1-8 ilustran este método de enfriamiento.

El ventilador se puede encender con la carpa en su lugar después de que las primeras cajas han sido apiladas para iniciar el enfriamiento. Se puede levantar la carpa para agregar más cajas al final del túnel y nuevamente colocarla sobre las cajas agregadas. Cuando todo el producto ha sido enfriado adecuadamente, se apaga el ventilador y se enrolla la carpa. El hecho de apagar el ventilador cuando el producto ha sido enfriado a una temperatura óptima de almacenaje, reduce los costos de energía y de deshidratación causada por la aplicación excesiva de aire de alta velocidad.

Dado a que el aire es forzado a través de las cajas de producto por la diferencia de presión del aire entre ambos lados, es necesario llenar las cajas

apropiadamente y estibarlas en una forma para minimizar vacíos y aperturas. Las aperturas entre las cajas permiten que el aire rodee el producto, reduciendo la capacidad de enfriamiento. Se pueden colocar deflectores sobre las aperturas inevitables para dirigir el aire hacia las cajas empacadas.

Además de controlar la temperatura y flujo de aire, será necesario controlar la humedad. El aire en movimiento tiende a remover el agua de la superficie de la hoja, causando marchites, encogimiento y perdida general de calidad y valor. La mayoría de productos hortícolas frescos requieren de una humedad relativa en un rango de 95 a 98% durante el enfriamiento por aire forzado y también durante su almacenamiento en frío antes de su embarque.

Si la condensación en el embobinado del evaporador se drena hacia afuera, la humedad en los cuartos refrigerados puede hacerse lenta. La cantidad de condensación que se colecta en estos embobinados puede decrecer substancialmente por la limitación de la caída de la temperatura a través de ellos hacia 2.5°C. Esto puede lograrse por el incremento del tamaño o cantidad de los embobinados. En la práctica, niveles de 80 u 85% humedad relativa no se puede lograr fácilmente sin ningún tipo de sistema de humedecimiento.

La baja humedad puede corregirse por varios tipos de sistemas comerciales de humedecimiento. Muchos operadores simplemente mojan el piso con mangueras de vez en cuando, pero este método puede que no sea consistente con un buen saneamiento y particularmente no es efectivo en muchas situaciones.

El tiempo requerido por productos individuales para ser enfriados varía significativamente. La cantidad de cajas en el congelador también puede afectar el período de enfriamiento. La temperatura de los productos debe de ser controlada de cerca durante su enfriamiento. Las cajas deberán removerse sólamente después de que la temperatura del producto dentro de las cajas ha sido revisada. Es ideal usar un termómetro con un punzón largo de metal para medir la temperatura. Deberá revisarse la temperatura en ambos lados de la caja, el lado tibio y el lado fresco.

### 1. Cálculos del Tiempo de Enfriamiento

El tiempo necesario para alcanzar la temperatura deseada se expresa por medio de una curva típica de enfriamiento. El tiempo de enfriamiento de 7/8 ó el tiempo necesario para bajar la temperatura de un producto en 7/8 de la temperatura inicial hacia la temperatura del aire de enfriamiento, se considera como el punto más significativo dentro de la curva de enfriamiento (figura 9). El grado de enfriamiento

se hace muy lento a medida que la temperatura del producto asemeja la temperatura del aire refrigerado. En la figura 9, una hora de enfriamiento (7/8 de tiempo de enfriamiento) es requerido para alcanzar 40°F (5°C) (7/8 de temperatura de enfriamiento) de la temperatura inicial de 75°F de un producto.

La siguiente ecuación puede ser usada para calcular el tiempo requerido para enfriar una caja de fruta, vegetales o flores de corte hacia una temperatura específica.

$$T = 1.107\ V\ \mathrm{Log}\left(\frac{S - M}{F - M}\right)$$

*Donde:*

| | | |
|---|---|---|
| *T* | = | *tiempo (minutos) para enfriar a temperatura °F* |
| *V* | = | *7/8 tiempo de enfriamiento (minutos)* |
| *S* | = | *Temperatura (°F) del producto inicialmente* |
| *F* | = | *Temperatura (°F) del producto ya frío* |
| *M* | = | *Temperatura (°F) del aire frío que entra en la caja* |

$$V = \frac{(0.903T)}{\log \frac{S - M}{F - M}}$$

*Donde T, S, F, M, son medidos bajo condiciones actuales de operación.*

La Tabla 6 muestra el flujo de aire y presión necesaria para enfriar una caja de un tipo especifico de flor. El requerimiento de flujo de aire (en pies cúbicos por minuto) para un sistema puede ser determinado por la multiplicación del requerimiento por el número de cajas a ser enfriadas y por la suma de un 25% adicional de capacidad para compensar las fugas de aire. La cantidad de cajas enfriadas deberá basarse en la cantidad máxima de un día de cosecha. La caída de presión para el sistema es equivalente a la caída de presión a través de una caja más 25% de presión adicional como factor de seguridad. (No es recomendable para la operación de pre-enfriamiento, estibar las cajas de punta a punta).

Las figuras 7 y 8 ilustran dos métodos para establecer un pequeño sistema portátil de enfriamiento por aire forzado en un cuarto frío

existente. Se deben de diseñar específicamente instalaciones de enfriamiento que permitan el manejo de 30 a 40 cajas por hora. Comúnmente las cajas se manejan en estibas de seis a ocho cajas de alto y son colocadas en una carretilla con ruedas o en tarimas. La unidad de cajas es colocada en frente de un plenum de aire llamado pared fría (ver figura 10). Las unidades de cajas también pueden estibarse en dos columnas, separadas por algunos pies, a la par de una entrada de aire. El espacio entre columnas se cubre con una lona, causando que el aire sea llevado a través de las cajas (ver figura 11).

Las instalaciones para el sistema de enfriamiento por aire forzado deberán diseñarse de manera que haya un flujo continuo de cajas del área de empaque hacia el área de enfriamiento y del área de enfriamiento hacia un área de espera o de almacenaje.

## 2. Ventiladores

Los enfriadores por aire forzado utilizan ventiladores centrífugos (más conocidos como "squirrel cage") ó de fluido axial (impulsados por hélice). Diagramas esquemáticos de ventiladores típicos usados en el enfriamiento por aire forzado se muestran en las figuras 1-3, 7, 8 y 12. Se seleccionan los ventiladores en base a dos criterios, el flujo de aire requerido, medido en pie cúbico por minuto (cfm), y la presión estática requerida, medida en pulgadas de agua. Los requerimientos específicos son determinados por el tipo de producto, la cantidad de cajas, la ventilación de las cajas y el grado de enfriamiento deseado. Uno puede esperar una tasa comparativamente lenta de enfriamiento sin movimiento de aire forzado (enfriamiento de cuarto), (Figura 13, curva A). Las curvas B y C demuestran el incremento en el grado de enfriamiento posible con grados de flujo de aire de 1/2 a 1 pie cúbico por minuto por libra de producto, respectivamente. Los requerimientos de flujo de aire y presión estática para enfriar por aire forzado ciertas frutas y vegetales se muestran en la Tabla 7. En general, el enfriamiento por aire forzado logra remover el calor de 5 a 10 veces más rápido que el enfriamiento convencional de cuarto.

No todos los ventiladores están diseñados para mover el aire al volumen y presión estática requerida por el enfriamiento por aire forzado. (La presión estática, en este caso, es la resistencia al movimiento de aire presentado por los paquetes de producto.) Las curvas de ventiladores que muestran información de presión y volumen, tal como el mostrado en la figura 14, están disponibles para la mayoría de ventiladores comerciales e industriales. Notese que hay una relación inversa entre el grado de presión y de flujo de aire. En la

figura, por ejemplo, el grado de flujo de 1 pulgada de presión de agua es 4,000 pies cúbicos por minuto (cfm), mientras que a la presión de 1/2 pulgada el grado de flujo se incrementa a más de 6,000 cfm.

Además de grados y temperaturas de flujo de aire, muchas otras variables influyen en el tiempo requerido para enfriar producto con aire forzado, incluyendo el tamaño y figura del producto y la configuración y ventilación de las cajas. Mientras más grande la distancia del flujo de aire, mayor será la caída de presión y más largo el período de tiempo de enfriamiento para un flujo de aire dado. El grado y duración óptima del flujo de aire para un enfriamiento apropiado varía con el tipo de producto que se está enfriando. En la práctica, sin embargo, un grado de flujo de aire de aproximadamente 1 a 3 pies cúbicos por minuto a 1/2 pulgada de presión estática debería ser suficiente para la mayoría de frutas y vegetales.

El grado de flujo de aire a través de un sistema de ventilación en una estructura de enfriamiento puede ser medido con suficiente exactitud usando un manómetro de tubo-U barato montado en el ventilador (Figura 15). Los manómetros de tubo-U son diseñados para medir las diferencias en la presión del aire. Un lado del manómetro está conectado en el lado contra corriente del ventilador, lo más lejos posible de las aspas y el otro lado esta abierto al aire del cuarto. Sabiendo la presión estática del aire a través del ventilador y consultando el cuadro de funcionamiento que usualmente está provisto en los nuevos ventiladores, el grado de flujo de aire puede ser determinado con exactitud.

El interior de un cuarto frío es a menudo húmedo o incluso mojado. Por lo tanto, los motores de los ventiladores deben de ser del tipo totalmente encerrados, enfriados por ventiladores, y con su respectiva tierra para prevenir una descarga eléctrica.

También es buena idea controlar el ventilador con un termostato de voltaje de línea montado en la corriente de aire. El termostato apagará el ventilador cuando el producto se ha enfriado a un punto predeterminado, conservando de esta manera energía. También reducirá los efectos desecantes del aire enfriador ya que no permitirá que el ventilador continué funcionando por un período prolongado de tiempo después que el producto se ha enfriado.

## 3. Cajas

Se han usado gran variedad de empaques para enfriamiento por aire forzado. Estos incluyen cajas de cartón de fibra, jabas de madera, y cajas de bulto. El único requerimiento es que estas tengan suficiente espacio abierto en los lados y en el fondo para asegurar el movimiento apropiado de aire a través de las cajas. La mayoría de cajas comerciales están diseñadas con aperturas adecuadas. De lo contrario, se deben de agregar o agrandar aperturas para que un 5% de la superficie lateral y un 3 a 5% del fondo estén abiertos. Ranuras de por lo menos 1/2 pulgada de ancho son mejores que aperturas circulares que pueden ser bloqueadas por el producto. Estas aperturas deberán estar bien distribuidas sobre la superficie de la caja para asegurar una buena distribución de aire. La velocidad de aire y suficiente capacidad de refrigeración son componentes críticos para el enfriamiento por aire forzado, asi como el uso de cajas ventiladas y la utilización de un patrón apropiado de estiba para las cajas.

Algunos productores usan contenedores refrigerados para el enfriamiento de su producto. Estas unidades normalmente tienen una capacidad de refrigeración de 2.5 - 3 toneladas. No tienen suficiente flujo de aire para que el aire frío haga contacto con el producto para un enfriamiento rápido. No obstante, se puede colocar un ventilador dentro del contenedor refrigerado y adaptado para incrementar el grado de enfriamiento. La duración total de tiempo desde el inicio de enfriamiento por aire forzado hasta una temperatura final del producto de 1°C no deberá ser más de una hora para los productos altamente perecederos.

## 4. Enfriamiento Evaporativo

Un tipo de enfriamiento por aire forzado de bajo costo adaptado a areas de producción templadas del altiplano en Centro América se llama enfriamiento evaporativo. El enfriamiento evaporativo puede usarse como un método barato para remover algún calor del campo de producto donde no hay refrigeración disponible. Se puede reducir la temperatura del aire de 5-8°C al pasar por un enfriador evaporativo durante el tiempo más caliente del día. Se logra rociando o mojando el producto en presencia de una corriente de aire seco o forzando aire seco a través de una almohadilla mojada. El enfriamiento evaporativo trabaja mejor cuando la humedad relativa del aire es menor del 65%. Sin embargo, en su mejor punto, reduce la temperatura del producto solamente de 5° - 8°C bajo ambiente y no provee enfriamiento consistente y completo.

El enfriamiento evaporativo es relativamente barato comparado con refrigeración y consume muy poca energía. El costo inicial será de varios cientos de dólares para un sistema nuevo y los costos de operación serán de 10-15 Centavos por hora. La figura 16a, inciso b, ilustra un sistema sencillo de enfriamiento evaporativo.

Los enfriadores tipo gaveta son usualmente equipados con un ventilador centrífugo de jaula de ardilla para proveer flujo de aire, una bomba de succión para el envío de agua hacia la parte alta de las almohadillas de enfriamiento y un flotador para mantener el nivel del agua. Los requerimientos de agua son mínimos por lo que el agua no tendrá que ser recirculada. Una línea de presión puede enviar suficiente agua hacia los canales de distribución para mantener las almohadillas mojadas y el exceso puede ser eliminada.

Las fugas de aire deberán ser selladas. Ya sea en un sistema de ventilación a presión o de extracción, es esencial que todo el aire que va a través de las almohadillas de enfriamiento, este dirigido hacia el producto a ser enfriado.

Cualquier aire que esquive las almohadillas de enfriamiento, disminuye la eficiencia del sistema. En sistemas de ventilación de extracción el sistema de ductos deberá ser reforzado para soportar el vacio creado. En un sistema de presion el aire debe de ser conducido hacia el producto.

## C. Hidroenfriamiento

Cuando el producto tibio se enfría directamente con agua fría, el proceso se llama hidroenfriamiento. Hidroenfriamiento es una forma rápida y efectiva para enfriar el producto, principalmente debido a que el agua posee un coeficiente de transferencia de calor mucho mas alto que el aire. Una comparación de los grados de enfriamiento relativos de hidroenfriamiento contra enfriamiento por aire forzado contra cuartos fríos se muestra en la figura 17. El hidroenfriamiento es generalmente el doble de efectivo sobre enfriamiento por aire forzado. Se pueden diseñar hidroenfriadores ya sea para pequeñas o grandes cantidades de producto. Hay ciertas restricciones en cuanto a los arreglos de tipos de empaque y estiba usados por el producto que debe hidroenfriarse.

El diseño del empaque del producto y los arreglos de apilamiento son críticos para el proceso de transferencia de calor en el hidroenfriamiento. Una gran

variedad de empaques se han usado exitosamente en hidroenfriamiento. Estos empaques incluyen jabas de madera, cajas parafinadas de fibra de cartón, costal de polietileno y empaque a granel. Se deben de apilar cuidadosamente los paquetes para permitir que el agua ingrese al empaque. Si el agua corre alrededor y no a través del empaque habrá muy poco enfriamiento. Los productos en cajas de cartón parafinadas con cubierta solida son particularmente difíciles de enfriar ya que la cubierta no permite el ingreso del agua.

Jabas de madera con un gran porcentaje de espacio abierto, son más adecuadas para hidroenfriamiento ya que permiten suficiente ingreso de agua. Producto en canastas plásticas se enfría muy bien debido a que el agua fría se percola a través del producto.

Entre los cultivos de EANT de Centro América. los siguientes son los apropiados para el hidroenfriamiento: esparrago, alcachofa, elotillo, ejotes frescos, arveja china, melones honeydew y cantaloupe.

Es esencial tomar en cuenta los siguientes aspectos para un buen hidroenfriamiento:

- usar agua lo suficientemente fría.
- proveer un flujo apropiado de agua
- colocar suficiente tiempo el producto en el hidroenfriador

La siguiente información sobre hidroenfriamiento pretende ayudar a productores y exportadores de productos hortícolas frescos a tomar decisiones precisas sobre la aplicación de hidroenfriamiento. Se presentan varios tipos de hidroenfriamiento, cálculos de grados de hidroenfriamiento y control de plagas poscosecha. También se incluye literatura del producto de fabricantes de equipo de hidroenfriamiento. Los hidroenfriadores pueden construirse en la finca, comprarse nuevos o usados. Los componentes de un hidroenfriador consisten básicamente de un tanque con capacidad de mantener varios miles de galones de agua, una bomba de gran capacidad, tubería y válvulas asociadas y una unidad de refrigeración mecánica con bobinas.

Un hidroenfriador produce agua frisada y la mueve para tener contacto con el producto. El tipo de hidroenfriador más común y eficiente utiliza un flujo axial o bomba de succión la cual bombea volúmenes más grandes de agua bajo muy poca presión. Esta agua es bombeada hacia una lámina que se extiende sobre la tapa superior y a lo largo de longitud del enfriador. La parte inferior de esta lámina distribuidora contiene agujeros que permiten que el agua fría caiga en forma de lluvia pareja sobre el producto removiendo el

calor del campo y produciendo un efecto de lavado. Cuando se considera el hidroenfriador como método de enfriamiento, es importante entender los métodos de enfriamiento de agua que son usados y conocer los requerimientos de empaque y apilamiento del producto.

## 1. Métodos de Hidroenfriamiento

En la mayoría de hidroenfriadores, una bomba dirige el agua helada en contacto con el producto tibio. El agua tibia entonces se re-enfría y recicla. Para el enfriamiento del agua, muchos hidroenfriadores tienen un sistema de refrigeración con compresión de vapor (mecánico). Algunos hidroenfriadores no usan un sistema de refrigeración, al contrario, usan hielo quebrado o triturado para enfriar el agua. El costo capital de un hidroenfriador de este tipo es mucho menor que el que usa un sistema integral de refrigeración y puede ser preferido por los productores que tienen una cantidad limitada de producto. Para un hidroenfriador de este tipo, se debe tener una fuente confiable de abastecimiento de hielo y a un precio razonable.

Los métodos de hidroenfriamiento difieren en sus grados de enfriamiento y en eficiencias de proceso en general. Adicionalmente, los hidroenfriadores varían en cuanto al método de enfriamiento que se usa y en el método de movimiento o colocación del producto para que el agua tenga contacto con él. Estos pueden ser separados en dos diseños generales, transportador contra grupos, basado en que el producto sea o no sea estacionario dentro del enfriador. Hidroenfriadores tipo transportador se pueden dividir aun más en tipos de regadera e inmersión. Hay tres tipos de hidroenfriadores que se pueden usar para el enfriamiento de frutas y vegetales frescos que son: tipo transportador-regadera, de grupos (batch) y tipo transportador-inmersión.

### a. Hidroenfriador Tipo Transportador - Regadera

Un hidroenfriador tipo transportador-regadera permite que el producto, ya sea en canastas plásticos abiertos usados en el campo, empacado en cajas parafinadas o en jabas de madera, pase por un transportador debajo de una regadera de agua helada. El producto tibio es colocado en uno de los extremos del transportador y el producto enfriado es removido en el extremo opuesto. La velocidad a la cual el transportador, y por ende el producto avanza a través de la regadera es de aproximadamente 1 pie por minuto y puede variar en la mayoría de los enfriadores de acuerdo a las condiciones. Esto provee un

flujo suave del producto para que la bomba esté trabajando constantemente y no requiere que se pare su funcionamiento para descargar o recargar el enfriador. Se lleva a cabo una canalización debido a que el agua sigue el camino de menor resistencia y por lo cual corre más rápido a través de las aperturas mayores (canales) entre los productos individuales. La canalización disminuye la uniformidad del enfriamiento dentro del contenedor e incrementa el tiempo requerido para el enfriamiento. La profundidad adecuada para el producto y un grado suficientemente alto de aplicación de agua puede minimizar la canalización. El tamaño de largo del transportador es critico y depende del volumen de producto a ser enfriado y la cantidad de enfriamiento requerida (temperatura inicial contra final del producto). La velocidad del transportador puede ser incrementada o disminuida como ajuste para diferentes grados de enfriamiento y temperaturas iniciales. Las figuras 18, 19a, b y 20 muestran un hidroenfriador tipo transportador-regadera.

Los fabricantes de hidroenfriadores tipo transportador-regadera comúnmente diferencian sus diferentes modelos por su largo. Por ejemplo, un hidroenfriador de '10 pies' tiene una longitud activa de enfriamiento de 10 pies, aunque tenga un largo de hasta 20. El largo adicional se usa para transportadores de carga y descarga. Mientras más grande sea el área activa de enfriamiento, mayor será la capacidad del hidroenfriador.

i. Requisitos de Flujo de Agua

El hidroenfriamiento requiere de grandes cantidades de agua para pasarla por el producto. Se han realizado pruebas para determinar la cantidad de flujo de agua fría necesaria para el enfriamiento más efectivo de frutas y vegetales. El grado de flujo de agua de 15 a 20 galones por minuto por pie cuadrado de área activa de enfriamiento (superficie de lámina de distribución) son recomendadas (i.e., 600 a 800 litros/min/$m^2$). Por ejemplo un hidroenfriador con un area activa de enfriamiento de 1 metro de ancho por 5 metros de largo (5 metros$^2$) requerirá la circulación de 4,000 litros por minuto. Una tarima de producto de 48" por 48" tiene un área de 16 pies$^2$ y requerirá de 240 a 320 galones por minuto para ser distribuido proporcionalmente sobre el producto en dicha tarima. Cualquier cantidad menor a este volumen, resultará en menos enfriamiento, mientras

que más de este volumen no proveerá un enfriamiento adicional considerado. La lámina de distribución esta perforada para permitir una caída de agua helada en el producto. La temperatura del agua debe de estar lo mas próxima a 0°C posible.

La mayoría de hidroenfriadores tipo transportador-regadera son unidades de alta producción con grandes sistemas de refrigeración y componentes de larga duración. Dado a su costo relativamente alto, estos deben de ser operados por períodos considerables de tiempo cada año para que sean económicamente justificados. Con areas de producción relativamente pequeñas, estos hidroenfriadores tendrán que ser usados por más de un productor (o con más de un producto) o por una cooperativa de productores y empacadores para que sean rentables.

b. Hidroenfriadores Tipo Grupos (Batch)

Hidroenfriadores de grupo (batch) son recintos sin transportadores. Cajas o paquetes de producto se cargan al recinto y se colocan directamente debajo de la la lámina (panel) de distribución. Se cierra la puerta del recinto y grandes cantidades de agua helada caen sobre el producto esta agua se colecta del fondo, es enfriada de nuevo y se recicla. El producto permanece estacionario durante el proceso de enfriamiento. Al finalizar el período de enfriamiento, se detiene el funcionamiento de la bomba, se reemplaza el producto enfriado por producto tibio y se repite todo el proceso.

La mayoría de hidroenfriadores tipo grupos (batch) pueden enfriar unicamente una tarima de producto a la vez como se muestra en las figuras 21a, b y 22a, b. Estos hidroenfriadores generalmente tienen menor capacidad que los tipo transportador. Son generalmente menos caros y más fáciles de construir. Son los más apropiados para productores con una cantidad limitada de producto y que no pueden justificar económicamente el uso de una unidad mayor.

Uno de los reclamos más comunes tanto del hidroenfriado tipo transportador como del tipo de grupos, es que estos no enfrían todas las cajas en forma uniforme. Es probable que el agua helada no sea distribuida uniformemente a través de la carga,

dejando algunas partes con menos enfriamiento. Para superar esta deficiencia, algunos hidroenfriadores de grupos usan un ventilador de alta capacidad para atraer una llovizna fina de agua helada a través de los paquetes de producto. El aire forzado tiene el efecto de hacer que el enfriamiento sea más consistente porque hace que el agua pase por el producto en una forma más pareja de la que ocurriría solamente por medio de flujo de gravedad. Este diseño conocido como hidroenfriador de aire se ha usado con exito con productos que son particularmente difíciles de enfriar. La figura 23 muestra una unidad típica de hidroenfriador por aire.

c. Hidroenfriador Tipo Transportador - Inmersión

Los hidroenfriadores tipo transportador-inmersión son tanques rectangulares largos y poco profundos que contienen agua helada en movimiento. Jabas o cajas de producto tibio se colocan en un extremo del tanque y se mueven por medio de transportadores sumergidos hacia el otro extremo en donde son removidos. Hielo triturado o un sistema de refrigeración de compresión de vapor mantiene el agua helada mientras que una bomba mantiene el agua en movimiento. Un mal enfriamiento ocurriría si el producto es movido con el agua, por lo tanto hidroenfriadores tipo inmersión transporta el producto ya sea en contra (contra el flujo) o a través del flujo. Se deben se diseñar los transportadores para que haya movimiento del producto a través y fuera del agua. La duración de tiempo que el producto permanece en el agua varía con las condiciones iniciales y temperatura final deseada. Este tipo de hidroenfriamiento elimina el problema de canalización del agua.. El agua entra en contacto con todas las superficies del producto. El problema principal de sumersión es que cuando el producto esta empacado a granel, el movimiento del agua es bastante restringido. Dado a que el movimiento del medio enfriador sobre la superficie del producto es un componente critico para obtener enfriamiento rápido, la restricción puede ser una desventaja seria. El movimiento restringido de agua generalmente se puede corregir con el uso de bombas o hélices para circular el agua alrededor del producto. Un segundo problema con sumersión es que muchos cultivos de hoja tienen menos densidad que el agua y como consecuencia flotan. Para impedir flotación, se requieren algunos métodos mecánicos para mantener el producto debajo del agua. La figura 24 muestra un hidroenfriador de inmersión cargado con jabas de maíz dulce.

Pruebas han demostrado que el hidroenfriamiento más rápido se obtiene al sumergir el producto en tanques con agua helada agitada. El hidroenfriamiento por inmersión es casi dos veces más rápido que el hidroenfriamiento tipo regadera. Con el hidroenfriamientio convencional, el agua helada que es rociada o derramada sobre el producto hace contacto con solo una porción de su superficie. Esto resulta en que la transferencia de calor no sea al máximo. El hidroenfriador por inmersión disminuye la temperatura más rápidamente dado a que el agua helada en movimiento rodea completamente la superficie exterior del producto.

El hidroenfriamiento por inmersión se practicó anteriormente colocando producto suelto en tanques de agua helada. Hoy en día, este método se practica muy raramente porque la mano de obra es intensiva y gran parte del efecto del enfriamiento se pierde al empacar el producto. Incluso, trabajadores en las plantas empacadoras a veces se muestras renuentes a manejar el producto mojado y frío. El lavado de un bulto de ejotes verdes en agua helada antes de su clasificación y empaque, es un ejemplo de hidroenfriamiento por inmersión.

Si hay hielo disponible, éste puede sustituir una unidad mecánica de refrigeración para mantener fría el agua. Se requiere de un bloque de hielo de aproximadamente 300 libras por cada 400 litros de agua para el enfriamiento inicial. A medida que el agua se entibia durante el proceso de enfriamiento, se agrega hielo periódicamente para mantener la temperatura del agua.

## 2. Determinación de grados de hidroenfriamiento

Para operar un hidroenfriador de forma eficaz y eficiente, es necesario entender la forma de como el agua quita el calor del producto y los factores que afectan el grado de enfriamiento. Cuando cualquier objeto se calienta o enfría, el proceso físico es conocido como transferencia de calor. Hay varios mecanismos diferentes de transferencia de calor. En el proceso de hidroenfriamiento, el calor en el producto es llevado por la corriente del agua en movimiento. Este tipo de transferencia de calor se conoce como convección. Varios factores contribuyen al grado en el cual el calor se transfiere durante la convección. Uno de estos factores, llamado el coeficiente de transferencia de calor, permanece casi constante para todo tipo de

productos. El coeficiente de transferencia de calor es una medida de qué tan rápidamente se transfiere el calor de la superficie de un objeto. Un valor comúnmente usado para el coeficiente de transferencia de calor es de 120 Btu por hora por pie cuadrado por grado farenheit.

Otros factores también afectan el grado de transferencia de calor, como el área de superficie del producto y la diferencia de temperatura entre la superficie del producto y el agua fría. El grado de transferencia de calor se incrementa cuando el área de superficie del producto se incrementa o cuando la diferencia entre la temperatura del producto y la temperatura del agua se incrementa.

El area de superficie que está expuesta al agua fría varia considerablemente entre diferentes tipos de productos. Por ejemplo, el área de 10 kg de cantaloupes es menor que la de 10 kg de esparrago. Por lo tanto, si es hidroenfriado en agua de su misma temperatura, se espera que los esparragos se enfríen más rápido que los cantaloupes. Adicionalmente, mientras más grande la diferencia entre el agua y la temperatura del producto, más rápido será el enfriamiento.

Cuando se hidroenfria una fruta o producto vegetal, el grado de enfriamiento del interior del producto es de importancia primordial.

### 3. Capacidad de refrigeración

Los investigadores han desarrollado una gráfica que sumariza información actualizada sobre la transferencia de calor para varias frutas y vegetales. Esta gráfica se muestra en la figura 24 y muestra una familia de 8 líneas ideales de enfriamiento para varios tipos de productos sumergidos en agua helada agitada. Estas líneas son solo aproximaciones y están basadas principalmente en el tamaño físico del producto. El eje horizontal es el tiempo de enfriamiento en minutos y el eje vertical es la diferencia de temperatura decimal (DTD) de la temperatura que se desea alcanzar. Para calcular el tiempo de hidroenfriamiento para un tipo específico de producto, use esta ecuación para el DTD:

$$DTD = \frac{T - W}{P - W}$$

*donde:* $T$ = *la temperatura que se desea alcanzar (°F)*
$W$ = *la temperatura del agua*
$P$ = *la temperatura inicial del producto (°F)*

Ejemplo: Un turión de espárragos con una temperatura de 75°F, será hidroenfriado por inmersión en agua a 33°F. ¿Cuánto tiempo tomará reducir la temperatura hasta 37°F? La figura 25 deberá consultarse antes, para localizar la línea de enfriamiento (B) que es aplicable a esparrágos. Seguidamente se calcula el DTD a través de la siguiente ecuación:

$$DTD = \frac{37-33}{75-44} = 0.1$$

Encontrando la localización en la figura 25 en donde la curva B intersecta el DTD = línea 0.1 y proyectandose hacia abajo al eje X, verá que el tiempo requerido para enfriar el espárrago de 75°F a 37°F es aproximadamente 30 minutos.

En el ejemplo anterior, se asumía que los turiones individuales de espárragos fueron sumergidos completamente en agua helada agitada. Recuerden que la inmersión es el método de hidroenfriamiento más rápido posible. Cuando el esparrago es totalmente sumergido, todas las superficies exteriores son cubiertas por agua helada. Si los espárragos fueran hidroenfriados en un hidroenfriador tipo regadera, o empacados en jabas con otros turiones de espárragos, el t empo de enfriamiento sería más largo. Información publicada por los fabricantes de hidroenfriadores tipo regadera sugieren que el tiempo de enfriamiento para su equipo sea estimado de 40 a 80% más que para hidroenfriamiento por inmersión. El tiempo de enfriamiento para espárragos en un hidroenfriador tipo regadera puede ser estimado por la multiplicación del grado de hidroenfriamiento por inmersión por un factor de conversión de 1.5:

| | | |
|---|---|---|
| 30 minutos (grado de hidroenfriamiento por inmersión) | x 1.5 (Factor conversión) | = 45 minutos (grado de hidroenfriamiento tipo regadera |

Se debe de usar la figura 25 como una breve guía únicamente.

La cantidad de capacidad de refrigeración necesaria para hidroenfriamiento contínuo se muestra en la Tabla No. 8. Grandes cantidades de producto a ser enfriado requieren mayores cantidades de refrigeración. Requerimientos de refrigeración se expresan como la cantidad de refrigeración por peso unitario del producto. Los requisitos de capacidad de refrigeración también aumentan con los

incrementos en la cantidad de calor que debe ser removido y con la fuga de calor dentro del medio de enfriamiento del medio ambiente. Típicamente cerca del 50% del total de refrigeración se usa para absorber el calor del producto, el calor sobrante viene del medio ambiente. Con insulación apropiada, el porcentaje absorbido del producto puede incrementarse hasta un 80%.

Los requerimientos de refrigeración son comúnmente presentados como toneladas de refrigeración, la cantidad de enfriamiento producido cuando 1 tonelada (2,000 libras) de hielo (0°C) se derrite durante un período de 24 horas.

Los enfriadores que requieren menos de 40 KW (equivalente a cerca de 12 toneladas de refrigeración) de capacidad de refrigeración (4 KW de refrigeración requiere cerca de 1 KW de capacidad de compresor, ó 1 tonelada requiere aproximadamente 1 caballo de fuerza de capacidad de compresor) pueden ser fácilmente construidos en el campo. Sistemas más grandes deben de ser diseñados por un ingeniero.

Un estimado de la cantidad de capacidad de refrigeración necesaria para instalaciones de menor escala no requieren cálculos detallados. Se puede usar la figura 26 para estimar la capacidad de refrigeración necesaria para el manejo de enfriador poco mayor de 4,000 kg por hora (10,000 lb/hr). Por ejemplo, si se enfría un producto de 24°C (75°F) hacia 2°C (35°F), sería necesaria una caída de temperatura de cerca de 22°C (40°F) y el enfriador deberá manejar un máximo de 1800 kg por hora (4000 lb/hr), y después 70 KW (20 toneladas) de capacidad de refrigeración. Los estimados de esta figura se basan en enfriamiento rápido y razonable. La figura también se basa en la suposición de que el calor ingresado al enfriador desde fuentes ajenas al producto son menos que un 25% del total.

También se puede determinar la capacidad de tonelaje de refrigeración mecánica a través de la siguiente formula: multiplique la mayor cantidad de libras de producto a ser enfriado por hora por la reducción deseada de temperatura en grados F. Después lo divide por 12,000. Agregue 15% a esta cantidad para permitir el calor atmosférico y el calor aportado de la maquinaria (bombas). El total es la cantidad de toneladas de refrigeración requerida. Por ejemplo, para hidroenfriar 600 libras de espárrago a 35°F de la temperatura del turión, de un turión cosechado a una temperatura inicial de 85°F:

600 libras de producto
x50°F (85°F a 35°F)
30,000 ÷ 12,000 = 2.5 toneladas

2.5 toneladas x .15 = .375 toneladas
2.5 + .375 = 2.875 toneladas requeridas por hora

El costo de una unidad de refrigeración mecánica es de $1250 por tonelada aproximadamente.

Para un estimado de consumo de energía de la unidad mecánica de refrigeración, use 2 caballos de fuerza (HP) por tonelada y 2.5 amps por HP con una línea de corriente trifásica de 230 voltios. Use esta fórmula para cálculos de kilowats (corriente trifásica unicamente) de consumo de energía: 1.73 x amps x voltios x factor de energía ÷ 1000.

Algunos hidroenfriadores a pequeña escala usan hielo para enfriamiento. Se puede utilizar la figura 27 para estimar la cantidad diaria de hielo necesaria para operar un hidroenfriador pequeño. Por ejemplo, si 2700 kg de producto por día (6000 lb/día) se enfrían a aproximadamente 22°C (40°F) entonces un poco más de 1.7 toneladas del hielo serían derretidas. La figura se basa en un 50% del hielo que se está usando para el enfriamiento de producto y el restante del potencial de enfriamiento se pierde a una ganancia de calor externo. Este nivel de eficiencia es común para hidroenfriadores que usan hielo.

## 4. Eficiencia de Energía

Los hidroenfriadores de inmersión son los mejores para la conservación de energía porque el contacto de agua al aire es mínimo.

El uso de energía en hidroenfriadores puede reproducirse con:

- Usando cantidades generosas de insulación en todas las superficies refrigeradas y colocando el hidroenfriador oculto del viento y del sol.

- Usando tiras plásticas en ambos extremos de ingreso y egreso del hidroenfriador tipo transportador para reducir la ganancia de calor del agua al aire.

- Operando el hidroenfriador a su capacidad máxima. La operación intermitente desperdicia energía así como la operación a capacidad reducida. Un hidroenfriador de capacidad baja en operación por períodos largos es más eficiente y económico que una unidad de alta capacidad en operación por períodos cortos. Algunos hidroenfriadores se pueden comprar ahora con una opción de almacenaje termal. Una capacidad de almacenaje termal disminuye el tamaño de la unidad de refrigeración que se requiere.

- Usando un depósito de agua de un tamaño apropiado. Un depósito demasiado grande desperdicia más energía porque la cantidad restante de enfriamiento se pierde cuando se tira el agua al final del día.

## 5. Clorinacion y Control de Enfermedades

Aunque el hidroenfriamiento es un método excelente de enfriamiento, éste moja el producto. La superficie del producto tibio y mojado provee un sitio excelente para enfermedades de poscosecha. Por lo tanto, es esencial que, una vez hidroenfriado el producto no se permita volver a calentar. El producto es particularmente susceptible a enfermedades de poscosecha cuando ha sido sujeto a daños mecánicos (roces, moretes, abrasiones). Además dado que el agua del hidroenfriador es nuevamente circulada, puede diseminar después enfermedades de algunas frutas infectadas a todo el producto hidroenfriado. Para disminuir la diseminación de enfermedades de postcosecha, se recomienda el uso de cloro como un desinfectante a un grado de 50 a 150 partes por millón. La clorinación es un método barato y preventivo de poscosecha para el control de enfermedades que representa poca amenaza para la salud humana y el medio ambiente. El cloro es un desinfectante usado universalmente en sistemas públicos de agua. También es el único químico aceptado por la Agencia para la Protección Medio Ambiental de los Estados Unidos (U.S. EPA por sus siglas en Inglés) y por la Agencia de Alimentos y Drogas de los Estados Unidos (U.S. FDA por sus siglas en Inglés) para su uso en vegetales después de cosechados. El cloro no deja residuo ya que se convierte en gas y se evapora después de desinfectar la superficie del producto. El cloro para su uso en agua de hidroenfriamiento se puede comprar en forma de una solución de hipoclorito de sodio (por ejemplo Clorox) (5.25% de cloruro disponible) o como hipoclorito de calcio seco y en forma polvorosa (65% de cloruro disponible). Ambos cloruros que contengan químicos

del mismo ingrediente activo, ácido hipocloruro, cuando se les agrega agua. Si se usa agua dura, puede haber un problema de precipitación con el hipoclorito de calcio. En ese caso, el hipoclorito de sodio deberá usarse a cambio. Al agregar Ca $(OC1)_2$ granulado directamente al agua a menudo resulta en particulas no disueltas que se adhieren al producto y que pueden causar quemaduras de cloro y descoloración. Esto es particularmente cierto en hidroenfriamiento ya que Ca $(OC1)_2$ se disuelve muy lentamente en agua fría. El Ca $(OC1)_2$ granulado siempre deberá ser disuelto en una pequeña cantidad de agua tibia antes de agregarlo al hidroenfriador. El peso de 65% Ca $(OC1)_2$ y el volumen de 5.25% NaOC1 requerido para obtener una concentración específica de cloruro disponible en el agua del hidroenfriador se muestra en las Tablas 9 y 10.

Para la misma cantidad de clorinacion, una solución de NaOC1 es generalmente más cara que la de $Ca(OC1)_2$ granulada debido a los costos adicionales de envío y manejo asociados con la menor formulación liquida concentrada.

Varios tipos de sistemas de clorinacion pueden usarse para la medición del cloro. Un sistema manual puede construirse fácilmente usando una bomba de inyección conectada al tanque de agua del hidroenfriador. Los costos de un sistema manual incluyen el costo del tanque, fuente de cloro, tubería, una bomba de inyección ($350-$450) y un equipo profesional de análisis para cloro (Hach) (aprox. $60), un medidor de pH portátil (aprox $60) o papel "litmus". El juego de análisis de cloro para piscinas no deberá usarse, ya que éste está diseñado para medir niveles bajos de cloro (2 a 6 ppm).

Agregue 2 onzas de Ca $(OC1)_2$ por 100 galones de agua ó 150 grms por 1000 litros para obtener 100 ppm de cloro activo. Si la fuente de cloro es NaOC1, agregue 1.6 pintas por 100 galones, ó 2 litros por 1000 litros de agua, para obtener 100 ppm de cloro.

Varios factores afectan la cantidad de cloro disponible en el agua a través del tiempo. El cloro usado en el agua para hidroenfriamiento es bastante volátil y se dispersará en el aire a un grado que incrementa con la temperatura del agua. Mientras más caliente este el agua, mas rápido se separará el cloro de la solución. Además el cloro tiende a juntarse con las partículas del suelo. Entonces, un producto sucio usa el cloro disponible mucho más rápido que un producto relativamente limpio.

Además de los factores arriba mencionados, el pH del agua tiene un efecto significativo en la disponibilidad del cloro. Aun cuando una cantidad de cloro que normalmente sería suficiente se agrega al agua, puede ser que el cloro no esté disponible en una forma utilizable si el agua es ácida (un pH abajo de 6.5) o básica (un pH arriba de 7.5). Para que el cloro sea optimamente utilizable, el pH del agua para hidroenfriamiento deberá ser casi neutral (pH de 7.0). Se requiere más de siete veces el cloro para desinfectar a un pH de 8.5 que a uno de 7.0.

Debido a que el pH del agua de pozo varía desde moderadamente ácida a moderadamente básica, siempre es una buena idea analizar el agua con un medidor de pH o con papelitos de prueba. Varias compañías fabrican equipo de análisis de cloro (i.e. Hach o Chemetrics) aptos para el análisis de agua de hidroenfriadores. Aun cuando el agua tiene un pH casi neutral, la adición de hipocloritos causa que el agua se vuelva básica. Por lo tanto, puede ser necesario agregar una cantidad pequeña de ácidos comunes como jugo de limón o vinagre para corregir el pH. Se debe mantener un control frecuente de ambas, la concentración de cloro y el pH del agua.

Los organismos que causan enfermedades pueden ingresar al agua de hidroenfriamiento tanto en la forma vegetativa activa como en la forma de espora. El cloro matará rápidamente la forma vegetativa pero las esporas son de 10 a 1,000 veces más difícil de matar. Por lo tanto, el tratamiento de cloro no eliminan todos los patógenos. Muchas esporas pueden quedarse en la superficie y desarrollarse después si el producto su vuelve a calentar. La efectividad del tratamiento de cloro depende del tiempo de la exposición. Afortunadamente, la exposición larga que es común con el hidroenfriamiento es mucho más efectiva que un tratamiento de una inmersión rápida. Sin embargo, la clorinacion solamente es un tratamiento de superficie. Si los patógenos ya han empezado a desarrollarse dentro de la superficie, el cloro no tendrá efecto. Incluso, las soluciones de cloro pueden producir descolorización de la superficie. Es necesario la precisión en las concentraciones de cloro en el agua de hidroenfriamiento.

## D. Enfriamiento por Cuarto Frío

El enfriamiento por cuarto frío consiste en la exposición de productos frescos al aire frío en un cuarto refrigerado. Este es un método comunmente usado para productos con una vida de almacenaje relativamente larga, tales como:

cebollas, cultivos de raiz y cítricos. También se usa para frutas tropicales y melones honeydew. Un arreglo sencillo de cuarto frío es la descarga de aire frío del evaporador dentro del cuarto, en forma horizontal un poco abajo del techo. El aire frío topa en el techo y regresa hacia el producto apilado en el piso. El grado de enfriamiento es relativamente lento. Una perdida significativa de vida de mercado puede ocurrir si este método de enfriamiento es usado para productos altamente perecederos. Por lo tanto, no es conveniente el uso de este método de enfriamiento para la mayoria de productos de EANT. Para obtener los mejores resultados de enfriamiento por cuarto frío se requiere de una velocidad de aire de 200 a 400 pies/minuto (60 a 120 metros/minuto) alrededor de las cajas, las cuales tienen que estar debidamente ventiladas. Cuando el enfriamiento ha terminado, la velocidad del aire alrededor de las cajas deberá ser reducida hasta de 10 a 20 pies/minuto.

Una de las ventajas principales de enfriamiento en cuarto frío es que el producto puede ser enfriado y almacenado en el mismo cuarto sin necesidad de ser trasladado.

La utilización de inyectores de aire en el cielo (ceiling jets) es una modificación de cuarto frío la cual dirige el flujo de aire a través de la superficie de las cajas para mejorar la remoción de calor. Aire frío es inyectado entre el techo y un cielo falso. La presión positiva que resulta, forza el aire dentro del cuarto a través de conos en el cielo. El piso de un cuarto frio está marcado para la estiba de tarimas o cajones para que el aire de los conos alcance las esquinas de las unidades estibadas y lo riege dentro de los canales entre si. Seguidamente, un plenun de retorno de aire, lo conduce en una sola dirección.

Mientras que el enfriamiento por cuarto frío es mejor a nada, es el método menos deseado debido al largo tiempo que toma para remover el calor del campo de un producto. Pequeños cuartos fríos pueden ser construidos por productores, se compran en forma prefabricada, o como vehículos usados de transportación (i.e., trailers o contenedores maritimos). Estos contenedores usualmente tienen una capacidad de refrigeración de 2.5 a 3 toneladas. Se puede colocar y adaptar un ventilador dentro del contenedor para incrementar el grado de enfriamiento.

## E. Enfriamiento por Hielo

También se puede usar hielo líquido o triturado para enfriar ciertos productos hortícolas. Este se adapta a los siguientes cultivos de EANT: brocoli, melón cantaloupe, elotillo y vegetales de hoja. No obstante, no es tan versátil o económico como el aire forzado o hidroenfriamiento, y no puede ser usado

con muchos productos de EANT. El enfriamiento se logra llenando las cajas empacadas con producto de cantidad pre-escritas de hielo o una combinación de hielo o hielo liquido. La efectividad del enfriamiento incrementa el creciente contacto entre el hielo y el producto. Un enfriamiento rápido ocurre con hielo, pero el grado de enfriamiento disminuye conforme el hielo se derrite y menos hielo se mantiene en contacto con el producto. Se pueden comprar unidades de fabricación de hielo y almacenaje del mismo en una gran variedad de tamaños, y la mayoria representan una gran inversion de capital. Se coloca hielo empacado en el contenedor de forma automática por medio del uso de una máquina dispensadora automática o manual con una palanca. Si se usa hielo empacado, es usualmente necesario comprar y operar un recipiente de almacenaje para que se pueda almacenar hielo para su uso posterior. El hielo líquido provee un grado mayor de contacto inicial entre el producto y el hielo y se puede aplicar después de haber estibado las cajas. El rango de masa aguada del hielo líquido en proporción del agua a hielo es de 1.1 a 1.4 y puede contener una pequeña cantidad de sal para disminuir el punto de derretimiento. La naturaleza líquida de la masa aguada permite que el hielo se mueva a través de la caja, llenando todos los volumenes de vacío de la caja y alcanzando todos los agujeros y grietas alrededor de las unidades individuales del producto. Después de removerla de la máquina de hielo, el agua escurre dejando una masa relativamente sólida de hielo triturado en la cual se introduce el producto (ver las figuras 28a, b, c, 29 y 30). La ventaja principal de usar hielo líquido es el gran contacto entre el hielo y el producto costeado por este método.

El uso de hielo es particularmente efectivo en paquetes densos que no se pueden enfriar con aire forzado. Debido a que el hielo tiene un efecto de residuo, este método trabaja bien con productos que tienen un grado alto de respiración tales como el elotillo. El uso de hielo es relativamente eficiente en energía. Una libra de hielo enfriará aproximadamente 3 libras de producto de 85° a 40°F.

Se usan cajas de cartón parafinadas con perforaciones inferiores o jabas de madera con este proceso de enfriamiento.

Hay máquinas de hielo portátiles disponibles para uso en empacadoras o en el campo. Se puede usar hielo corno el único método de enfriamiento para el producto, o como enfriamiento complementario para producto que haya sido enfriado con aire forzado o hidroenfriador.

## 1. Cálculo de requerimiento de hielo

Se puede considerar el hielo como una energía termal almacenada. El derretimiento de una libra de hielo absorberá 144 btu de calor. Se ha demostrado que en la mayoria de aplicaciones de hielo comerciales, solamente cerca de ¼ ó ½ del hielo es efectivamente usado para enfriar el producto. El resto se derrite por el calor externo que pasa a través de los lados de la caja.

Para un ejemplo de como calcular la cantidad de hielo necesaria para enfriar una cantidad dada de producto, se puede considerar el enfriamiento de brocoli. Brocoli es un cultivo extremadamente perecedero y es uno de los vegetales más comunmante enfriados por hielo. La mayoría de compradores en Estados Unidos requieren que el brocoli llegue con porciones de hielo dentro de la caja como prueba de un enfriamiento suficiente y continuo. El brocoli frecuentemente se empaca en cajas de cartón que contienen aproximadamente 20 libras de producto.

El enfriamiento de 20 libras de brocoli de 85°F a 45°F requiere la remoción de aproximadamente 800 Btu de calor. Asumiendo que durante su envío y manejo adquiera otros 1,000 Btu del exterior, el total de carga de calor por caja sería de 1,800 Btu. Por lo tanto, la cantidad mínima de hielo requerida para proveer un enfriamiento apropiado seria de:

$$\frac{1{,}800 \text{ Btu/caja}}{144 \text{ Btu/libra de hielo}} = 12.5 \text{ libras de hielo/caja}$$

El la practica, se requiere de aproximadamente 16 libras de hielo por cada caja de 20 libras de brocoli. El hielo adicional asegura un enfriamiento apropiado bajo condiciones extraordinarias. Si se usa el método de hielo líquido, es posible que se requiera de otras 10 libras de hielo por caja para enfriar y mantener el agua en la masa aguada a una temperatura baja. Por lo tanto, en este ejemplo, un total de aproximadamente 26 libras de hielo serían requeridas para un enfriamiento apropiado de cada caja de 20 libras de brocoli.

Para algunos productores de un volumen de poco a moderado, el uso de hielo puede proveer una opción de enfriamiento a bajo costo.

La desventaja principal del uso de hielo en un producto es que el peso del hielo incrementa substancialmente el peso de embarque. El peso adicional puede igualar en 35-40% del peso del producto. Por lo cual, se debe

considerar el uso de hielo sólamente como un método de enfriamiento y no como un medio para mantener la cadena fría durante su transporte aéreo. No es económico el envío de cajas de producto altamente perecedero llenas de hielo por la vía aérea.

## F. Condiciones de Almacenaje

Las temperaturas que se muestran en la tabla 2 y 3 son las generalmente consideradas como óptimas para el producto. Se recomienda que se almacenen frutas, vegetales y flores frescas a 0°-1°C, a menos que sean susceptibles a daño por frío. Es muy importante que las temperaturas dentro de un cuarto frío de almacenamiento no fluctuen para que el producto no se congele. Es aconsejable instalar un termostato de rango exacto de temperatura (con rango de 1-2°C) para prevenir grandes fluctuaciones de temperatura en el cuarto de almacenamiento. Los termostatos deberán colocarse a aproximadamente 1.5m (5 pies) sobre el piso (para su fácil revisión) y en varios lugares del cuarto. No deberán situarse cerca de puertas o cerca de descargas de aire de las unidades de refrigeración. Se necesita una circulación uniforme de aire dentro del cuarto de almacenaje para remover el calor de respiración del producto. La circulación de aire dentro del cuarto de almacenaje deberá ser suficiente para remover el calor producido durante la respiración, así como para remover el calor que se infiltra dentro del cuarto. Generalmente, es adecuado un rango de aire de 0.06 a 0.12$m^3$/min por tonelada métrica de producto (20 a 40 cfm/ton).

Esto asume una colocación apropiada de las cajas dentro del cuarto para permitir el movimiento de aire a través de uno o dos lados de la caja. También asume que el producto fue completamente enfriado antes de su almacenaje.

Dado que todas las frutas, vegetales y flores de corte están sujetas a marchitez, es esencial un grado alto de HR dentro del cuarto de almacenamiento. Se recomienda que la mayoría de productos sean almacenados entre 90 y 95% de HR. Los productos deben ser enfriados a cerca de 0°-1°C antes de ser almacenados en ambientes de alta humedad. La condensación de humedad en la superficie del producto (sudor) puede producir pudrición y debe de evitarse.

Las puertas de areas refrigeradas de almacenaje deberán ser protegidas con cortinas de tiras plásticas para reducir la ganancia de calor. El aire tibio reducirá rápidamente la HR en el cuarto frío de almacenaje. Se puede obtener una HR alta por medio de lo siguiente:

- agregar humedad al aire con el uso de humectantes.
- mojar el piso.
- regular el movimiento de aire dentro del cuarto de almacenaje.
- tener un area grande de superficie de la serpentina del evaporador.
- mantener la temperatura de las serpentinas de refrigeración dentro de 1°C de la temperatura del aire.

El agregar agua en el cuarto de almacenaje incrementará la HR pero la mayor condensación de humedad en las superficies enfriadoras incrementará la frecuencia de descongelación de sistemas de serpentinas secas.

Hay varios tipos de instrumentos de medición de humedad relativa disponibles. Un instrumento común es el psicrómetro tipo "sling" con dos termómetros. El bulbo de un termómetro esta descubierto y el del otro esta cubierto con una mecha que ha sido mojada con agua destilada. Este psicrómetro de bulbo seco y bulbo mojado trabaja bajo el principio de que si el aire del ambiente no está saturado, el agua de la mecha mojada se evaporará y así enfriará el bulbo mojado. El bulbo mojado cae a una temperatura definitiva cuando el calor recibido por conducción y convección del aire flotando sobre el bulbo balancea el agua pura en la mecha. De las diferencias en las temperaturas de los bulbos seco y mojado, se puede determinar la HR de reglas generales proveidas con el psicrómetro o de tablas psicométricas (ver figura 31). La influencia de la presión atmosférica es insignificante y no necesita ser tomada en cuenta para los propósitos más prácticos. El movimiento rápido de aire sobre los termómetros es esencial para determinaciones exactas. Esto puede ser efectuado por el movimiento de los termómetros o más efectivamente llevando un flujo constante de aire a través de los bulbos en un recipiente cerrado. Las lecturas deberán hacerse rápida y cuidadosamente.

Las lecturas directas de humedad relativa pueden hacerse con higrómetros de pelo o bien con los de tipo "gold beater's skin". Estas medidas están basadas en el principio de que los filamentos orgánicos cambian su longitud como función de humedad relativa. Estos instrumentos son relativamente baratos y no muy exactos, especialmente en humedades altas. Los higrómetros eléctricos se están usando cada vez más para mediciones de humedad y para controlar equipo humedecedor. La operación de éstos se basa en la habilidad de una película higroscópica para cambiar su resistencia eléctrica instantaneamente con un pequeño cambio en la humedad relativa.

### 1. Sistemas de Refrigeración

Los elementos básicos de un sistema de refrigeración son: refrigerante, compresor, condensador y evaporador. En el almacenaje convencional refrigerado, el aire en el cuarto de almacenaje se enfría dirigiéndolo sobre

tuberías o serpentinas a través del cual circula el refrigerante. Mientras más grande sea la superficie de las serpentinas enfriadoras, más cercana será la temperatura del refrigerante en alcanzar la temperatura de aire deseada, y por ende se alcanzará la mayor humedad (ya que la condensación de humedad en las serpentinas se minimiza).

Las figuras 32 y 33 muestran los componentes de un sistema típico de refrigeración mecánico. El líquido refrigerante pasa a través de la válvula de expansión, donde la presión cae y el líquido se evapora a temperaturas lo suficientemente bajas para ser efectivo en la remoción del calor del area de almacenaje. El calor del material a ser enfriado, se transfiere hacia el aire del cuarto, el cual es forzado a pasar por el evaporador (serpentinas de enfriamiento localizadas en el cuarto), usualmente es un tubo transformador de calor, el cual cambia el calor del aire hacia el refrigerante causando que éste se evapore. Despúes de su cambio total a gas, éste cambia o aumento su presión por medio de un compresor y luego pasa a través de un condensador en donde es enfriado y se convierte en líquido. El condensador está colocado afuera del area de almacenaje y despide calor. El líquido se almacena en el recibidor y es expulsado conforme sea necesario para el enfriamiento. Una serpentina de refrigeración diseñada específicamente para un hidroenfriador se muestra en la figura 34.

a. Válvula de Expansión

Pequeños sistemas mecánicos de refrigeración son controlados principalmente por una válvula de expansión, la cual regula la presión del refrigerante en el evaporador. Las presiones bajas causan que el líquido refrigerante se evapore a temperaturas bajas. La válvula también controla el flujo del refrigerante, el cual afecta la cantidad de capacidad de refrigeración disponible. Los tipo más comunes de válvulas de expansión son tubos capilares y válvulas de expansión termostática.

b. Evaporador

Los cuartos fríos de almacenamiento modernos usualmente utilizan evaporadores de tubos refinados. El aire del almacenaje es forzado a pasar a través de los tubos por los ventiladores, los cuales son parte de una unidad completa de evaporación. Los evaporadores que operan cerca de 0°C (32°F) acumulan escarcha que debe ser removida para mantener una eficiente transferencia de calor. El proceso de descongelamiento puede hacerse por medio de: la inundación con agua de las serpentinas en forma período; por medio de calentadores eléctricos; dirigiendo gas refrigerante caliente hacia los evaporadores,

o puede hacerse también si se descongela continuamente con una solución salina o una de glicol.

c. Condensador

Los condensadores se catalogan como enfriados por aire o bien enfriados por agua. Los sistemas pequeños generalmente utilizan una unidad de enfriamiento por aire. Muchos tipos de refrigeración domésticos, por ejemplo, tienen un tubo de serpentina en la parte de atrás la cual permite que fluya una corriente natural de aire. Los sistemas más grandes utilizan un ventilador que provee que el flujo de aire pase por el condensador. Los condensadores grandes generalmente son enfriados por agua. El agua e. mejor conductor de calor que el calor, permitiendo que condensadores enfriados por agua sean más pequeños que unidades de aire forzado de igual capacidad. Los condensadores evaporadores reducen el consumo de agua reciclando el agua calentada del condensador; estos requieren mayor atención a la calidad del agua para mantener la eficiencia y prevenir daños al transformador de calor.

e. Refrigerantes

Los refrigerantes más comúnmente usados son amonia y frion. Ambos tienen gran capacidad de absorber el calor. La elección de cual refrigerante usar en un sistema mecánico (recompresión de vapor) se basa en los siguientes factores:

- Costo del refrigerante. Los refrigerantes de haluro son más caros que los de amonia. (Restricciones ambientales pueden afectar la disponibilidad de algunos refrigerantes de haluro que ahora usamos).

- Compatibilidad. El amonia no puede ser usada con metales que contengan cobre; los refrigerantes de haluro no pueden ser usados con magnesio y pueden ocasionar daño a materiales plásticos.

- Toxicidad. El amonia en concentraciones muy pequeñas puede dañar los productos hortícolas. También es tóxico para los seres humanos.

## IV. SUMARIO

El reto para el futuro para pequeños productores de pocos recursos será el adoptar y utilizar metodos de enfriamiento de poscosecha apropiados a las empacadoras existentes. Solo a través del manejo apropiado de temperaturas el productor podrá abastecer consistentemente con producto de alta calidad al comprador. La competencia en el mercado internacional es intensa. Debemos comprender que la tecnologia de poscosecha apropiada es un ingrediente esencial para alcanzar el éxito en comercio internacional de productos hortícolas.

**Table 1.**
**Respiration rates of fruits and vegetables, expressed as rates of carbon dioxide production (mg/kg•h), at various temperatures[1]**

| Commodity and source reference | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 0°C (32°F) | 4-5°C (40-41°F) | 10°C (50°F) | 15-16°C (59-60°F) | 20-21°C (68-70°F) | 25-27°C (77-80°F) |
| Apples, summer (*857, 882*) | 3-6 | 5-11 | 14-20 | 18-31 | 30-41 | — |
| Apples, fall (*428, 882*) | 2-4 | 5-7 | 7-10 | 9-20 | 15-25 | — |
| Apricots (*158, 356*) | 5-6 | 6-9 | 11-19 | 21-34 | 29-52 | — |
| Artichokes, globe (*751*) | 15-45 | 26-60 | 55-98 | 78-145 | 135-233 | 145-300 |
| Asparagus (*516*) | 27-80 | 55-138 | 90-304 | 160-327 | 275-500 | 500-600 |
| Avocados (*87*) | — | 20-30 | — | 62-157 | 74-347 | 118-428 |
| Bananas, green[2] (*262*) | — | — | — | 21-23 | 33-35 | — |
| Bananas, ripening (*262, 681*) | — | — | 21-39 | 25-75 | 33-142 | 50-245 |
| Beans, lima (*941*) | 10-30 | 20-36 | — | 100-125 | 133-179 | — |
| Beans, snap (*1011*) | 20 | 35 | 58 | 93 | 130 | 193 |
| Bean sprouts (*528*) | 21-25 | 42 | 93-99 | — | — | — |
| Beets, topped (*857*) | 5-7 | 9-10 | 12-14 | 17-23 | — | — |
| Beets, with leaves (*768*) | 11 | 14 | 22 | 25 | 40 | — |
| Berries | | | | | | |
| Blackberries (*768, 857*) | 18-20 | 31-41 | 62 | 75 | [3]155 | — |
| Blueberries[4] | 2-10 | 9-12 | 23-35 | 34-62 | 52-87 | 78-124 |
| Cranberries[4] (*40*) | — | 4-5 | — | — | 11-18 | — |
| Gooseberries (*428, 861*) | 5-7 | 8-16 | 12-32 | 27-69 | 41-105 | — |
| Raspberries (*324*) | 18-25 | 31-39 | 28-55 | 82-101 | — | — |
| Strawberries (*600*) | 12-18 | 16-23 | 49-95 | 71-92 | 102-196 | 169-211 |
| Broccoli (*817*) | 19-21 | 32-37 | 75-87 | 161-186 | 278-320 | — |
| Brussels sprouts (*558*) | 10-30 | 22-48 | 63-84 | 64-136 | 86-190 | — |
| Cabbage (*817, 977*) | 4-6 | 9-12 | 17-19 | 20-32 | 28-49 | 49-63 |
| Carrots, topped (*817*) | 10-20 | 13-26 | 20-42 | 26-54 | 46-95 | — |
| Carrots, bunched (*817, 768*) | 18-35 | 25-51 | 32-62 | 55-106 | 87-121 | — |
| Cauliflower (*817*) | 16-19 | 19-22 | 32-36 | 43-49 | 75-86 | 84-140 |
| Celery (*554, 977*) | 5-7 | 9-11 | 24 | 30-37 | 64 | — |
| Celeriac (*428*) | 7 | 15 | 25 | 39 | 50 | — |
| Cherries, sweet (*270, 623*) | 4-5 | 10-14 | — | 25-45 | 28-32 | — |
| Cherries, sour (*356*) | 6-13 | 13 | — | 27-50 | 39-50 | 53-71 |
| Citrus | | | | | | |
| Grapefruit (*323, 325, 817*) | — | — | 7-9 | 10-18 | 13-26 | 19 |
| Lemons (*323, 325*) | — | — | 11 | 10-23 | 19-25 | 20-28 |
| Limes, Tahiti[4] | — | — | — | 6-10 | 7-19 | 15-45 |
| Oranges (*323, 325, 817*) | 2-5 | 4-7 | 6-9 | 13-24 | 22-34 | 25-40 |
| Cucumbers (*224*) | — | — | 23-29 | 24-33 | 14-48 | 19-55 |
| Endive (*428*) | 45 | 52 | 73 | 100 | 133 | 200 |
| Figs, fresh (*159*) | — | 11-13 | 22-23 | 49-63 | 57-95 | 85-106 |
| Garlic (*570*) | 4-14 | 9-33 | 9-10 | 14-29 | 13-25 | — |
| Grapes, American (*549*) | 3 | 5 | 8 | 16 | 33 | 39 |
| Grapes, vinifera (*706*) | 1-2 | 3-6 | 8 | 10-12 | — | 25-30 |
| Kale (*409*) | 16-27 | 34-47 | 72-84 | 120-155 | 186-265 | — |
| Kohlrabi (*713*) | 10 | 16 | 31 | 49 | — | — |
| Kiwifruit (*353*) | 3 | 6 | 12 | — | 16-22 | — |
| Leeks (*412*) | 10-20 | 20-29 | 50-70 | 75-117 | 110 | 107-119 |
| Lettuce, head (*648, 817*) | 6-17 | 13-20 | 21-40 | 32-45 | 51-60 | 73-91 |
| Lettuce, leaf (*817*) | 19-27 | 24-35 | 32-46 | 51-74 | 82-119 | 120-173 |
| Lychees (*18*) | — | — | — | — | — | 75-128 |
| Mangos (*455*) | — | 10-22 | — | 45 | 75-151 | 120 |

See footnotes at end of table.

**Table 1.**
**Respiration rates of fruits and vegetables, expressed as rates of carbon dioxide production (mg/kg•h), at various temperatures[1]—Continued**

| Commodity and source reference | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 0°C (32°F) | 4-5°C (40-41°F) | 10°C (50°F) | 15-16°C (59-60°F) | 20-21°C (68-70°F) | 25-27°C (77-80°F) |
| **Melons** | | | | | | |
| Cantaloups (*817*) | 5-6 | 9-10 | 14-16 | 34-39 | 45-65 | 62-71 |
| Honey Dew (*736, 817*) | — | 3-5 | 7-9 | 12-16 | 20-27 | 26-35 |
| Watermelons (*817*) | — | 3-4 | 6-9 | — | 17-25 | — |
| Mushrooms (*554, 860*) | 28-44 | 71 | 100 | — | 264-316 | — |
| Onions, dry (*817*) | 3 | 3-4 | 7-8 | 10-11 | 14-19 | 27-29 |
| Onions, green (*410*) | 10-32 | 17-39 | 36-82 | 66-115 | 79-178 | 98-210 |
| Okra (*817*) | — | 53-59 | 86-95 | 138-153 | 248-274 | 328-362 |
| Olives (*598*) | — | — | — | 27-66 | 40-105 | 56-128 |
| Papayas (*442*) | — | 4-6 | — | 15-22 | — | 39-88 |
| Parsley (*417*) | 30-40 | 53-76 | 85-164 | 144-184 | 196-225 | 291-324 |
| Parsnips (*857, 977*) | 8-15 | 9-18 | 20-26 | 32-46 | — | — |
| Peaches (*322, 323*) | 4-6 | 6-9 | 16 | 33-42 | 59-102 | 81-122 |
| Pears, Bartlett (*24, 563*) | 3-7 | 5-10 | 8-21 | 15-60 | 30-70 | — |
| Pears, Kieffer (*553*) | 2 | — | — | 11-24 | 15-28 | 20-29 |
| Peas, unshelled (*941*) | 30-47 | 55-76 | 68-117 | 179-202 | 245-361 | 343-377 |
| Peas, shelled (*941*) | 47-75 | 79-97 | — | — | 349-556 | — |
| Peppers, sweet (*817*) | — | 10 | 14 | 23 | 44 | 55 |
| Persimmon, Japanese (*280*) | — | 6 | — | 12-14 | 20-24 | 29-40 |
| Pineapples, mature-green (*817*) | — | 2 | 4-7 | 10-16 | 19-29 | 28-43 |
| Plums, Wickson (*157*) | 2-3 | 4-9 | 7-11 | 12 | 18-26 | 28-71 |
| Potatoes, immature[4] | — | 12 | 14-21 | 14-31 | 18-45 | — |
| Potatoes, mature[4] | — | 3-9 | 7-10 | 6-12 | 8-16 | — |
| Radishes, with tops (*554*) | 14-17 | 19-21 | 31-36 | 70-78 | 124-136 | 158-193 |
| Radishes, topped (*554*) | 3-9 | 6-13 | 15-16 | 22-42 | 44-58 | 60-89 |
| Rhubarb, stalk (*407*) | 9-13 | 11-18 | 25 | 31-48 | 40-57 | — |
| Romaine (*817*) | — | 18-23 | 31-40 | 39-50 | 60-77 | 95-121 |
| Rutabagas (*428, 977*) | 2-6 | 5-10 | 15 | 11-28 | 41 | — |
| Spinach (*817*) | 19-22 | 35-58 | 82-138 | 134-223 | 172-287 | — |
| Squash, Butternut[4] | — | — | — | — | — | 66-121 |
| Squash, summer (*554*) | 12-13 | 14-19 | 34-36 | 75-90 | 85-97 | — |
| Sweet corn, w/husks (*817, 941*) | 30-51 | 43-83 | 104-120 | 151-175 | 268-311 | 282-435 |
| Sweetpotatoes, noncured (*554*) | — | — | — | 29 | — | 54-73 |
| Sweetpotatoes, cured[4] (*508*) | — | [illegible] | 14 | 20-24 | — | — |
| Tomatoes, mature-green (*817*) | — | 5-8 | 12-18 | 16-28 | 28-41 | 35-51 |
| Tomatoes, ripening (*817, 1058*) | — | — | 13-16 | 24-29 | 24-44 | 30-52 |
| Turnips, topped (*817, 857*) | 6-9 | 10 | 13-19 | 21-24 | 24-25 | — |
| Watercress (*417, 857*) | 15-26 | 44-49 | 91-121 | 136-205 | 302-348 | 348-438 |

[1] Respiration rate often shown as a range To compute heat evolution rates at harvest time, use either the highest figure or median one To convert to Btu/ton (2,000 lb)/24-h day, multiply respiration rate by 220 To convert to kcal per 1,000 kg/24 h, multiply by 61 2. Some data included for low temperatures which cause injury to certain commodities or cultivars, such as avocados, mango, okra, papaya, peppers, pineapple, tomatoes and Zucchini squash, these low temperatures are potentially dangerous and should be avoided (see text)

[2] At 13° C (55° F) green bananas 14-20 mg $CO_2$/kg•h

[3] Respiration rate at 18° C (65° F)

[4] Sources of unpublished data as follows: R E Hardenburg, formerly USDA, Beltsville, MD, data on blueberries and limes; R C Wright and T M Whiteman, formerly USDA, Beltsville, on cranberries and sweetpotatoes, L.L. Morris, Univ Calif, Davis, n potatoes and Butternut squash

**Tabla 2 . Temperatura y humedad relativa recomendadas, y vida de transito y almacenamiento aproximada para frutas y verduras**

| Producto | Temperatura °C | Temperatura °F | Humedad Relativa (por ciento) | Vida aproximada de almacenamiento |
|---|---|---|---|---|
| amaranto (*Amaranth*) | 0-2 | 32-36 | 95-100 | 10-14 dias |
| nise (*Anis*) | 0-2 | 32-36 | 90-95 | 2-3 semanas |
| pples (*Manzanas*) | -1-4 | 30-40 | 90-95 | 1-12 meses |
| pricots (*Albancoques*) | -0.5-0 | 31-32 | 90-95 | 1-3 semanas |
| rtichokes, globe (*Alacachofa, globo*) | 0 | 32 | 95-100 | 2-3 semanas |
| sian pear (*Pera asiatica*) | 1 | 34 | 90-95 | 5-6 meses |
| sparagus (*Esparrago*) | 0 2 | 32-36 | 95-100 | 2-3 semanas |
| temoya (*Atemoya*) | 13 | 55 | 85-90 | 4-6 semanas |
| vocados Fuerte, Hass (*Aguacate, Fuerte, Hass*) | 7 | 45 | 85-90 | 2 semanas |
| vocados, Lula Booth-1 (*Aguacate, Lula, Booth-1*) | 4 | 40 | 90-95 | 4-8 semanas |
| vocados Fuchs, Pollock (*Aguacate, Fuchs, Pollock*) | 13 | 55 | 85-90 | 2 semanas |
| ibaco (*Babaco*) | 7 | 45 | 85-90 | 1-3 semanas |
| nanas, green (*Banano, verde*) | 13-14 | 56-58 | 90-95 | 1-4 semanas |
| rbados cherry (*Cereza de Barbados*) | 0 | 32 | 85-90 | 7-8 semanas |
| ean sprouts (*Retoños de frijol*) | 0 | 32 | 95-100 | 5-9 dias |
| ans, dry (*Frijol seco*) | 4-10 | 40-50 | 40-50 | 6-10 meses |
| ans, green or snap (*Ejotes*) | 4-7 | 40-45 | 95 | 7-10 dias |
| ans, lima, in pods (*Frijol, lima en vainas*) | 5-6 | 41-43 | 95 | 5 dias |
| ets bunched (*Remolacha, manojos*) | 0 | 32 | 98-100 | 10-14 dias |
| ets topped *Remolacha deshojada*) | 0 | 32 | 98-100 | 4-6 meses |
| gian endive (*Endivia belga*) | 2-3 | 36-38 | 95-98 | 2-4 semanas |
| er melon (*Melon amargo*) | 12-13 | 53-55 | 85-90 | 2-3 semanas |
| ck sapote (*Zapote negro*) | 13-15 | 55-60 | 85-90 | 2-3 semanas |
| ckbernes (*Mora*) | -0 5-0 | 31-32 | 90-95 | 2-3 dias |
| od orange (*Naranjas sanguina*) | 4-7 | 40-44 | 90-95 | 3-8 semanas |
| eberries (*Arandano*) | -0 5-0 | 31-32 | 90-95 | 2 semanas |
| choy (*Bok choy*) | 0 | 32 | 95-100 | 3 semanas |
| ato (*Boniato*) | 13-15 | 55-60 | 85-90 | 4-5 meses |
| adfruit (*Fruta del pan*) | 13-15 | 55-60 | 85-90 | 2-6 semanas |
| coli (*Brocoli*) | 0 | 32 | 95-100 | 10-14 dias |
| sels sprouts (*Col de bruselas*) | 0 | 32 | 95-100 | 3-5 semanas |
| bage, early (*Repollo tempranero*) | 0 | 32 | 98-100 | 3-6 semanas |
| bage, late (*Repollo tardio*) | 0 | 32 | 98-100 | 5-6 meses |
| tus leaves (*Hojas de cacto*) | 2-4 | 36-40 | 90-95 | 3 semanas |
| tus Pear (*Tuna*) | 2-4 | 36-40 | 90-95 | 3 semanas |
| nito (*Camito*) | 3 | 38 | 90 | 3 semanas |
| baza (*Calabaza*) | 10-13 | 50-55 | 50-70 | 2-3 meses |
| mondin (*Calamondin*) | 9-10 | 48-50 | 90 | 2 semanas |
| stel (*Canistel*) | 13-15 | 55-60 | 85-90 | 3 semanas |
| aloups [3/4-slip] (*Cantalupo [3/4 slip]*) | 2-5 | 36-41 | 95 | 15 dias |
| aloups [full-slip] (*Cantalup [slip entero]*) | 0-2 | 32-36 | 95 | 5-14 dias |
| mbola (*Carambola*) | 9-10 | 48-50 | 85-90 | 3-4 semanas |
| ts, bunched (*Zanahona, manojo*) | 0 | 32 | 95-100 | 2 semanas |
| ts, mature (*Zanahona, madura*) | 0 | 32 | 98-100 | 7-9 meses |
| ts, immature (*Zanahona, tierna*) | 0 | 32 | 98-100 | 4-6 semanas |
| ew apple (*Marañon*) | 0-2 | 32-36 | 85-90 | 5 semanas |
| flower (*Coliflor*) | 0 | 32 | 95-98 | 3-4 semanas |
| iac (*Celeriac*) | 0 | 32 | 97-99 | 6-8 meses |
| y (*Apio*) | 0 | 32 | 98-100 | 2-3 meses |
| l (*Acelga*) | 0 | 32 | 95-100 | 10-14 dias |
| xo squash (*Chayote*) | 7 | 45 | 85-90 | 4-6 semanas |

**Tabla 2. Temperatura y humedad relativa recomendadas, y vida de transito y almacenamiento aproximada para frutas y verduras.—Sigue**

| Producto | Temperatura °C | Temperatura °F | Humedad Relativa (por ciento) | Vida aproximada de almacenamiento |
|---|---|---|---|---|
| Cherimoya (*Chirimoya*) | 13 | 55 | 90-95 | 2-4 semanas |
| Cherries, sour (*Cerezas, amargas*) | 0 | 32 | 90-95 | 3-7 días |
| Cherries, sweet (*Cerezas, dulces*) | -1-0 5 | 30-31 | 90-95 | 2-3 semanas |
| Chinese broccoli (*Brocoli chino*) | 0 | 32 | 95-100 | 10-14 días |
| Chinese cabbage (*Repollo chino*) | 0 | 32 | 95-100 | 2-3 meses |
| Chinese long bean (*Ejote chino largo*) | 4-7 | 40-45 | 90-95 | 7-10 días |
| Clementine (*Clementina*) | 4 | 40 | 90-95 | 2-4 semanas |
| Coconuts (*Coco*) | 0-1 5 | 32-35 | 80-85 | 1-2 meses |
| Collards (*Col rizada*) | 0 | 32 | 95-100 | 10-14 días |
| Corn, sweet (*Maíz dulce*) | 0 | 32 | 95-98 | 5-8 días |
| Cranberries (*Arándano*) | 2-4 | 36-40 | 90-95 | 2 4 meses |
| Cucumbers (*Pepino*) | 10-13 | 50-55 | 95 | 10-14 días |
| Currants (*Pasa*) | -0 5-0 | 31-32 | 90-95 | 1-4 semanas |
| Custard apples (*Anona*) | 5-7 | 41-45 | 85-90 | 4 6 semanas |
| Daikon (*Daikon*) | 0-1 | 32-34 | 95-100 | 4 meses |
| Dates (*Dátiles*) | -18-0 | 0-32 | 75 | 6-12 meses |
| Dewberries (*Zarzamora*) | -0 5-0 | 31-32 | 90-95 | 2 3 días |
| Durian (*Durion*) | 4-6 | 39-42 | 85-90 | 6-8 semanas |
| Eggplants (*Berenjena*) | 12 | 54 | 90-95 | 1 semana |
| Elderberries (*Saúco*) | -0 5-0 | 31-32 | 90-95 | 1-2 semanas |
| Endive and escarole (*Endivia y escarola*) | 0 | 32 | 95-100 | 2-3 semanas |
| Feijoa (*Feijoa*) | 5-10 | 41-50 | 90 | 2 3 semanas |
| Figs, fresh (*Higos frescos*) | -0 5-0 | 31-32 | 85-90 | 7-10 días |
| Garlic (*Ajo*) | 0 | 32 | 65-70 | 6-7 meses |
| Ginger root (*Gangibre*) | 13 | 55 | 65 | 6 meses |
| Gooseberries (*Grosella espinosa*) | 0 5-0 | 31-32 | 90-95 | 3-4 semanas |
| Granadilla (*Granadilla*) | 10 | 50 | 85-90 | 3-4 semanas |
| Grapefruit Calif & Ariz (*Toronja, Calif y Ariz*) | 14-15 | 58-60 | 85-90 | 6-8 semanas |
| Grapefruit, Fla & Texas (*Toronja, Fla y Texas*) | 10-15 | 50-60 | 85-90 | 6-8 semanas |
| Grapes Vinifera (*Uva vinífera*) | -1 a -0 5 | 30-31 | 90-95 | 1-6 meses |
| Grapes American (*Uva, americana*) | -0 5-0 | 31-32 | 85 | 2 8 semanas |
| Greens leafy (*Verduras hojosas*) | 0 | 32 | 95-100 | 10-14 días |
| Guavas (*Guayaba*) | 5-10 | 41-50 | 90 | 2 3 semanas |
| Hancot vert (*Hancot vert*) | 4-7 | 40-45 | 95 | 7-10 días |
| Horseradish (*Rábano picante*) | -1-0 | 30-32 | 98-100 | 10-12 meses |
| Jaboticaba (*Jaboticaba*) | 13-15 | 55-60 | 90-95 | 2-3 días |
| Jackfruit (*Nanjea*) | 13 | 55 | 85-90 | 2-6 semanas |
| Jaffa orange (*Naranja de Jaffa*) | 8-10 | 46-50 | 85-90 | 8-12 semanas |
| Japanese eggplant (*Berenjena japonesa*) | 8-12 | 46-54 | 90-95 | 1 semana |
| Jerusalem Artichoke (*Tupinambu*) | -0 5-0 | 31-32 | 90-95 | 4-5 meses |
| Jicama (*Jícama*) | 13-18 | 55-65 | 65-70 | 1-2 meses |
| Kale (*Berza*) | 0 | 32 | 95-100 | 2-3 semanas |
| Kiwano (*Kiwano*) | 10-15 | 50-60 | 90 | 6 meses |
| Kiwifruit (*Kiwi*) | 0 | 32 | 90-95 | 3-5 meses |
| Kohlrabi (*Colinabo*) | 0 | 32 | 98-100 | 2-3 meses |
| Kumquats (*Kumquat*) | 4 | 40 | 90-95 | 2-4 semanas |
| Langsat (*Langsat*) | 11-14 | 52-58 | 85-90 | 2 semanas |
| Leeks (*Puerro*) | 0 | 32 | 95-100 | 2-3 meses |
| Lemons (*Limones*) | 10-13 | 50-55 | 85-90 | 1-6 meses |
| Lettuce (*Lechuga*) | 0 | 32 | 98-100 | 2-3 semanas |
| Limes (*Limoncillo*) | 9-10 | 48-50 | 85-90 | 6-8 semanas |



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**Tabla 2. Temperatura y humedad relativa recomendadas, y vida de transito y almacenamiento aproximada para frutas y verduras.—Sigue**

| Producto | Temperatura °C | Temperatura °F | Humedad Relativa (por ciento) | Vida aproximada de almacenamiento |
|---|---|---|---|---|
| Lo Bok *(Lo Bok)* | 0-1 5 | 32-35 | 95-100 | 2-4 meses |
| Loganberries *(Frambuesa)* | -0 5-0 | 31-32 | 90-95 | 2-3 dias |
| Longan *(Longan)* | 1 5 | 35 | 90-95 | 3-5 semanas |
| Loquats *(Loquat)* | 0 | 32 | 90 | 3 semanas |
| Lychees *(Litchi)* | 1 5 | 35 | 90-95 | 3-5 semanas |
| Malanga *(Malanga)* | 7 | 45 | 70-80 | 3 meses |
| Mamey *(Mamey)* | 13-15 | 55-60 | 90-95 | 2-6 semanas |
| Mangoes *(Mango)* | 13 | 55 | 85-90 | 2-3 semanas |
| Mangosteen *(Mangostan)* | 13 | 55 | 85-90 | 2-4 semanas |
| Melons *(Melones)* | | | | |
| Casaba | 10 | 50 | 90-95 | 3 semanas |
| Crenshaw | 7 | 45 | 90-95 | 2 semanas |
| Honeydew | 7 | 45 | 90-95 | 3 semanas |
| Persian *(Persia)* | 7 | 45 | 90-95 | 2 semanas |
| lushrooms *(Hongos)* | 0 | 32 | 95 | 3-4 dias |
| ectarines *(Melocotón)* | -0 5-0 | 31-32 | 90-95 | 2-4 semanas |
| kra *(Okra [Quimbombo])* | 7-10 | 45-50 | 90-95 | 7-10 dias |
| ives, fresh *(Aceitunas, frescas)* | 5-10 | 41-50 | 85-90 | 4-6 semanas |
| nions, green *(Cebollas, verdes)* | 0 | 32 | 95-100 | 3-4 semanas |
| nions, dry *(Cebollas, secas)* | 0 | 32 | 65-70 | 1-8 meses |
| nion sets *(Cebolla, plantula)* | 0 | 32 | 65-70 | 6-8 meses |
| anges Calif & Ariz *(Naranjas Calif y Ariz )* | 3-9 | 38-48 | 85-90 | 3-8 semanas |
| anges, Fla & Texas *(Naranjas Fla y Texas)* | 0-1 | 32-34 | 85-90 | 8-12 semanas |
| papaya *(Papaya)* | 7-13 | 45-55 | 85-90 | 1-3 semanas |
| ssionfruit *(Maracuya)* | 7-10 | 45-50 | 85-90 | 3-5 semanas |
| rsley *(Perejil)* | 0 | 32 | 95-100 | 2-2 5 meses |
| rsnips *(Pestinaca)* | 0 | 32 | 95-100 | 4-6 meses |
| aches *(Duraznos)* | -0 5-0 | 31-32 | 90-95 | 2-4 semanas |
| ars *(Peras)* | -1 5 a -0 5 | 29-31 | 90-95 | 2-7 meses |
| as, green *(Arvejas)* | 0 | 32 | 95-98 | 1-2 semanas |
| as, southern *(Arvejas del sur)* | 4-5 | 40-41 | 95 | 6-8 dias |
| ino *(Pepino [tree melon])* | 4 | 40 | 85-90 | 1 mes |
| pers, Chili [dry] *(Chiles picantes [seco])* | 0-10 | 32-50 | 60-70 | 6 meses |
| pers, sweet *(Pimiento)* | 7-13 | 45-55 | 90-95 | 2-3 semanas |
| ummons, Japanese *(Caqui)* | 1 | 30 | 90 | 3-4 meses |
| apples *(Pina)* | 7-13 | 45-55 | 85-90 | 2-4 semanas |
| tain *(Plátano)* | 13-14 | 56-58 | 90-95 | 1-5 semanas |
| s and prunes *(Ciruelas y ciruela pasa)* | -0 5-0 | 31-32 | 90-95 | 2-5 semanas |
| egranates *(Granada)* | 5 | 41 | 90-95 | 2-3 meses |
| toes, early crop *(Papas, tempraneras)* | 10-16 | 50-60 | 90-95 | 10-14 dias |
| toes, late crop *(Papas, tardias)* | 4 5-13 | 40-55 | 90-95 | 5-10 meses |
| melo *(Pomelo)* | 7-9 | 45-48 | 85-90 | 12 semanas |
| kins *(Calabazas)* | 10-13 | 50-55 | 50-70 | 2-3 meses |
| es *(Membrillo)* | -0 5-0 | 31-32 | 90 | 2-3 meses |
| ichio *(Raddichio)* | 0-1 | 32-34 | 95-100 | 2 3 semanas |
| hes, spring *(Rábano de primavera)* | 0 | 32 | 95-100 | 3-4 semanas |
| hes, winter *(Rábano de invierno)* | 0 | 32 | 95-100 | 2-4 meses |
| utan *(Rambutan)* | 12 | 54 | 90-95 | 1-3 semanas |
| berries *(Frambuesa)* | -0 5-0 | 31-32 | 90-95 | 2-3 dias |
| arb *(Ruibarbo)* | 0 | 32 | 95-100 | 2-4 semanas |
| agas *(Rutabaga)* | 0 | 32 | 98-100 | 4-6 meses |

**Tabla 2 . Temperatura y humedad relativa recomendadas, y vida de transito y almacenamiento aproximada para frutas y verduras.—Sique**

| Producto | Temperatura °C | Temperatura °F | Humedad Relativa (por ciento) | Vida aproximada de almacenamiento |
|---|---|---|---|---|
| Salsify *(Salsifi)* | 0 | 32 | 95-98 | 2-4 meses |
| Santol *(Santol)* | 7-9 | 45-48 | 85-90 | 3 semanas |
| Sapodilla *(Chico Zapote)* | 16-20 | 60-68 | 85-90 | 2-3 semanas |
| Scorzonera *(Salsidi negro)* | 0-1 | 32-34 | 95-98 | 6 meses |
| Seedless cucumbers *(Pepinos sin semilla)* | 10-13 | 50-55 | 85-90 | 10-14 dias |
| Snow peas *(Arveja china)* | 0-1 | 32-34 | 90-95 | 1-2 semanas |
| Soursop *(Guanabana)* | 13 | 55 | 85-90 | 1-2 semanas |
| Spinach *(Espinaca)* | 0 | 32 | 95-100 | 10-14 dias |
| Squashes, summer *(Calabacita de veranos)* | 5-10 | 41-50 | 95 | 1-2 semanas |
| Squashes winter *(Calabacita de invierno)* | 10-13 | 50-55 | 50-70 | 2 3 meses |
| Strawbernes *(Fresa)* | 0 | 32 | 90-95 | 5-7 dias |
| Sugar apples *(Anona)* | 7 | 45 | 85-90 | 4 semanas |
| Sweetpotatoes *(Camote)* | 13-15 | 55-60 | 85-90 | 4-7 meses |
| Tamanilos *(Tamanio)* | 3-4 | 37-40 | 85-95 | 10 semanas |
| Tamarinds *(Tamarindo)* | 7 | 45 | 90-95 | 3-4 semanas |
| Tangennes mandanns and related citrus fruits *(Tangernas mandannas y frutas citricas afines)* | 4 | 40 | 90-95 | 2-4 semanas |
| Taro root *(Taro)* | 7-10 | 45-50 | 85-90 | 4-5 meses |
| Tomatillos *(Tomatillo)* | 13-15 | 55-60 | 85-90 | 3 semanas |
| Tomatoes mature-green *(Tomate sazon)* | 18-22 | 65-72 | 90-95 | 1-3 semanas |
| Tomatoes firm-ripe *(Tomate maduro firme)* | 13-15 | 55-60 | 90-95 | 4-7 dias |
| Turnips *(Nabo)* | 0 | 32 | 95 | 4-5 meses |
| Turnip greens *(Hojas de nabo)* | 0 | 32 | 95-100 | 10-14 dias |
| Ugli fruit *(Ugli)* | 4 | 40 | 90-95 | 2-3 semanas |
| Waterchestnuts *(Castaña de agua)* | 1-2 | 32-36 | 98-100 | 1-2 meses |
| Watercress *(Berro)* | 0 | 32 | 95-100 | 2-3 semanas |
| Watermelon *(Sandia)* | 10-15 | 50-60 | 90 | 2-3 semanas |
| White sapote *(Zapote blanco)* | 19-21 | 67-70 | 85-90 | 2-3 semanas |
| White asparagus *(Esparrago blanco)* | 0-2 | 32-36 | 95-100 | 2 3 semanas |
| Winged bean *(Ejote alado)* | 10 | 50 | 90 | 4 semanas |
| Yams *(Ñame)* | 16 | 61 | 70-80 | 6-7 meses |
| Yucca root *(Yuca)* | 0-5 | 32-41 | 85-90 | 1-2 meses |

Fuentes En gran parte de Hardenbug, Watada, y Wang (7), tambien de Bushard Houwing, y Jansen (3) Martin (11), Maxwell y Maxwell (12), (13), Ortho Books (15), Pantastico (17), Pipers Constant y Jansen (18), The Packer (16) Produce Marketing Association (20) Safeway Stores Inc (25) United Fresh Fruit and Vegetable Association (30) Tambien se obtuvo informacion de J R Brooks & Son Inc y de Frieda s Finest Produce Specialties Inc

**Tabla 3. Temperatura, humedad relativa y periodo aproximado de transito y almacenamiento recomendados para flores cortadas y follaje de floristeria.**

| Producto | Temperatura de almacenamiento °C | Temperatura de almacenamiento °F | Periodo aproximado de almacenamiento |
|---|---|---|---|
| Cut Flowers *(Flores cortadas)*[2] | | | |
| Acacia *(Acacia)* | 4 | 40 | 3-4 dias |
| Alstroemeria *(Alstroemeria)* | 4 | 40 | 2-3 dias |
| Allium *(Allium)* | 0-2 | 32-35 | 2 semanas |
| Anemone *(Anemone)* | 4-7 | 40-45 | 2 dias |
| Anthurium *(Anthrulum)*[4] | 13 | 56 | 2-4 semanas |
| Aster, China *(Aster, China)* | 0-4 | 32-40 | 1-3 semanas |
| Bird of Paradise *(Ave del paraiso)* | 7-8 | 45-46 | 1-3 semanas |
| Bouvardia *(Bouvardia)* | 0-2 | 32-35 | 1 semana |
| Buddleia *(Buddeia)* | 4 | 40 | 1-2 dias |
| Calendula *(Calendula)* | 4 | 40 | 3-6 dias |
| Calla *(Calla)* | 4 | 40 | 1 semana |
| Camellia *(Camelia)*[5] | 7 | 45 | 3-6 dias |
| Candytuft *(Carraspique)* | 4 | 40 | 3 dias |
| Carnation *(Clavel)*[4] | -0 5-0 | 31-32 | 3-4 semanas |
| Carnation buds *(Capullos de Clavel)* | -0 5-0 | 31-32 | 4-12 semanas |
| Carnation, miniature *(Clavel miniatura)* | -0 5-0 | 31-32 | 2 semanas |
| Chrysanthemum *(Crisantemo)* | -0 5-0 | 31-32 | 3-4 semanas |
| Clarkia | 4 | 40 | 3 dias |
| Colombine | 4 | 40 | 2 dias |
| Coreopsis | 4 | 40 | 3-4 dias |
| Cornflower *(Anciano)* | 4 | 40 | 3 dias |
| Cosmos | 4 | 40 | 3-4 dias |
| Crocus | 0 5-2 | 33-36 | 1-2 semanas |
| Dahlia *(Dalia)* | 4 | 40 | 3-5 dias |
| Daisy, English *(Marganta Inglesa)* | 4 | 40 | 3 dias |
| Daisy, Marguerite *(Marganta)* | 2 | 36 | 1-2 semanas |
| Daisy, Shasta | 4 | 40 | 7-8 dias |
| Delphinium *(Delfinio)* | 4 | 40 | 1-2 dias |
| Euchans *(Euchans)*[5] | 7-10 | 45-50 | 7-10 dias |
| Feverfew *(Matricana)* | 4 | 40 | 3 dias |
| Forget-me-not *(No me olvides)* | 4 | 40 | 1-2 dias |
| Foxglove *(dedalera)* | 4 | 40 | 1-2 dias |
| Freesia *(Freesia)*[6] | 0-0 5 | 32-33 | 10-14 dias |
| Gaillardia *(Gaillardia)* | 4 | 40 | 3 dias |
| Gardenia *(Gardenia)*[5] | 0-1 | 32-34 | 2 semanas |
| Gerbera *(Gerbera)* | 1-4 | 34-40 | 1-2 semanas |
| Ginger *(Gengibre)* | 13 | 55 | 4-7 dias |
| Gladiolus *(Gladiolus)* | 2-5 | 35-42 | 5-8 dias |
| Gloriosa *(Gloriosa)* | 4-7 | 40-45 | 4-7 dias |

Ver notas al final de la tabla

**Tabla 3. Temperatura, humedad relativa y periodo aproximado de transito y almacenamiento recomendados para flores cortadas y follaje de floristeria.—Sigue**

| Producto | Temperatura de almacenamiento °C | Temperatura de almacenamiento °F | Periodo aproximado de almacenamiento |
|---|---|---|---|
| Godetia *(Godetia)* | 10 | 50 | 1 semana |
| Gypsophila *(Gyposophila)* | 4 | 40 | 1-3 semanas |
| Heather *(Brezo)* | 4 | 40 | 1-3 semanas |
| Heliconia *(Heliconia)* | 12 | 54 | 10 dias |
| Hyacinth *(Jacinto)* | 0-0 5 | 32-33 | 2 semanas |
| Ins, bulbous *(Ins bulbosa)* | –0 5-0 | 31-32 | 1-2 semanas |
| Laceflower *(Encaje)* | 4 | 40 | 3 dias |
| Lilac forced *(Lila forzada)* | 4 | 40 | 4-6 dias |
| Lily *(Lino)* | 0-1 | 32-34 | 2-3 semanas |
| Lily-of-the-valley *(Lino del valle)* | –0 5-0 | 31-32 | 2-3 semanas |
| Lupine *(Lupine)* | 4 | 40 | 3 dias |
| Mangolds *(Maravilla)* | 4 | 40 | 1-2 semanas |
| Mignonette *(Reseda)* | 4 | 40 | 3-5 dias |
| Narcissus *(Narciso)* | 0-0 5 | 32-33 | 1-3 semanas |
| Orchid, cattelya *(Orquidea cattleya)*[4 5] | 7-10 | 45-50 | 2 semanas |
| Orchid, cymbidium *(Orquidea cymbidium)* | –0 5-4 | 31-40 | 2 semanas |
| Orchid, vanda *(Orquidea vanda)* | 13 | 55 | 5 dias |
| Ornithogalum | 4 | 40 | 4-6 semanas |
| Peony, tight buds *(Peonia capullo apretado)* | 0-1 | 32-34 | 2-6 semanas |
| Phlox *(Plox)* | 4 | 40 | 1-3 dias |
| Poinsettia | 10-15 | 50-60 | 4-7 dias |
| Poppy *(Amapola)* | 4 | 40 | 3-5 dias |
| Primrose *(Primavera)* | 4 | 40 | 1-2 dias |
| Protea | 4 | 40 | 7-10 dias |
| Ranunculus | 0-5 | 32-41 | 7-10 dias |
| Rose [in preservative] *(Rosa [en preservativo])* | 0 5-2 | 33-35 | 4-5 dias |
| Rose [dry pack] *(Rosa [empaque seco])* | –0 5-0 | 31-32 | 2 semanas |
| Snapdragon *(Dragon)* | 4 | 40 | 1-2 semanas |
| Snowdrop *(Copo de nieve)* | 4 | 40 | 2-4 dias |
| Squill *(Esquila)* | 0-0 5 | 32-33 | 2 semanas |
| Statice *(Statice)* | 2-4 | 35-40 | 3-4 semanas |
| Stephanotis[5] | 4 | 40 | 1 semana |
| Stevia | 4 | 40 | 3 dias |
| Stock *(Alheli)* | 4 | 40 | 3-5 dias |
| Strawflower, fresh *(Siempreviva, fresca)* | 2-4 | 35-40 | 3-4 semanas |
| Sweet pea *(Guisante de olor)* | –0 5-0 | 31-32 | 2 semanas |
| Sweet-william *(Clavel de olor)* | 7 | 45 | 3-4 dias |
| Tulip *(Tulipan)* | –0 5-0 | 31-32 | 2-3 semanas |
| Violet *(Violeta)* | 1-5 | 34-41 | 3-7 dias |
| Zinnia *(Cinia)* | 4 | 40 | 5-7 dias |

Ver notas al final de la tabla

**Tabla 3. Temperatura, humedad relativa y periodo aproximado de transito y almacenamiento recomendados para flores cortadas y follaje de floristeria.—Sigue**

| Producto | Temperatura de almacenamiento °C | Temperatura de almacenamiento °F | Periodo aproximado de almacenamiento |
|---|---|---|---|
| Florist greens (decorative foilage) *(Follaje decorativo)*[2,3] | | | |
| Adiantum [maidenhair] *(Adiantum [culantrillo])* | 0-4 | 32-40 | — |
| Asparagus [plumosa] *(Esparrago [plumosa])*[6] | 2-4 | 35-40 | 2-3 semanas |
| Asparagus [sprenger] *(Esparrago [sprenger])*[6] | 2-4 | 35-40 | 2-3 semanas |
| Buxus [boxwood] *(Buxus [bojl])* | 2-4 | 35-40 | — |
| Camellia *(Camelia)* | 4 | 40 | — |
| Cedar *(Cedro)*[6] | 0 | 32 | — |
| Chamaedorea *(Chamaedorea)* | 7 | 45 | 2-3 semanas |
| Cordyline [ti] *(Cordyline [ti])* | 7-10 | 45-50 | 2-3 semanas |
| Croton *(Croton)* | 2-4 | 35-40 | — |
| Dieffenbachia *(Dieffenbachia)* | 13 | 55 | — |
| Dracaena *(Dracaena)* | 2-4 | 35-40 | — |
| Dagger & wood ferns *(Helechos)*[6] | 0 | 32 | 2-3 meses |
| Eucalyptus *(Eucapilto)* | 2-4 | 35-40 | 1-3 semanas |
| Galax *(Galax)*[6] | 0 | 32 | — |
| Ground pine *(Pino)*[6] | 0 | 32 | — |
| Hedera *(Hedera)* | 2-4 | 35-40 | 2-3 semanas |
| Ilex [holly] *(Ilex [acebo])*[6] | 0-4 | 32-40 | 3-5 semanas |
| Juniper *(Juripero)* | 0 | 32 | 1-2 meses |
| Leatherleaf [baker fern] *(Helecho Hoja de Cuero)* | 1-4 | 34-40 | 1-2 meses |
| Leucothoe drooping *(Leucothoe)* | 2-4 | 35-40 | — |
| Magnolia *(Magnolia)* | 2-4 | 35-40 | 2-4 semanas |
| Mistletoe *(Muerdago)* | 0 | 32 | 3-4 semanas |
| Mountain-laurel *(Laurel de Montaña)* | 0 | 32 | 2-4 semanas |
| Myrtus [myrtle] *(Myrtus [mirto])* | 2-4 | 35-40 | — |
| Palm *(Palma)* | 7 | 45 | — |
| Philodendron *(Filodendro)* | 2-4 | 35-40 | — |
| Pittosporum *(Pittosporum)* | 2-4 | 35-40 | 2-3 semanas |
| Podocarpus *(Podocarpus)* | 7 | 45 | — |
| Pothos *(Pothos)* | 2-4 | 35-40 | — |
| Rhododendron *(Rododendro)* | 0 | 32 | 2-4 semanas |
| Salal [lemon leaf] *(Salal [hoja de limón])*[6] | 0 | 32 | 2-3 semanas |
| Scotch-broom *(Hinnesta)* | 4 | 40 | 2-3 semanas |
| Smilax, southern *(Smilax del sur)*[6] | 4 | 40 | — |
| Staghorn fern *(Helecho cuerno de venado)* | 13 | 55 | — |
| Vaccinium [huckleberry] *(Vaccinium [arandano])*[6] | 0 | 32 | 1-4 semanas |
| Woodwardia fern *(Helecho [woodwardia])* | 0-4 | 32-40 | — |

[1] Los periodos de almacenamiento deberan permitir el manejo y mantenimiento satisfactorio despues de sacar los productos de almacenamiento

[2] Alta humedad relativa de 90 - 95 % recomendada en cuartos de almacenamiento refrigerado para flores cortadas y follaje de floristeria. Es probable que algunas flores para las cuales se recomienda una temperatura de 4°C podrian almacenarse por mas tiempo con toda seguridad a temperaturas inferiores

[3] Al nivel de detallista follajes de floristeria mantenidos a aproximadamente 4°C por unicamente 1 o 2 semanas. La mayoria almacenados con tallos en a excepto donde se indica lo contrario

[4] Los tallos de las orquideas y algunos antiuos deberian ser colocados en frascos de agua. Sin embargo algunas orquideas y antiuos podran ser almacenados siguiendo metodos de empaque en seco

[5] No se colocan en agua para su manejo o almacenamiento pero podran ser rociados

[6] Generalmente se mantienen en cajas para embarque que retienen la humedad

Fuente: Hardenburg, Watada y Wang (7)

**Table 4.**
**Recommended temperature and relative humidity, approximate storage life, highest freezing point, water content, and specific heat of fresh fruits in commercial storage[1]**

| Commodity | Temperature °C | Temperature °F | Relative humidity (percent) | Approximate storage life | Highest freezing point[1] °C | Highest freezing point[1] °F | Water content (percent) | Specific heat[3] (Btu/lb · °F) |
|---|---|---|---|---|---|---|---|---|
| Apples | −1–4 | 30–40 | 90–95 | 1–12 months | −1.5 | 29.3 | 84.1 | 0.87 |
| Apricots | −0.5–0 | 31–32 | 90–95 | 1–3 weeks | −1.0 | 30.1 | 85.4 | .88 |
| Avocados | [4]4.4–13 | 40–55 | 85–90 | 2–8 weeks | −.3 | 31.5 | 76.0 | .81 |
| Bananas, green | 13–14 | 56–58 | 90–95 | ([5]) | −.7 | 30.6 | 75.7 | .81 |
| Berries | | | | | | | | |
| Blackberries | −0.5–0 | 31–32 | 90–95 | 2–3 days | −.7 | 30.5 | 84.8 | .88 |
| Blueberries | −0.5–0 | 31–32 | 90–95 | 2 weeks | −1.2 | 29.7 | 83.2 | .86 |
| Cranberries | 2–4 | 36–40 | 90–95 | 2–4 months | −.8 | 30.4 | 87.4 | .90 |
| Currants | −0.5–0 | 31–32 | 90–95 | 1–4 weeks | −1.0 | 30.2 | 84.7 | .88 |
| Dewberries | −0.5–0 | 31–32 | 90–95 | 2–3 days | −1.2 | 29.7 | 84.5 | .88 |
| Elderberries | −0.5–0 | 31–32 | 90–95 | 1–2 weeks | — | — | 79.8 | .84 |
| Gooseberries | −0.5–0 | 31–32 | 90–95 | 3–4 weeks | −1.0 | 30.0 | 88.9 | .91 |
| Loganberries | −0.5–0 | 31–32 | 90–95 | 2–3 days | −1.2 | 29.7 | 83.0 | .86 |
| Raspberries | −0.5–0 | 31–32 | 90–95 | 2–3 days | −1.0 | 30.0 | 82.5 | .86 |
| Strawberries | 0 | 32 | 90–95 | 5–7 days | −.7 | 30.6 | 89.9 | .92 |
| Carambola | 9–10 | 48–50 | 85–90 | 3–4 weeks | — | — | 90.4 | .92 |
| Cherries, sour | 0 | 32 | 90–95 | 3–7 days | −1.7 | 29.0 | 83.7 | .87 |
| Cherries, sweet | −1 to −0.5 | 30–31 | 90–95 | 2–3 weeks | −1.8 | 28.8 | 80.4 | .84 |
| Coconuts | 0–1.5 | 32–35 | 80–85 | 1–2 months | −.9 | 30.4 | 46.9 | .58 |
| Dates | [4]−18 or 0 | 0 or 32 | 75 | 6–12 months[4] | −15.7 | 3.7 | 22.5 | .38 |
| Figs, fresh | −0.5–0 | 31–32 | 85–90 | 7–10 days | −2.4 | 27.6 | 78.0 | .82 |
| Grapefruit, Calif. & Ariz. | 14–15.5 | 58–60 | 85–90 | 6–8 weeks | — | — | 87.5 | .90 |
| Grapefruit, Fla. & Texas | 10–15 | 50–60 | 85–90 | 6–8 weeks | −1.0 | 30.0 | 89.1 | .91 |
| Grapes, Vinifera | −1 to −0.5 | 30–31 | 90–95 | 1–6 months[4] | −2.1 | 28.1 | 81.6 | .85 |
| Grapes, American | −0.5–0 | 31–32 | 85 | 2–8 weeks | −1.2 | 29.7 | 81.9 | .86 |
| Guavas | 5–10 | 41–50 | 90 | 2–3 weeks | — | — | 83.0 | .86 |
| Kiwifruit | −0.5–0 | 31–32 | 90–95 | 3–5 months | −1.6 | 29.0 | 82.0 | .86 |
| Lemons | ([5]) | | 85–90 | 1–6 months[5] | −1.4 | 29.4 | 87.4 | .90 |
| Limes | 9–10 | 48–50 | 85–90 | 6–8 weeks | −1.6 | 29.1 | 89.3 | .91 |
| Loquats | 0 | 32 | 90 | 3 weeks | — | — | 86.5 | .89 |
| Lychees | 1.5 | 35 | 90–95 | 3–5 weeks | — | — | 81.9 | .86 |
| Mangos | [5]13 | 55 | 85–90 | 2–3 weeks | −.9 | 30.3 | 81.7 | .85 |
| Nectarines | −0.5–0 | 31–32 | 90–95 | 2–4 weeks | −.9 | 30.4 | 81.8 | .85 |
| Olives, fresh | [4]5–10 | 41–50 | 85–90 | 4–6 weeks[4] | −1.4 | 29.4 | 80.0 | .84 |
| Oranges, Calif. & Ariz. | 3–9 | 38–48 | 85–90 | 3–8 weeks | −1.2 | 29.7 | 85.5 | .88 |
| Oranges, Fla. & Texas | 0–1 | 32–34 | 85–90 | 8–12 weeks | −.7 | 30.6 | 86.4 | .89 |
| Papayas | 7 | 45 | 85–90 | 1–3 weeks | −.9 | 30.4 | 88.7 | .91 |
| Passion fruit | 7–10 | 45–50 | 85–90 | 3–5 weeks | — | — | 75.1 | .80 |
| Peaches | −0.5–0 | 31–32 | 90–95 | 2–4 weeks | −.9 | 30.3 | 89.1 | .91 |
| Pears | −1.5 to −0.5 | 29–31 | 90–95 | 2–7 months[4] | −1.5 | 29.2 | 83.2 | .87 |
| Persimmons, Japanese | −1 | 30 | 90 | 3–4 months | −2.1 | 28.1 | 78.2 | .83 |
| Pineapples | [5]7–13 | 45–55 | 85–90 | 2–4 weeks[4] | −1.1 | 30.0 | 85.3 | .88 |
| Plums and prunes | −0.5–0 | 31–32 | 90–95 | 2–5 weeks[4] | −.8 | 30.5 | 86.6 | .89 |
| Pomegranates | 5 | 41 | 90–95 | 2–3 months | −3.0 | 26.6 | 82.3 | .86 |
| Quinces[1] | −0.5–0 | 31–32 | 90 | 2–3 months | −2.0 | 28.4 | 83.8 | .87 |
| Tangerines, mandarins, & related citrus fruits | 4 | 40 | 90–95 | 2–4 weeks | −1.0 | 30.1 | 87.3 | .90 |

[1] Recommended storage temperatures, temperatures for ripening certain fruits given in text
[2] Data from Whiteman (*1030*)
[3] Specific heat calculated from Siebel's (*838*) formula. S = 0.008 × (percent water in food) + 0.20 in metric units of kJ/kg/°C, S = 0.0335 × (percent water in food) + 0.8374
[4] See text for maturity and cultivar differences
[5] See text

**Table 5.**
**Recommended temperature and relative humidity, approximate storage life, highest freezing point, water content, and specific heat for fresh vegetables in commercial storage**

| Commodity | Temperature °C | Temperature °F | Relative humidity (percent) | Approximate storage life | Highest freezing point[1] °C | Highest freezing point[1] °F | Water content (percent) | Specific heat[2] (Btu/lb · °F) |
|---|---|---|---|---|---|---|---|---|
| rtichokes, globe | 0 | 32 | 95-100 | 2-3 weeks | -1.1 | 29 9 | 83.7 | 0.87 |
| rtichokes, Jerusalem | -0 5-0 | 31-32 | 90-95 | 4-5 months | -2.2 | 28 0 | 79 8 | 84 |
| sparagus | 0-2 | 32-35 | 95-100 | 2-3 weeks | -6 | 30.9 | 93 0 | .94 |
| eans, dry | 4-10 | 40-50 | 40-50 | 6-10 months | — | — | 15 0 | .32 |
| eans, green or snap | [3]4-7 | 40-45 | 95 | 7-10 days | -7 | 30.7 | 88.9 | 91 |
| eans, lima | [3]3-5 | 37-41 | 95 | 5-7 days | -6 | 31.0 | 66 5 | .73 |
| ean sprouts | 0 | 32 | 95-100 | 7-9 days | — | — | 88 8 | 91 |
| eets, bunched | 0 | 32 | 98-100 | 10-14 days | -.4 | 31.3 | — | — |
| eets, topped | 0 | 32 | 98-100 | 4-6 months | -9 | 30 3 | 87 6 | 90 |
| roccoli | 0 | 32 | 95-100 | 10-14 days | -6 | 30.9 | 89 9 | 92 |
| russels sprouts | 0 | 32 | 95-100 | 3-5 weeks | -8 | 30.5 | 84 9 | 88 |
| abbage, early | 0 | 32 | 98-100 | 3-6 weeks | -9 | 30 4 | 92 4 | .94 |
| abbage, late | 0 | 32 | 98-100 | 5-6 months | -9 | 30 4 | 92 4 | 94 |
| abbage, Chinese | 0 | 32 | 95-100 | 2-3 months | — | — | 95 0 | 96 |
| arrots, bunched | 0 | 32 | 95-100 | 2 weeks | — | — | — | — |
| arrots, mature | 0 | 32 | 98-100 | 7-9 months | -1 4 | 29 5 | 88 2 | 91 |
| arrots, immature | 0 | 32 | 98-100 | 4-6 weeks | -1 4 | 29 5 | 88 2 | 91 |
| assava | 0-5 | 32-41 | 85-90 | 1-2 months | — | — | — | — |
| auliflower | 0 | 32 | 95-98 | 3-4 weeks | -8 | 30.6 | 91 7 | 93 |
| eleriac | 0 | 32 | 97-99 | 6-8 months | -9 | 30 3 | 88 4 | 91 |
| elery | 0 | 32 | 98-100 | 2-3 months | -5 | 31.1 | 93 7 | 95 |
| hard | 0 | 32 | 95-100 | 10-14 days | — | — | 91 1 | 93 |
| hicory, witloof | 0 | 32 | 95-100 | 2-4 weeks | — | — | 95 1 | .96 |
| ollards | 0 | 32 | 95-100 | 10-14 days | -8 | 30 6 | 86 9 | 90 |
| orn, sweet | 0 | 32 | 95-98 | 5-8 days | -6 | 30 9 | 73.9 | .79 |
| ucumbers | 10-13 | 50-55 | 95 | 10-14 days | -5 | 31 1 | 96 1 | 97 |
| ggplants | 8-12 | 46-54 | 90-95 | 1 week | -8 | 30 6 | 92.7 | 94 |
| ndive and escarole | 0 | 32 | 95-100 | 2-3 weeks | -1 | 31.9 | 93 1 | 95 |
| arlic | 0 | 32 | 65-70 | 6-7 months | -8 | 30 5 | 61 3 | 69 |
| inger | 13 | 55 | 65 | 6 months | — | — | 87 0 | .90 |
| reens, leafy | 0 | 32 | 95-100 | 10-14 days | — | — | — | — |
| orseradish | -1 0-0 | 30-32 | 98-100 | 10-12 months | -1 8 | 28 7 | 74.6 | .80 |

**Table 5.**
**Recommended temperature and relative humidity, approximate storage life, highest freezing point, water content, and specific heat for fresh vegetables in commercial storage—Continued**

| Commodity | Temperature °C | Temperature °F | Relative humidity (percent) | Approximate storage life | Highest freezing point[1] °C | Highest freezing point[1] °F | Water content (percent) | Specific heat[2] (Btu/lb °F) |
|---|---|---|---|---|---|---|---|---|
| Jicama | 13-18 | 55-65 | 65-70 | 1-2 months | — | — | — | — |
| Kale | 0 | 32 | 95-100 | 2-3 weeks | -.5 | 31.1 | 86.6 | .89 |
| Kohlrabi | 0 | 32 | 98-100 | 2-3 months | -1.0 | 30.2 | 90.3 | .92 |
| Leeks | 0 | 32 | 95-100 | 2-3 months | -.7 | 30.7 | 85.4 | .88 |
| Lettuce | 0 | 32 | 98-100 | 2-3 weeks | -.2 | 31.7 | 94.8 | .96 |
| Melons | | | | | | | | |
| Cantaloup (3/4-slip) | 2-5 | 36-41 | 95 | 15 days | -1.2 | 29.9 | 92.0 | .94 |
| Cantaloup (full-slip) | 0-2 | 32-36 | 95 | 5-14 days | -1.2 | 29.9 | 92.0 | .94 |
| Casaba | 10 | 50 | 90-95 | 3 weeks | -1.0 | 30.1 | 92.7 | .94 |
| Crenshaw | 7 | 45 | 90-95 | 2 weeks | -1.0 | 30.1 | 92.7 | .94 |
| Honey Dew | 7 | 45 | 90-95 | 3 weeks | -.9 | 30.3 | 92.6 | .94 |
| Persian | 7 | 45 | 90-95 | 2 weeks | -.8 | 30.5 | 92.7 | .94 |
| Watermelons | [3]10-15 | 50-60 | 90 | 2-3 weeks | -.4 | 31.3 | 92.6 | .94 |
| Mushrooms | 0 | 32 | 95 | 3-4 days | -.9 | 30.4 | 91.1 | .93 |
| Okra | 7-10 | 45-50 | 90-95 | 7-10 days | -1.8 | 28.7 | 89.8 | .92 |
| Onion, green | 0 | 32 | 95-100 | 3-4 weeks | -.9 | 30.4 | 89.4 | .91 |
| Onion, dry | 0 | 32 | 65-70 | 1-8 months[4] | -.8 | 30.6 | 87.5 | .90 |
| Onion sets | 0 | 32 | 65-70 | 6-8 months | -.8 | 30.6 | 87.5 | .90 |
| Parsley | 0 | 32 | 95-100 | 2-2.5 months | -1.1 | 30.0 | 85.1 | .88 |
| Parsnips | 0 | 32 | 98-100 | 4-6 months | -.9 | 30.4 | 78.6 | .83 |
| Peas, green | 0 | 32 | 95-98 | 1-2 weeks | -.6 | 30.9 | 74.3 | .79 |
| Peas, southern | 4-5 | 40-41 | 95 | 6-8 days | — | — | 66.8 | .73 |
| Peppers, chili (dry) | 0-10 | 32-50 | 60-70 | 6 months | — | — | 12.0 | .30 |
| Peppers, sweet | 7-13 | 45-55 | 90-95 | 2-3 weeks | -.7 | 30.7 | 92.4 | .94 |
| Potatoes, early crop | ([3]) | | 90-95 | ([3]) | -.6 | 30.9 | 81.2 | .85 |
| Potatoes, late crop | ([3]) | | 90-95 | 5-10 months | -.6 | 30.9 | 77.8 | .82 |
| Pumpkins | 10-13 | 50-55 | 50-70 | 2-3 months | -.8 | 30.5 | 90.5 | .92 |
| Radishes, spring | 0 | 32 | 95-100 | 3-4 weeks | -.7 | 30.7 | 94.5 | .96 |
| Radishes, winter | 0 | 32 | 95-100 | 2-4 months | — | — | — | — |
| Rhubarb | 0 | 32 | 95-100 | 2-4 weeks | -.9 | 30.3 | 94.9 | .96 |
| Rutabagas | 0 | 32 | 98-100 | 4-6 months | -1.1 | 30.0 | 89.1 | .91 |
| Salsify | 0 | 32 | 95-98 | 2-4 months | -1.1 | 30.0 | 79.1 | .83 |
| Spinach | 0 | 32 | 95-100 | 10-14 days | -.3 | 31.5 | 92.7 | .94 |
| Squashes, summer | 5-10 | 41-50 | 95 | 1-2 weeks | -.5 | 31.1 | 94.0 | .95 |
| Squashes, winter | 10 | 50 | [4]50-70 | ([3]) | -.8 | 30.5 | 85.1 | .88 |
| Sweetpotatoes | [3]13-16 | 55-60 | 85-90 | 4-7 months | -1.3 | 29.7 | 68.5 | .75 |
| Tamarillos | 3-4 | 37-40 | 85-95 | 10 weeks | — | — | — | — |
| Taro (Dasheen) | 7-10 | 45-50 | 85-90 | 4-5 months | — | — | 73.0 | .78 |
| Tomatoes, mature-green | [3]13-21 | 55-70 | 90-95 | 1-3 weeks | -.6 | 31.0 | 93.0 | .94 |
| Tomatoes, firm-ripe | [3]8-10 | 46-50 | 90-95 | 4-7 days | -.5 | 31.1 | 94.1 | .95 |
| Turnips | 0 | 32 | 95 | 4-5 months | -1.0 | 30.1 | 91.5 | .93 |
| Turnip greens | 0 | 32 | 95-100 | 10-14 days | -.2 | 31.7 | 90.3 | .92 |
| Waterchestnuts | 0-2 | 32-36 | 98-100 | 1-2 months | — | — | 78.3 | .83 |
| Watercress | 0 | 32 | 95-100 | 2-3 weeks | -.3 | 31.4 | 93.3 | .95 |
| Yams | 16 | 61 | 70-80 | 6-7 months | — | — | 73.5 | .79 |

[1] Data from Whiteman (*1030*)
[2] Specific heat calculated from Siebel's (*838*) formula S = 0.008 x (percent water in food) + 0.20 In metric units of kJ/kg/°C, S = 0.0335 x (percent water in food) + 0.8374
[3] See text
[4] See text for cultivar differences

TABLE 7.

## AIR FLOW RATES AND STATIC PRESSURE REQUIREMENTS TO FORCED-AIR COOL COMMON PRODUCE*

| Type of produce, method of air flow, and type of container | Air flow rate and static pressure needed for various cooling times | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hours needed to seven-eights cool downstream produce | | | | | | | |
| | 1.5 | 2 | 3 | 4 | 6 | 9 | 12 | 18 |
| | Air flow rate (cfm/lb produce) and static pressure (inches of water)‖ | | | | | | | |
| **Containers placed three deep and in register‖** | | | | | | | | |
| Artichokes in corrugated containers, 9 per cent side area vented | | | 1.5 (2.4) | 1.0 (1.2) | | | | |
| Grapes in lidded paper-wood laminated containers, no bottom cleat | | | 2.8 (>4) | 1.6 (2-3) | 0.7 (0.4-0.7) | 0.4 (0.20) | 0.25 (0.10) | |
| Grapes in lidded paper-wood laminated containers ½" bottom cleat | | | | 2.5 (0.7) | 1.3 (0.23) | 0.7 (0.10) | 0.5 (0.05) | |
| Grapes in full telescops, 17½" x 15" x 6" container, 5.8 per cent side area vented | 1.4 (3.0) | 1.0 (1.7) | 0.5 (0.7) | 0.4 (0.4) | 0.27 (0.16) | 0.17 (0.07) | | |
| Grapes in partial telescope 17½" x 14" x 6½" container, 3.5 per cent side area vented | 1.5 (>4) | 1.1 (2.6) | 0.7 (1.1) | 0.5 (0.5) | 0.3 (0.23) | 0.22 (0.09) | | |
| Canteloupes in corrugated containers 6 per cent side area vented | | 4 | 2.0 (2.0) | 1.2 (1.0) | 0.6 (0.4) | 0.3 (0.15) | 0.20 (0.06) | |
| Nectarines (or peaches) in corrugated containers with plastic trays 8 per cent side area vented | | | 0.5 (0.9) | 0.5 (0.4) | 0.20 (0.15) | 0.10 (0.04) | | |
| Peaches (or nectarines) in plastic trays in lidded wood lugs 20 per cent side-area vented | | 1.6 (2.3) | 1.0 (0.7) | 0.7 (0.3) | 0.4 (0.10) | 0.25 (0.03) | | |
| Pears in 12" x 18" x 9½" high corrugated containers (a) 2 per cent side area vented | | | 1.2 | 0.8 (4) | 0.5 (1.5) | 0.3 (0.5) | 0.20 (0.25) | |
| (b) 5 per cent side-area vented | | | 1.0 | 0.7 (1.5) | 0.4 (0.6) | 0.20 (0.20) | 0.15 (0.09) | |
| Plums in 11" x 17½" x 5" high corrugated containers, 4 per cent side-area vented | | 2.0 | 1.2 (2.9) | 0.8 (1.3) | 0.4 (0.3) | 0.25 (0.15) | 0.15 | |
| Strawberries in open crates on pallets | 2.0 (0.4) | 1.4 (0.20) | 0.8 (0.08) | 0.5 (0.04) | 0.3 (0.02) | 0.20 (0.02) | | |
| Tomatoes in corrugated containers 10 per cent side area vented | | 2.9 (2.3) | 1.6 (1.3) | 1.1 (0.8) | 0.6 (0.4) | 0.4 (0.20) | 0.25 (0.13) | |
| **Air flow is vertical through slotted bin bottoms** | | | | | | | | |
| Oranges | | | | | | | | |
| 2 ft depth | | | 1.0 (0.08) | 0.6 (0.04) | 0.4 (0.02) | 0.20 (0.02) | 0.15 (0.02) | |
| 3 ft depth | | | 1.0 (0.20) | 0.6 (0.10) | 0.4 (0.04) | 0.20 (0.02) | 0.15 (0.02) | |
| 4 ft depth | | | 0.9 | 0.6 (0.20) | 0.3 (0.07) | 0.20 (0.03) | 0.15 (0.02) | |
| **Bulk bins (47 inches square), air flows horizontally through slots in bin sides** | | | | | | | | |
| Plums, 3 per cent side area vented — Average fruit | | | | 0.7 (0.9) | 0.4 (0.25) | 0.20 (0.07) | 0.10 | |
| Plums, 3 per cent side area vented — Slowest cooling fruit | | | | | 1.0 (1.8) | 0.6 (0.7) | 0.4 (0.3) | 0.20 (0.12) |
| Plums, 5.5 per cent side-area vented — Average fruit | | | | 0.6 (0.4) | 0.3 (0.12) | 0.17 | | |
| Plums, 5.5 per cent side-area vented — Slowest cooling fruit | | | | | 0.8 (0.7) | 0.5 (0.25) | 0.3 (0.12) | 0.20 |

* Based on calculations of seven-eights cooling of produce. Figures compiled from laboratory and field data. References: Guilkey, 1967, Mitchell, et al., 1971, Parsons, et al., 1970, 1972, Parsons, 1972, Wang and Tunpun, 1968.

‖ Static pressure shown is for air path through three tiers stacked in register. For other stacking, multiply static pressure by: 1 tier, 0.05; 2 tiers, 0.3; 4 tiers, 2.3; 6 tiers, 7.0.

‖ Figures not in parentheses are flow rates needed to cool in time indicated. Figures in parentheses are pressures needed to force air through stack. Figures are approximate only.

Table 3. Refrigeration Capacity Needed for Continuous Precooling*

| Change in Product Temperature | | % of Total Refrigeration Used to Absorb Heat from the Product | | | | | |
|---|---|---|---|---|---|---|---|
| | | 50% | | 65% | | 80% | |
| °C | °F | Tons† | kW | Tons† | kW | Tons† | kW |
| 40 | 70 | 20.0 | 70.7 | 15.4 | 54.6 | 12.7 | 45.0 |
| 33 | 60 | 17.1 | 60.4 | 13.2 | 46.9 | 10.9 | 38.6 |
| 28 | 50 | 14.2 | 50.1 | 11.1 | 39.2 | 9.1 | 32.1 |
| 22 | 40 | 11.3 | 39.8 | 8.9 | 31.5 | 7.3 | 25.7 |
| 17 | 30 | 8.4 | 29.6 | 6.7 | 23.8 | 5.4 | 19.3 |
| 11 | 20 | 5.4 | 19.3 | 4.5 | 16.1 | 3.6 | 12.9 |

Source: After Guillou

*The fraction of the refrigeration needed to cool the product will depend on the amount of insulation and heat leakage into the system.

†Tons of kW of refrigeration per 1,000 kg of product per hour.

TABLE 6.—*Forced-air cooling: various static pressures, airflows, and cooling times required to cool one box of specific type of flowers*

| Type of flower | Static pressure | | | | | |
|---|---|---|---|---|---|---|
| | 0.5 inch | | 1.0 inch | | 2.0 inches | |
| | Airflow | 7/8-cooling time | Airflow | 7/8-cooling time | Airflow | 7/8-cooling time |
| | *Cfm/box* | *Minutes* | *Cfm/box* | *Minutes* | *Cfm/box* | *Minutes* |
| Carnations[1] | 70 | 48 | 90 | 40 | 110 | 35 |
| Chrysanthemums[2] | 80 | 62 | 130 | 58 | 210 | 54 |
| Gypsophila[3] | 170 | 10 | 260 | 8 | — | -- |
| Roses[4] | 140 | 34 | 200 | 25 | 290 | 20 |
| Statice[5] | 150 | 40 | 210 | 18 | 280 | 13 |

[1]Carnation box size 48 by 21 by 12 inches, with two, 2-inch diameter vent holes in each end and 51 lb gross weight.

[2]Chrysanthemum box size 57 by 21 by 12 inches with two, 2-inch diameter vent holes in each end and 33 lb gross weight; 45-lb box will allow 50 percent less air through box.

[3]Gypsophila box size 42 by 21 by 12 inches with two, 3-inch diameter vent holes in each end.

[4]Rose box size 48 by 21 by 12 with two, 2-inch diameter vent holes in each end with 20 bunches in box.

[5]Statice box size 42 by 21 by 12 inches with two, 3-inch diameter vent holes in each end and gross weight of 75 lb.

Table 10.

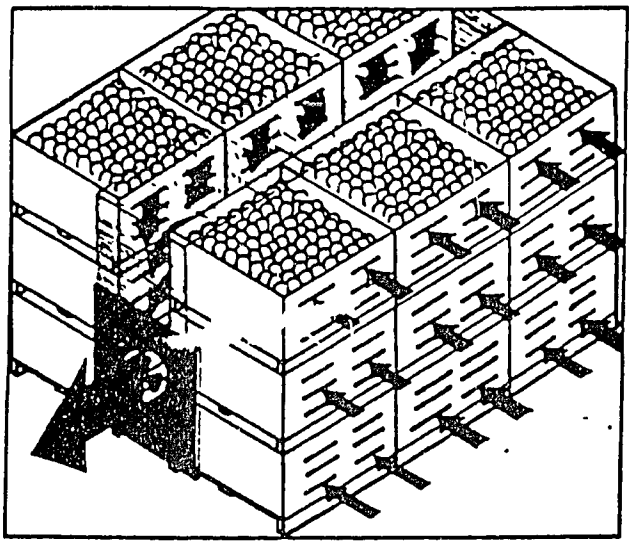
Volume of 5.25% sodium hypochlorite (NaOCl) solution required to obtain a specified concentration of available chlorine in 100 gal or 1000 liters of water (neutral pH).

| Pints/ 100 gal | Liters/ 1000 liters | Approximate available Cl concn. (ppm) |
|---|---|---|
| 0.8 | 1.0 | 50 |
| 1.2 | 1.5 | 75 |
| 1.6 | 2.0 | 100 |
| 2.0 | 2.5 | 125 |
| 2.4 | 3.0 | 150 |

Table 9.

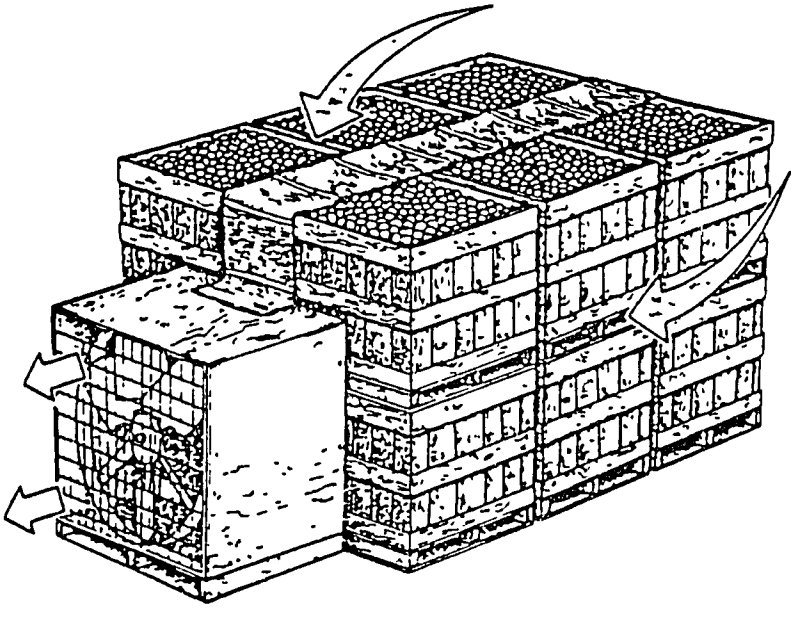
Weight of 65% calcium hypochlorite [$Ca(OCl)_2$] granules required to obtain a specified concentration of available chlorine in 100 gal or 1000 liters of water (neutral pH).

| Ounces/ 100 gal | Grams/ 1000 liters | Approximate available Cl concn. (ppm) |
|---|---|---|
| 1.0 | 75.0 | 50 |
| 1.5 | 112.5 | 75 |
| 2.0 | 150.0 | 100 |
| 2.5 | 187.5 | 125 |
| 3.0 | 225.0 | 150 |



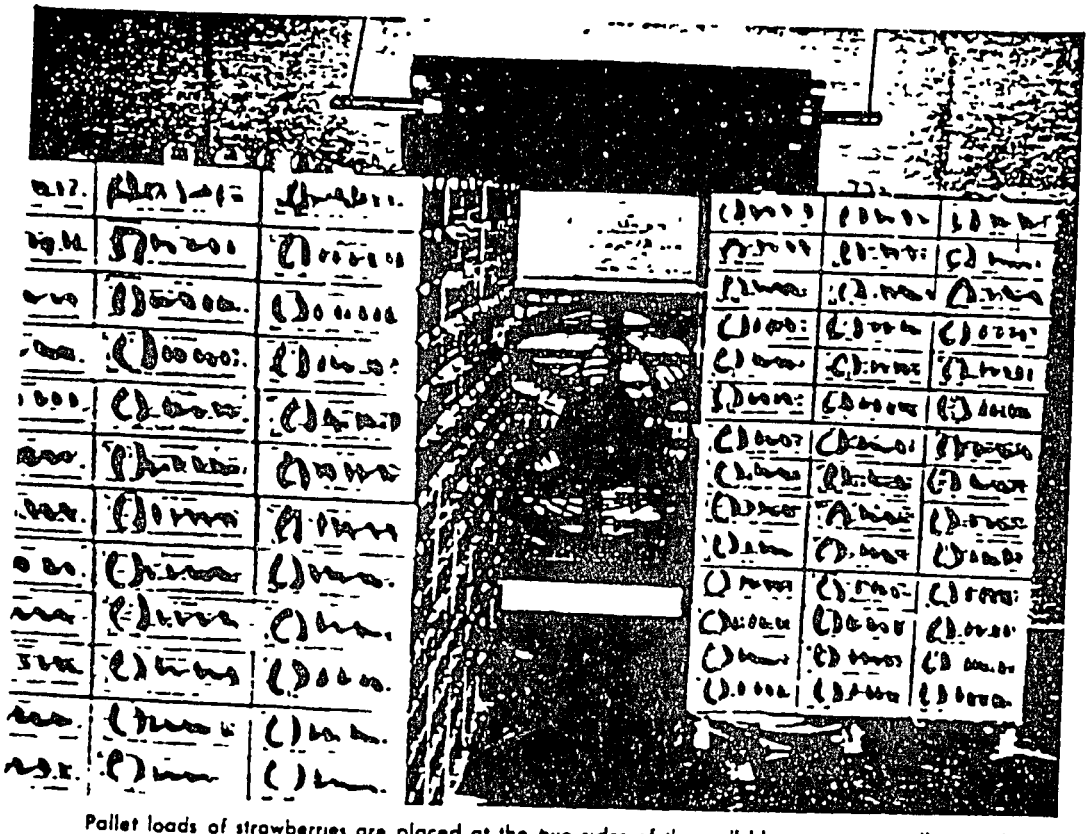
Diagrammatic view of a forced-air cooling tunnel. Either bins or palletized containers can be placed to form a tunnel from which air is exhausted. The negative pressure then causes cold air from the room to pass through ventilation slots to directly contact the warm product.

Figure 1 .



Shell arrangement with portable pallet-mounted fan.

Figure 2 .



Pallet loads of strawberries are placed at the two sides of the wall blower so as to allow a plenum (air-chamber or passageway) for air being drawn through produce to the blower.

Figure 3.

Forced-air cooling unit in operation with pallet loads of strawberries The fabric cover in front seals the air-return plenum, and air is thus forced to pass through side slots of containers and around the fruit in order to return to blower The blowers used in this procedure are controlled by time clocks

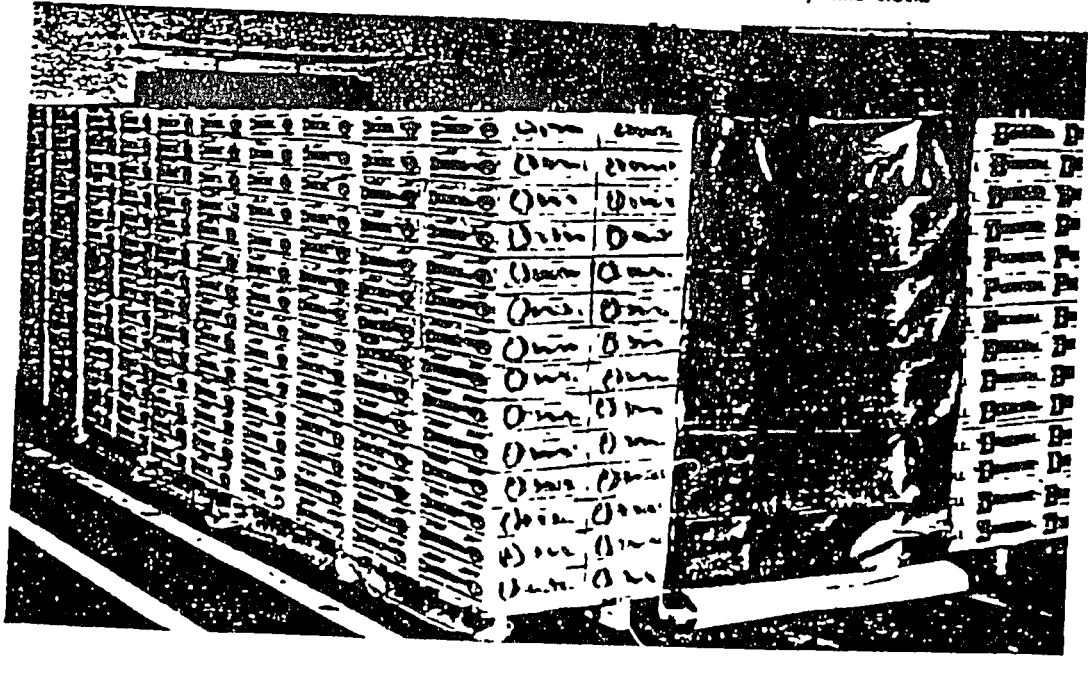


Figure 4.

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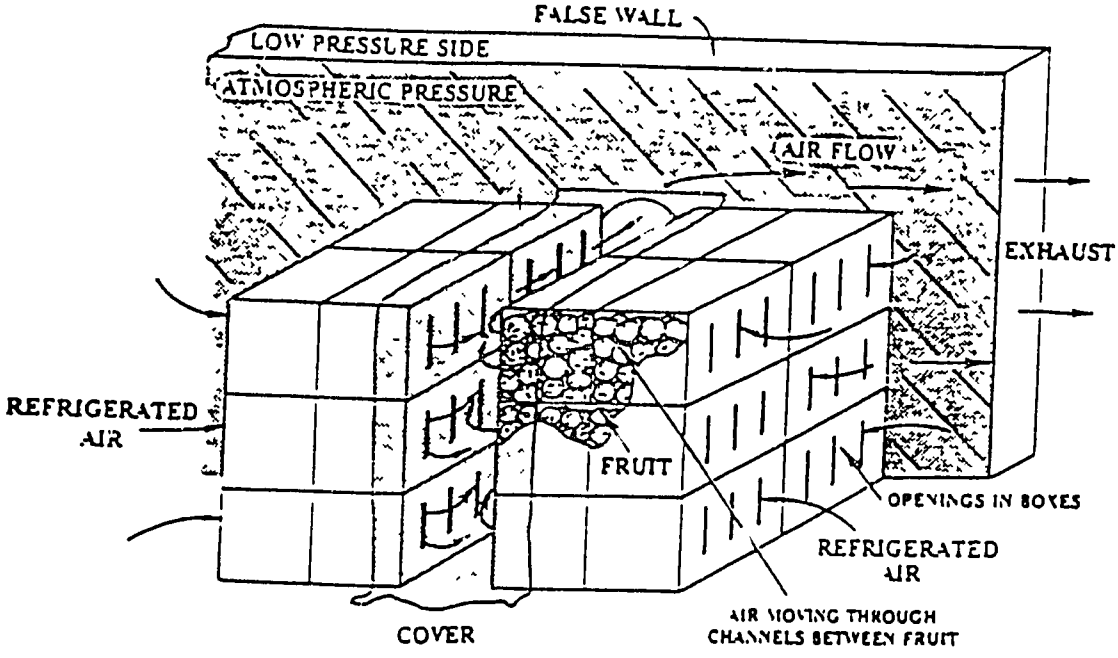


Figure 5.

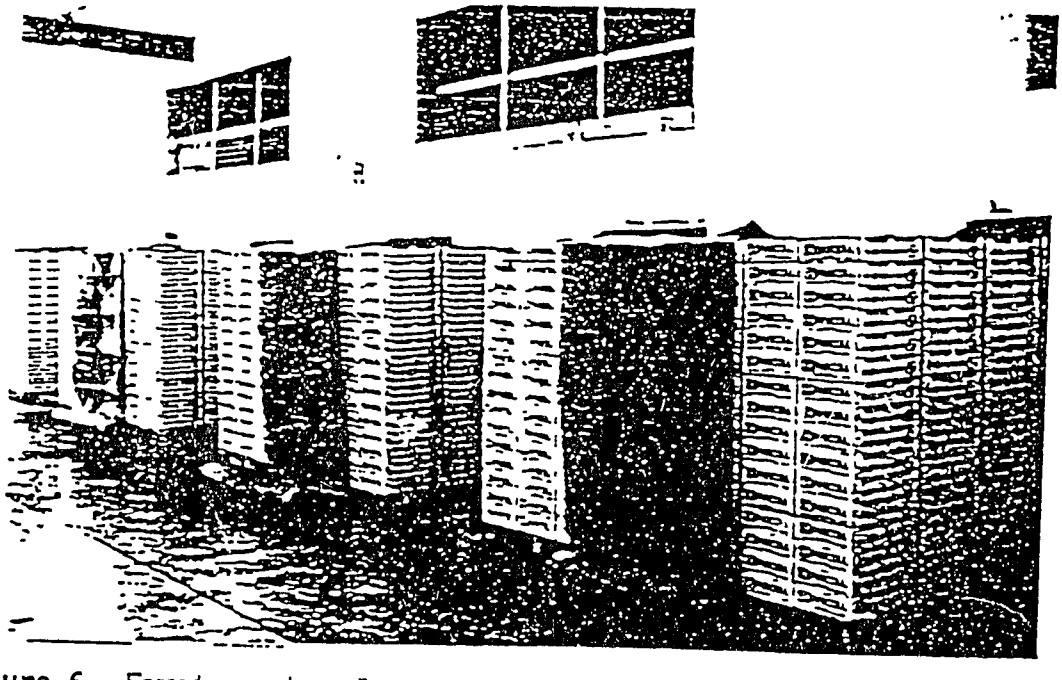

Figure 6. Forced-air cooling utilizes a pressure drop between the room and two rows of vented containers. The space between the containers is covered with a baffle made of a heavy but flexible material. The baffle seals the top and one end. An exhaust fan placed on the opposite end (in this case, mounted in the wall) pulls air from the space between the containers, creating a pressure drop. In response to the pressure differential, cold air moves through holes in the boxes, across the product, and into the interior chamber from which it is exhausted. This cools the product much faster than a more static airflow system (i.e., room cooling).

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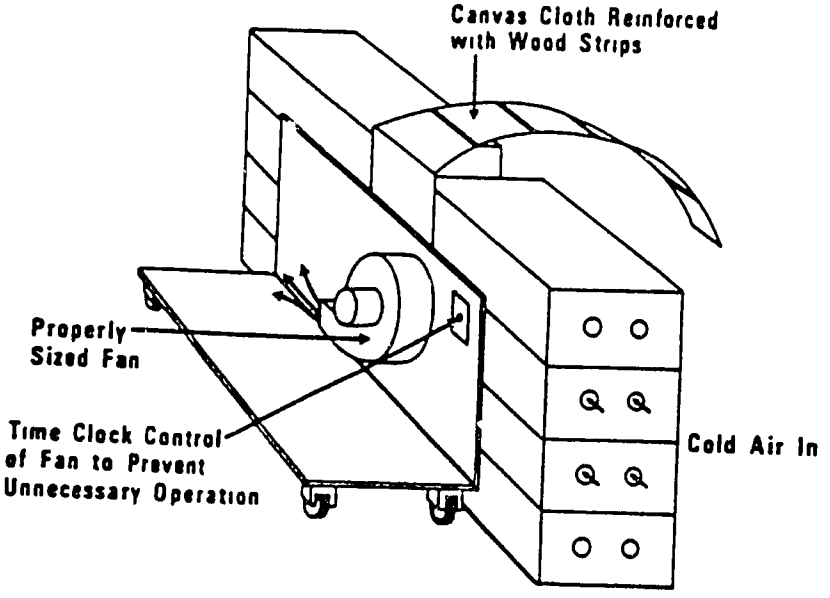



Figure 7 .--Portable forced-air cooler designed for 8 to 10 boxes of flowers.

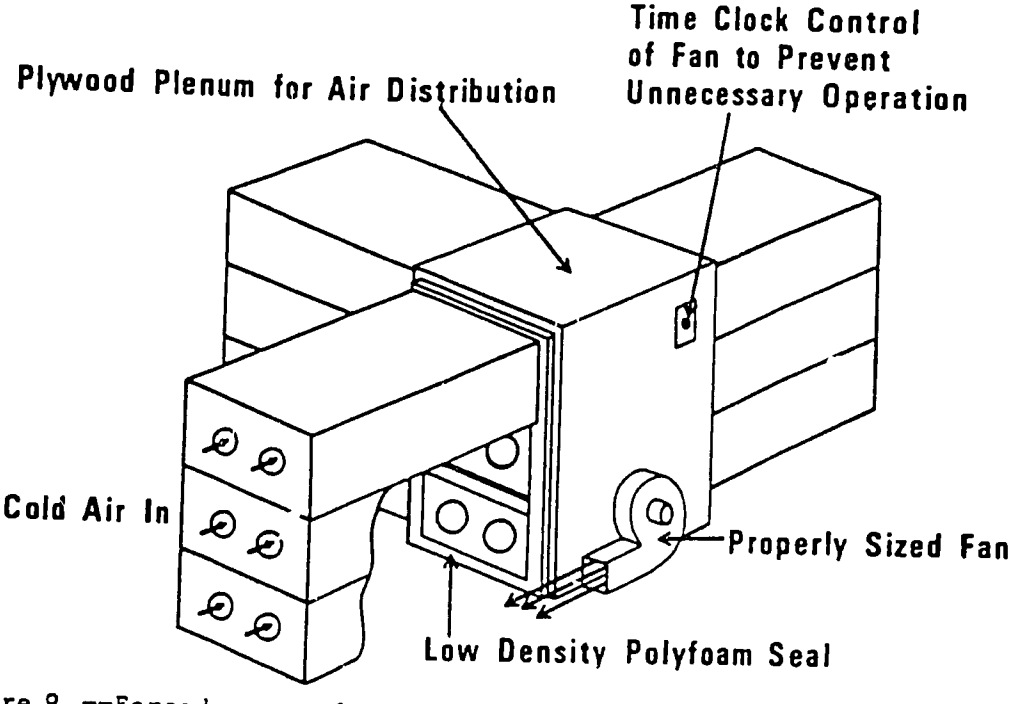



Figure 8.--Forced-air cooler designed for up to 25 boxes of flowers.

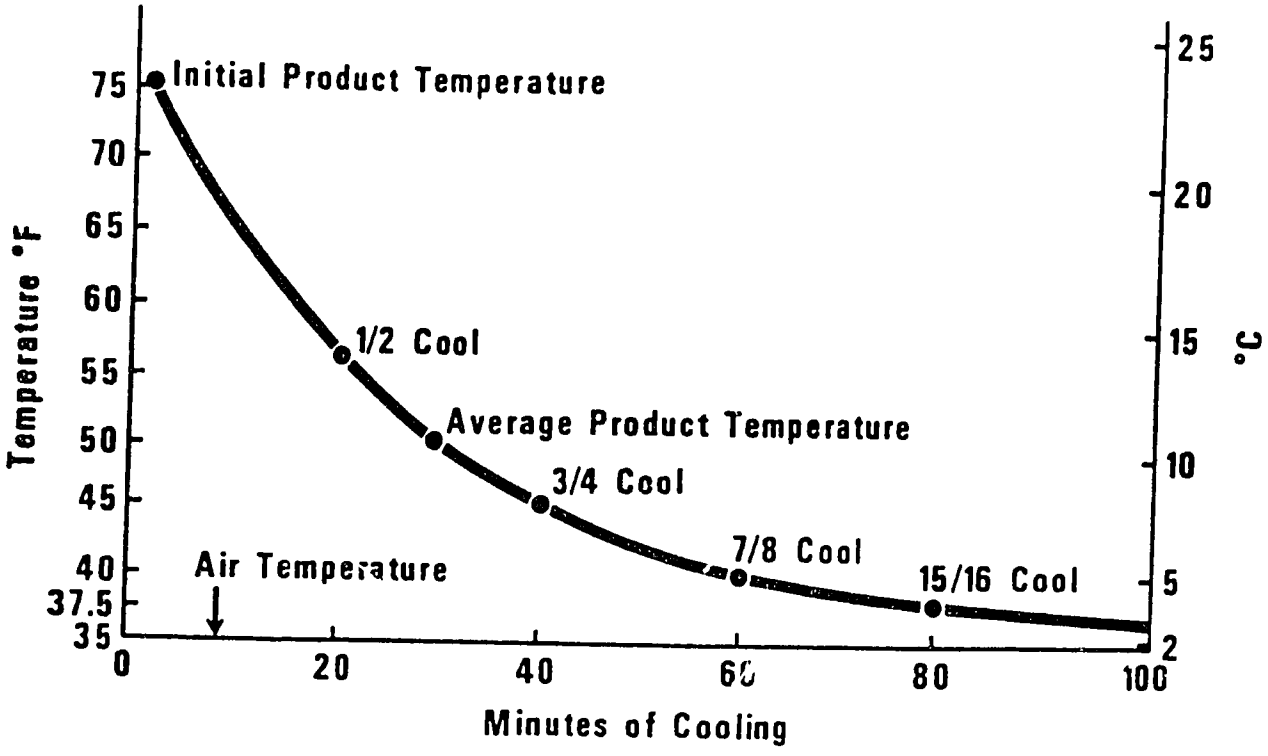



Figure 9. —Hypothetical cooling curve for fresh products.

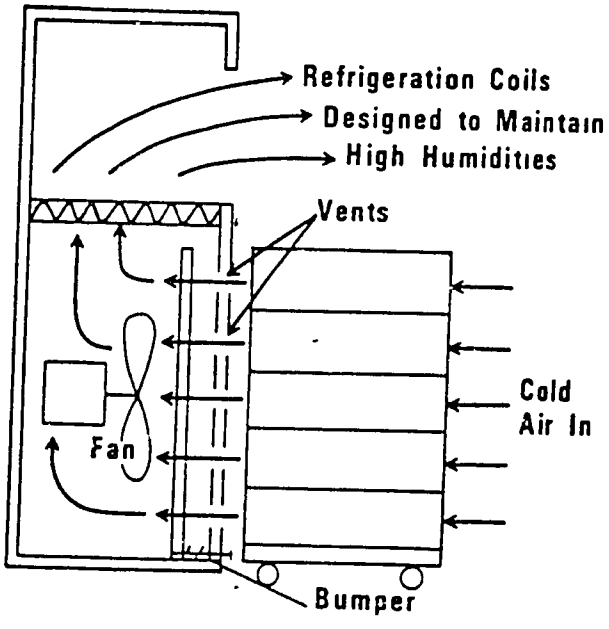



Figure 10.--Large-scale cooling facility or cold wall system.

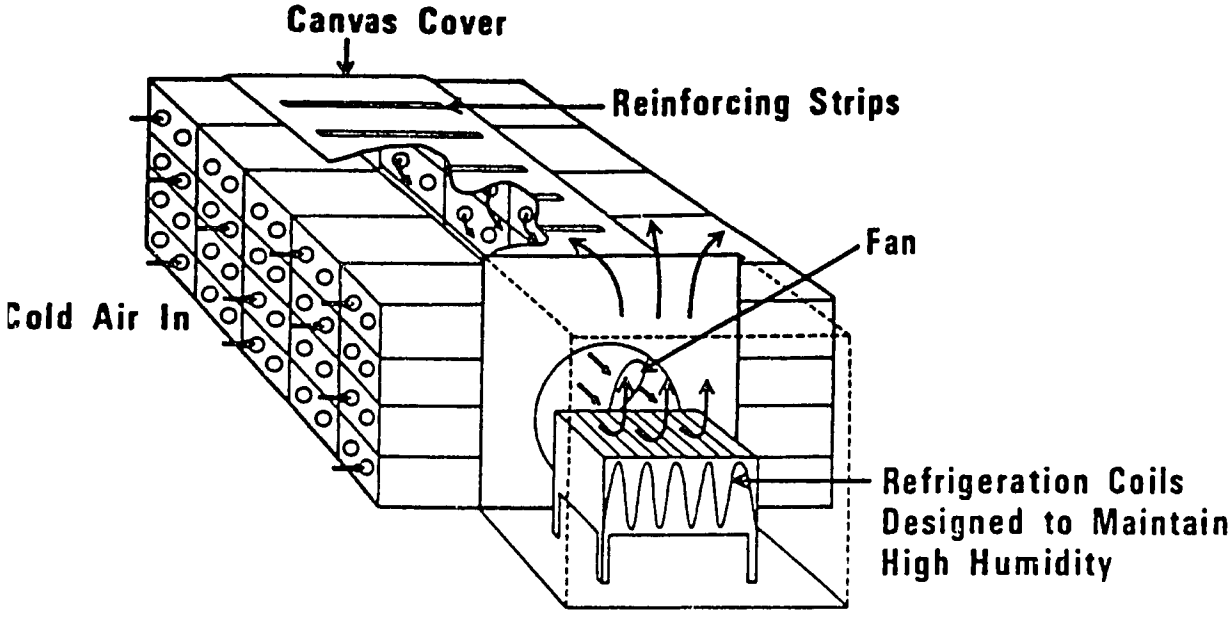



Figure11.—Large-scale cooling facility for cold room.

# Forced-Air Cooling Fan

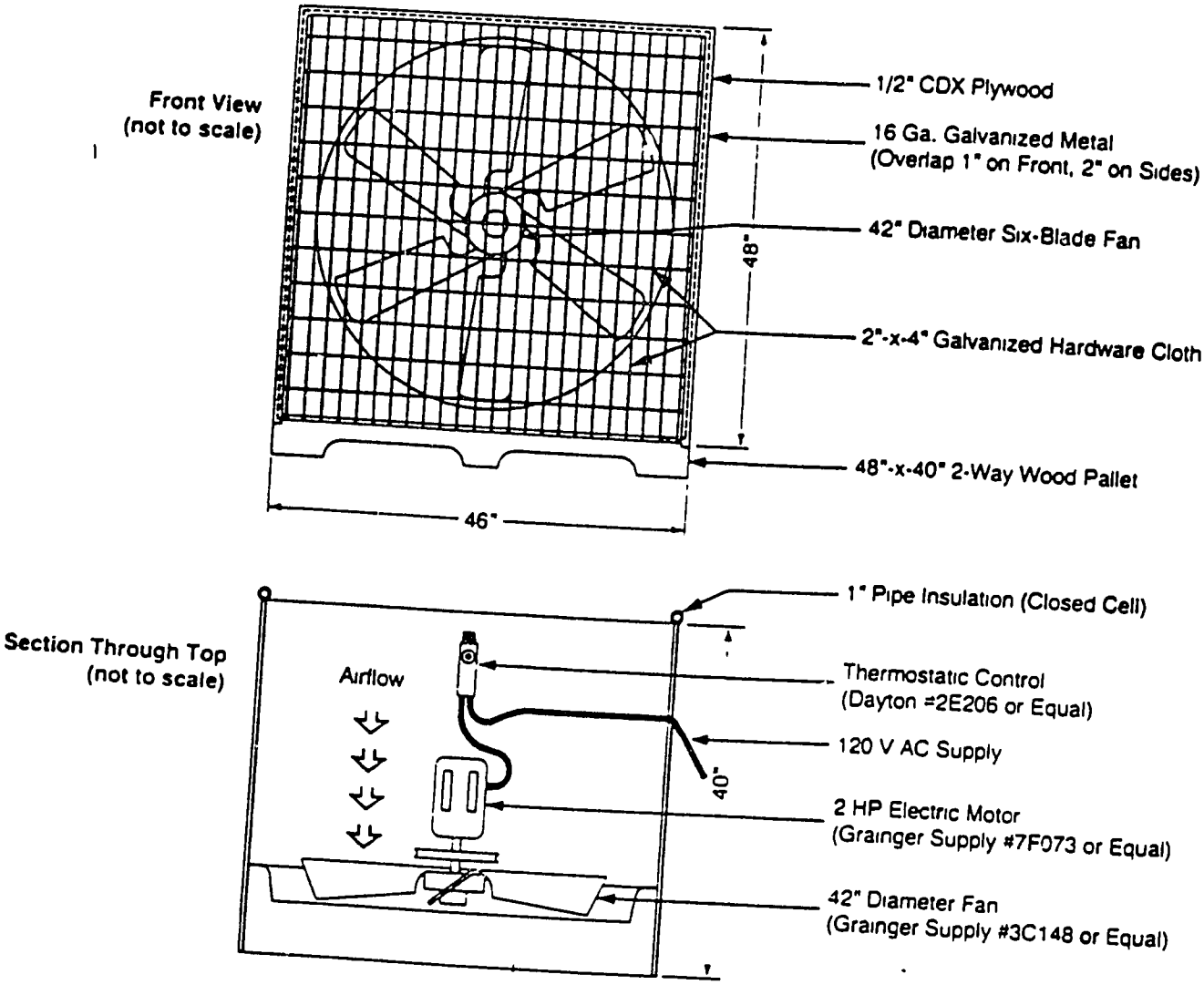
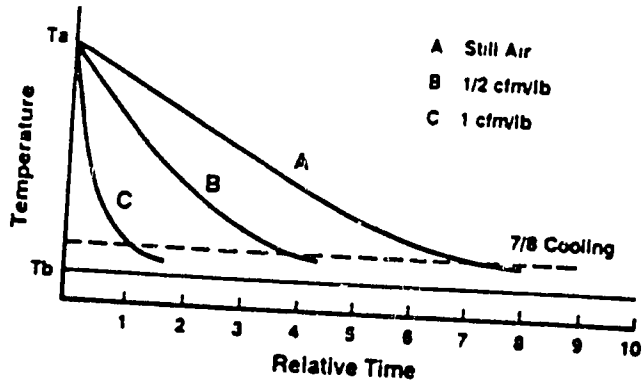
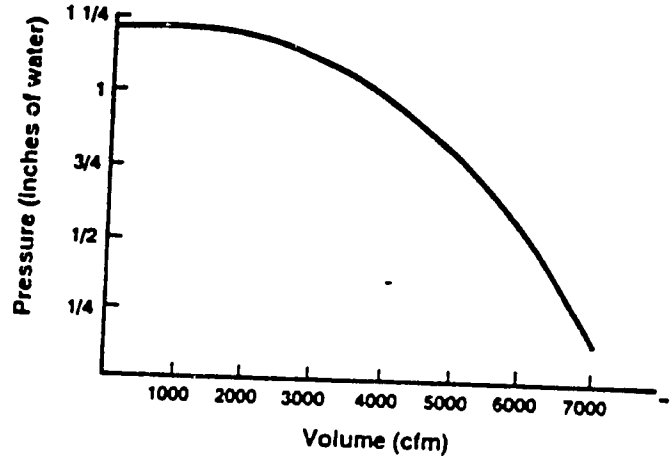



Figure 12.



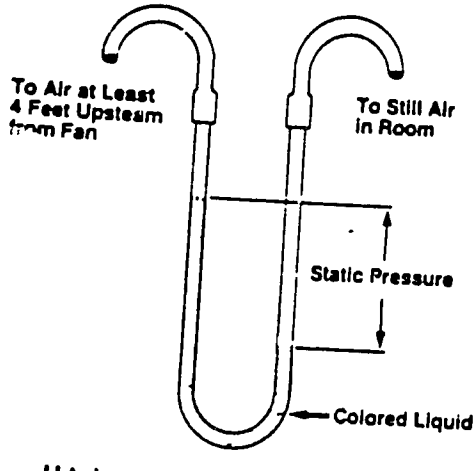

Cooling time for various airflow rates.

Figure 13.




Typical fan curve.

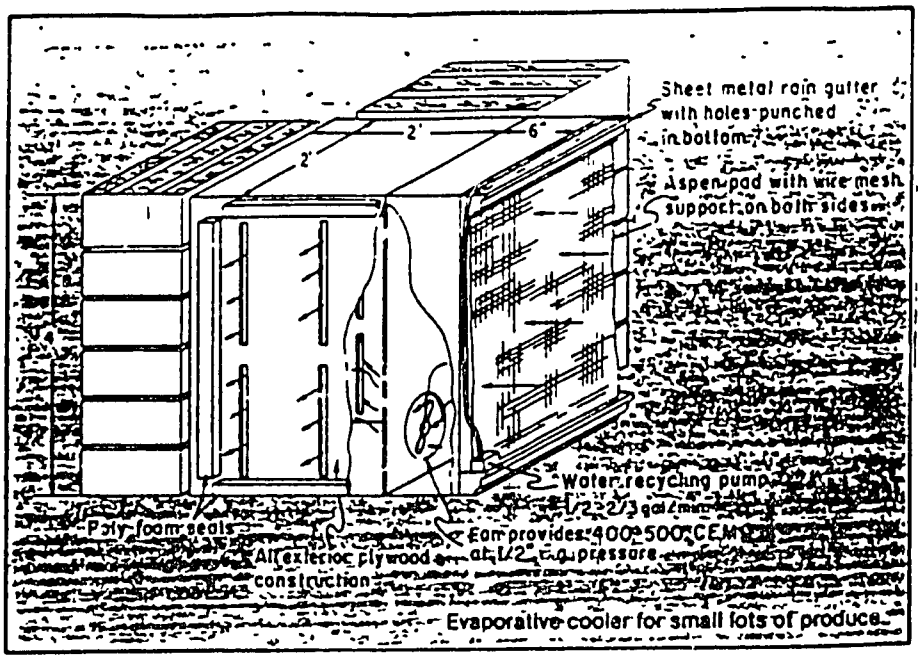
Figure 14.



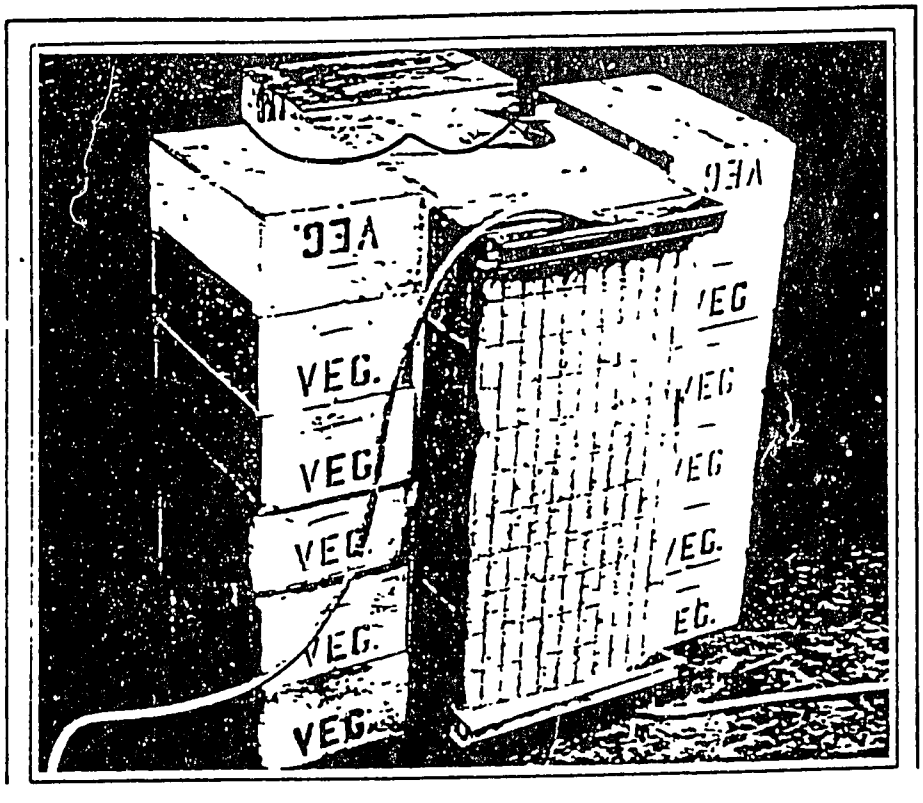

U-tube manometer.

Figure 15.

Figure 16a.




b.




c.

Summary of Evaporative Cooling Trials

| | Tomato | Sweet pepper | Zucchini squash Test #1 | Zucchini squash Test #2 | Crooked-neck squash |
|---|---|---|---|---|---|
| Weight cooled (lb) | 540 | 100 | 588 | 168 | 168 |
| Airflow (cfm) | 580 | 385 | 502 | 510 | 510 |
| Airflow/wt (cfm/lb) | 1 1 | 3 9 | 0 85 | 3 0 | 3 0 |
| ¾ cooling time (min) | 120 | 75 | 100* | 75 | 75 |
| Average initial pulp temp (°F) | 74 | 90 | 87 | 84 | 85 |
| Average pulp temp at ..¾ cool (°F) | 61 | 63 | — | 69 | 69 |
| Average dry bulb temp (°F) | 65 | 72 | 98 | 80 | 80 |
| Average wet bulb temp (°F) | 52 | 56 | 71 | 64 | 64 |
| Average temp of cooled air (°F) | 55 | 60 | 74 | 67 | 67 |

*Calculated from 1/2 cooling time data

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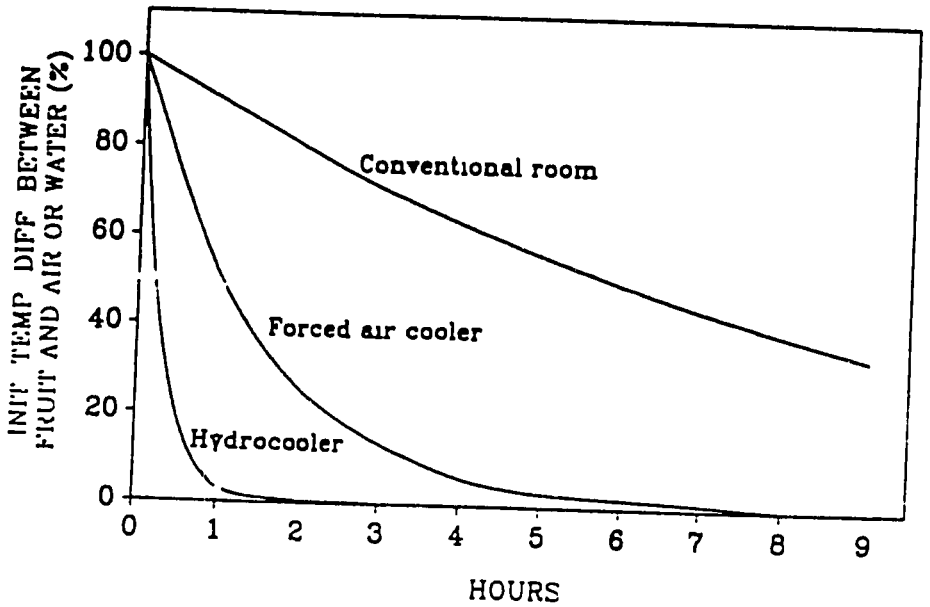
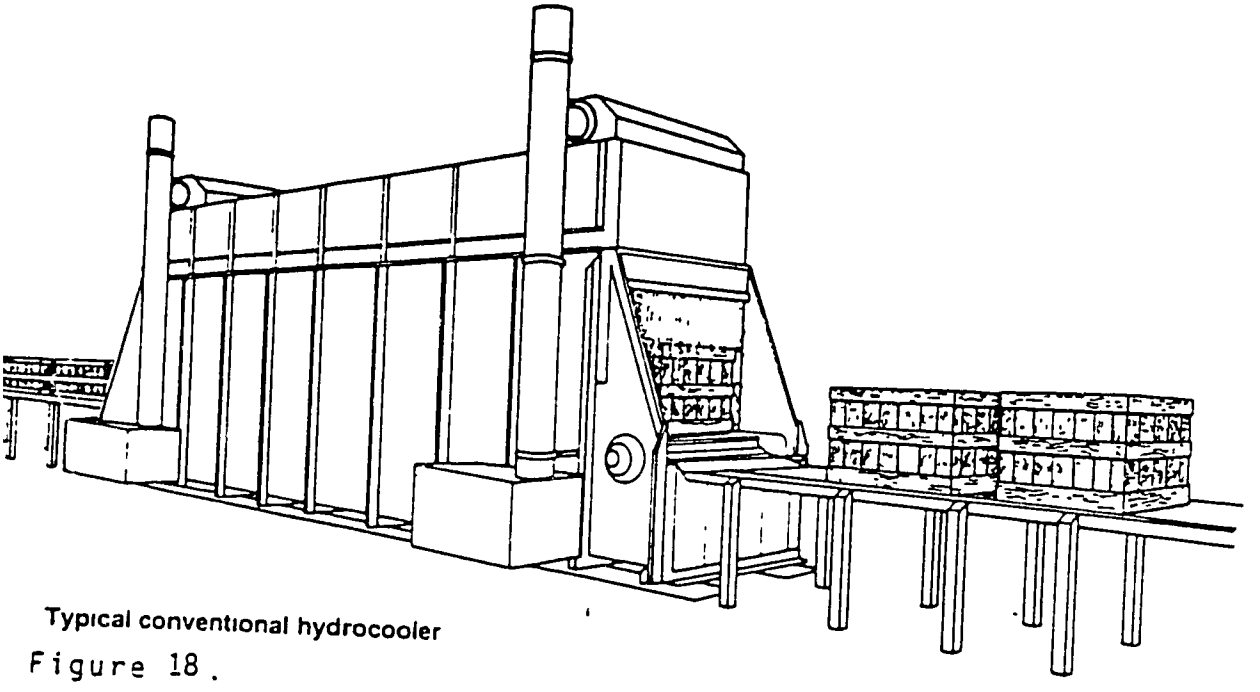



Figure 17. Comparison of three methods (room, forced-air, and hydrocooling) for cooling.



Typical conventional hydrocooler

Figure 18.

Hydrocooling sweet corn with a palletized system.

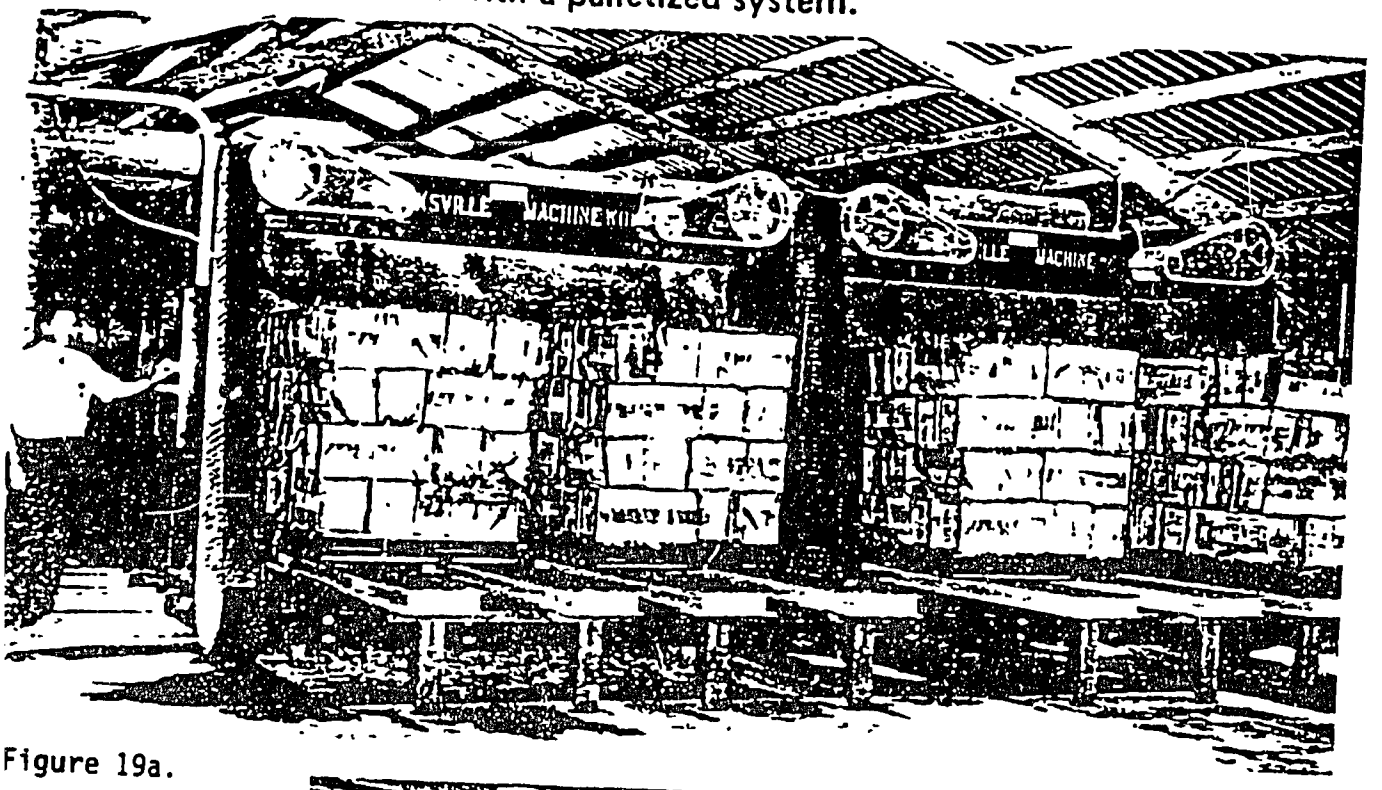
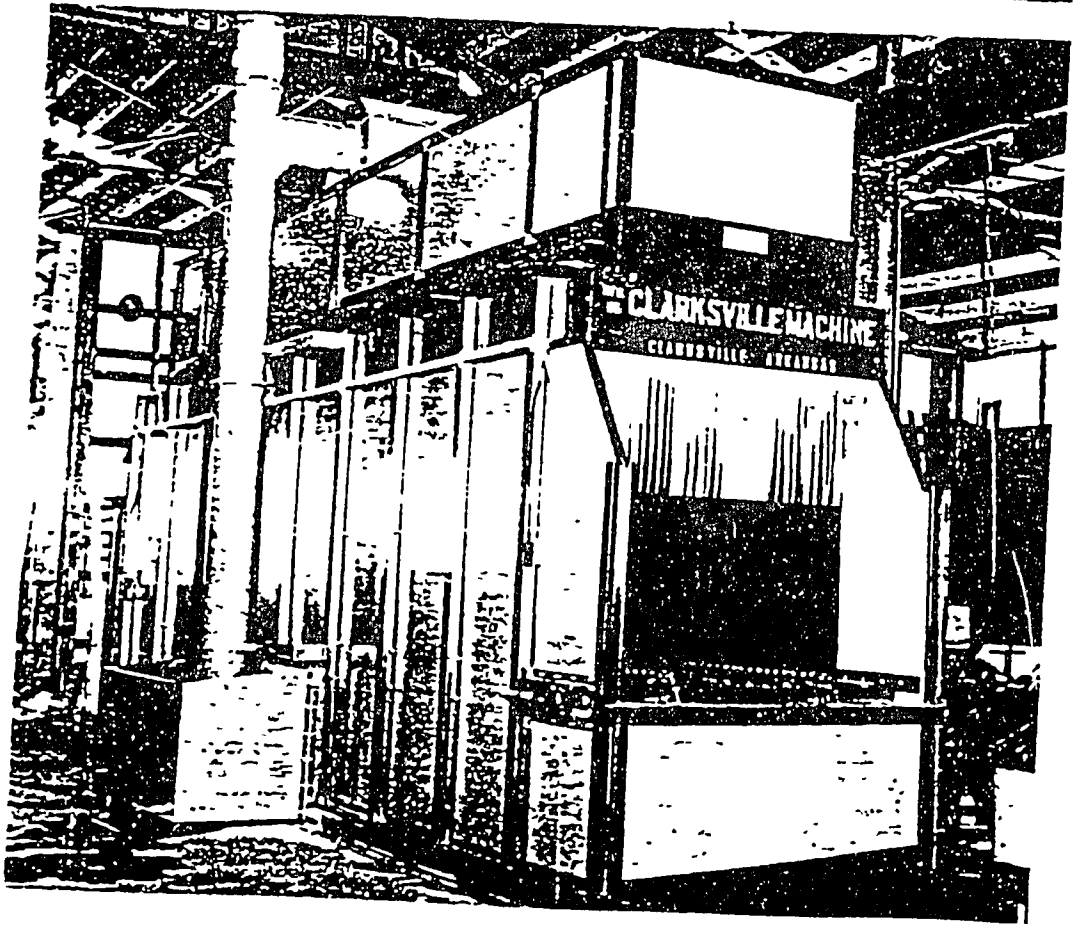


Figure 19a.




A palletized
or bin box
'drocooler with
a top coil tank

jure 19b.

Conveyer hydrocoolers move containers through a chamber in which ice water is either showered down upon the product or the product is submerged in water. The water is then recooled and recirculated through the system. Conveyer speed can be adjusted to increase or decrease the length of time the product is in the cooler.

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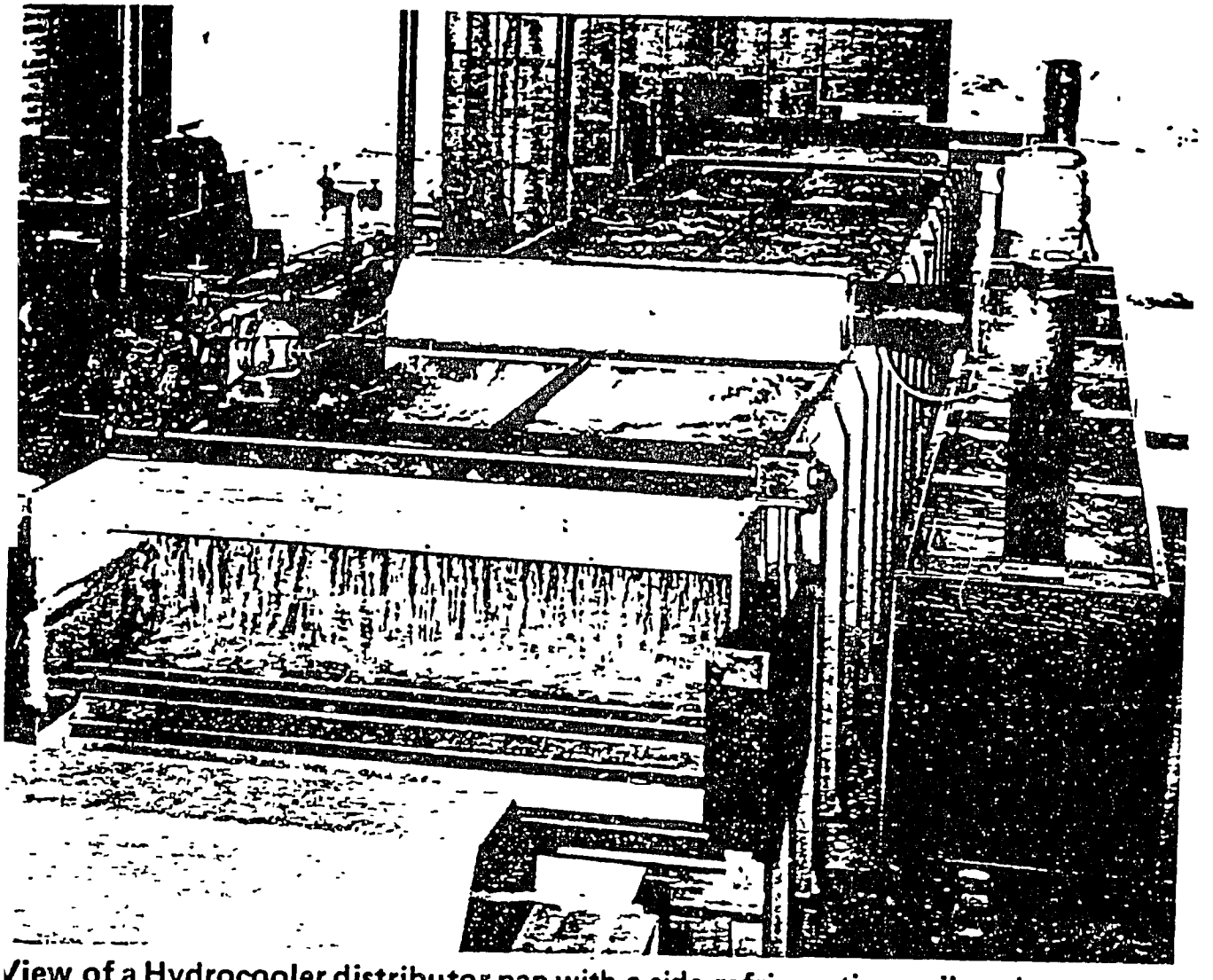

View of a Hydrocooler distributor pan with a side refrigeration coil tank.

Figure 20.

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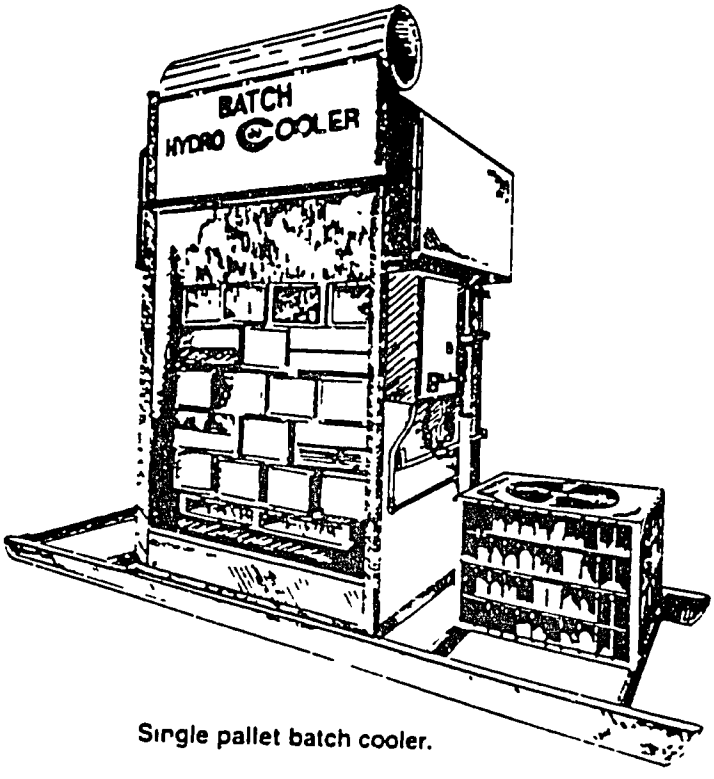



Single pallet batch cooler.

Figure 21a.

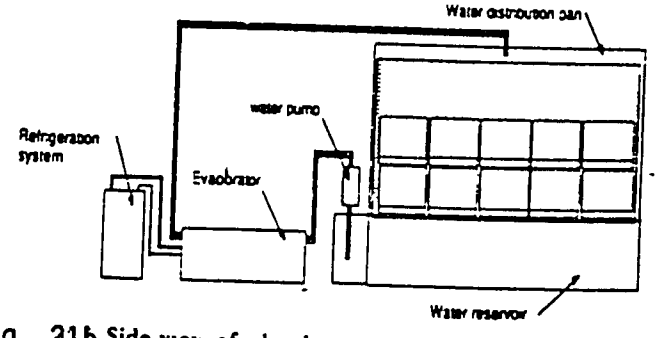
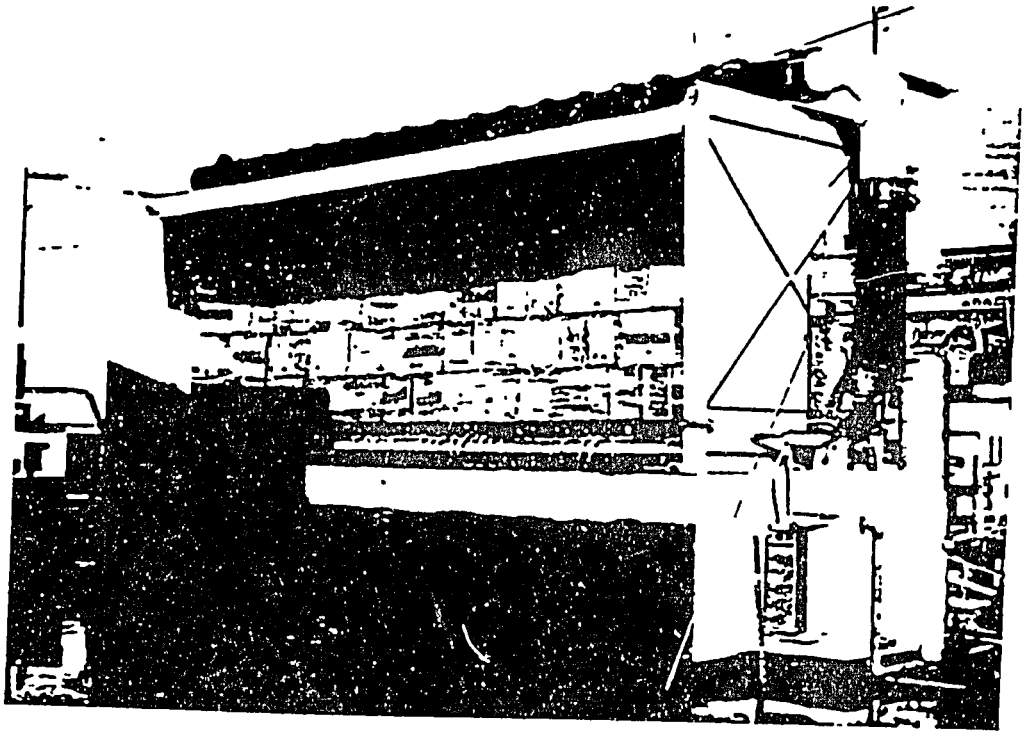



Fig. 21b. Side view of a batch-type hydrocooler for pallet bins.



a.

Figure 22b. Batch hydrocoolers differ from conveyer hydrocoolers in that the product is stationary As with shower-type conveyer coolers, ice water cascades down upon the product until it is adequately cooled. While less expensive to build and operate, batch coolers are less efficient in that they cannot be used while the product is being loaded or unloaded

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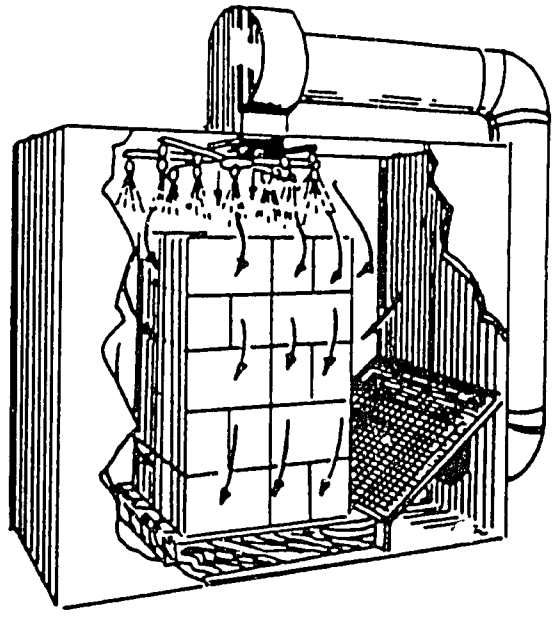
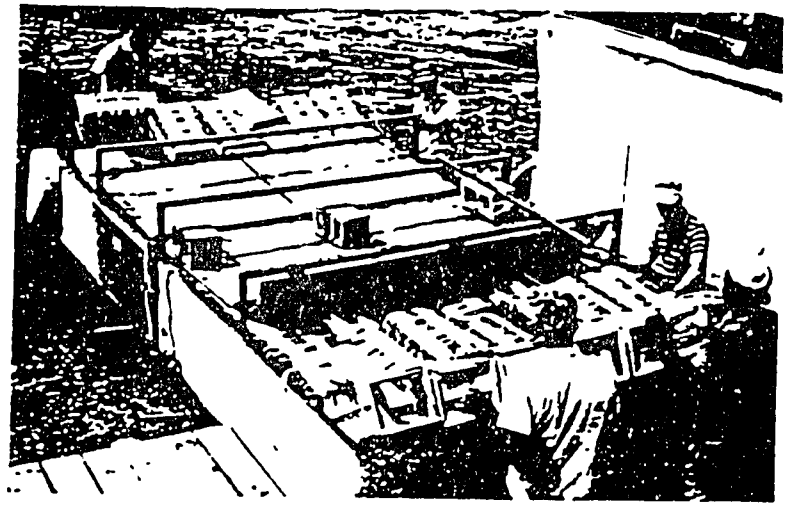


Cut-away view of a hydro-air-cooling hydrocooler.

Figure 23



Immersion hydrocooler

Figure 24

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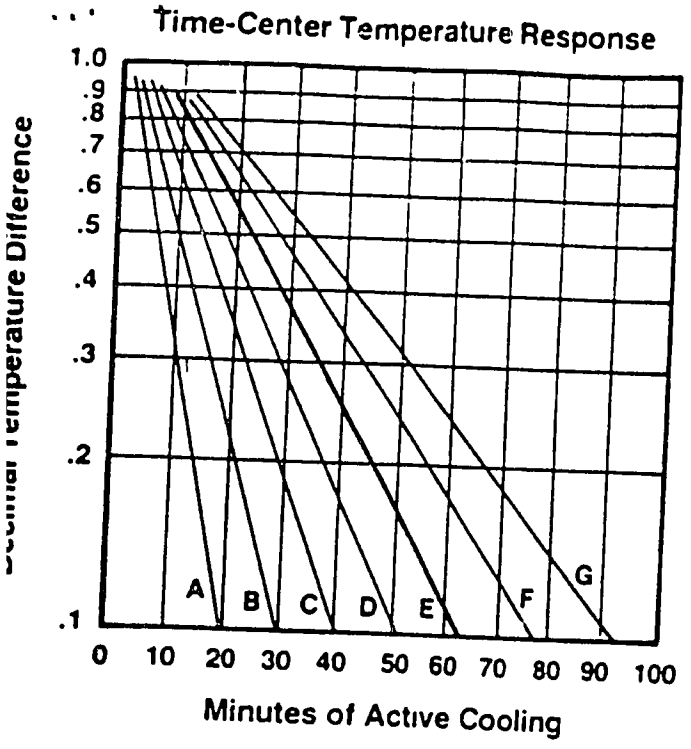



Figure25 Time-temperature response of various fruits and vegetables immersed in agitated chilled water.

KEY

A — Greens

B — Beans, peas, asparagus

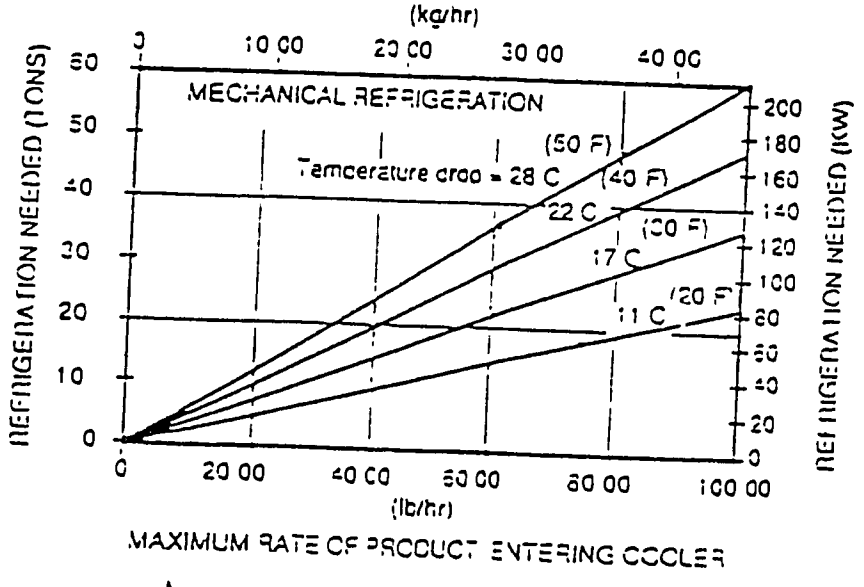
C — Small cucumbers, radishes, beets (<1 1/2" dia.)

D — Small apples and peaches, slicing cucumbers

E — Sweet corn, apples, and peaches (<2 1/2" dia.)

F — Large apples and peaches (>3" dia )

G — Cantaloupes, large eggplant




Approximate mechanical refrigeration requirements for small scale coolers based on maximum hourly product input and product temperature drop.

Figure 26.

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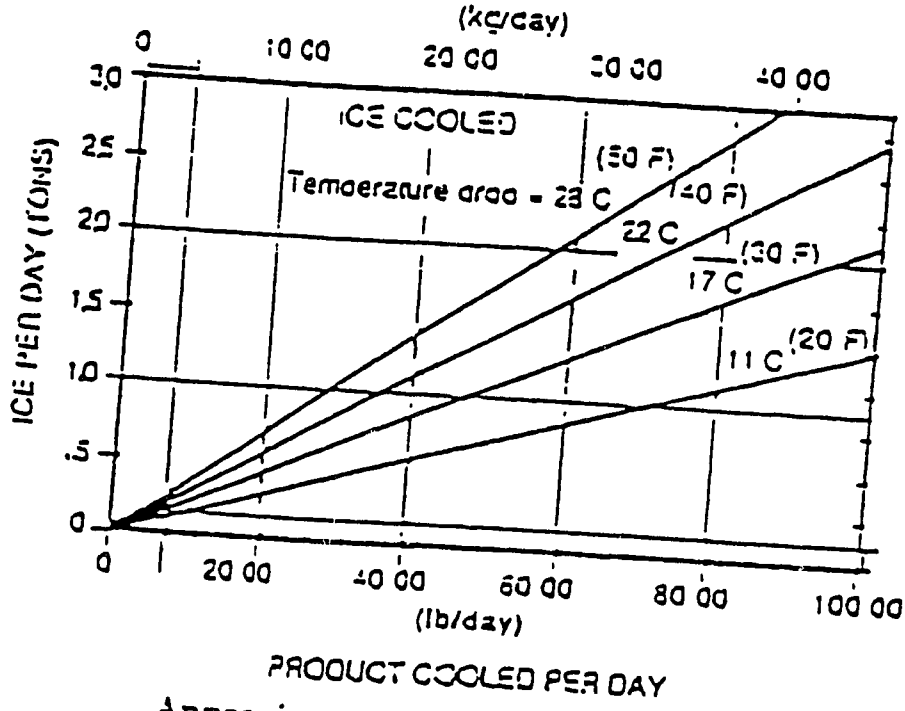


Approximate amount of ice needed to operate small scale coolers based on amount of product cooled per day and product temperature drop.

Figure 27.

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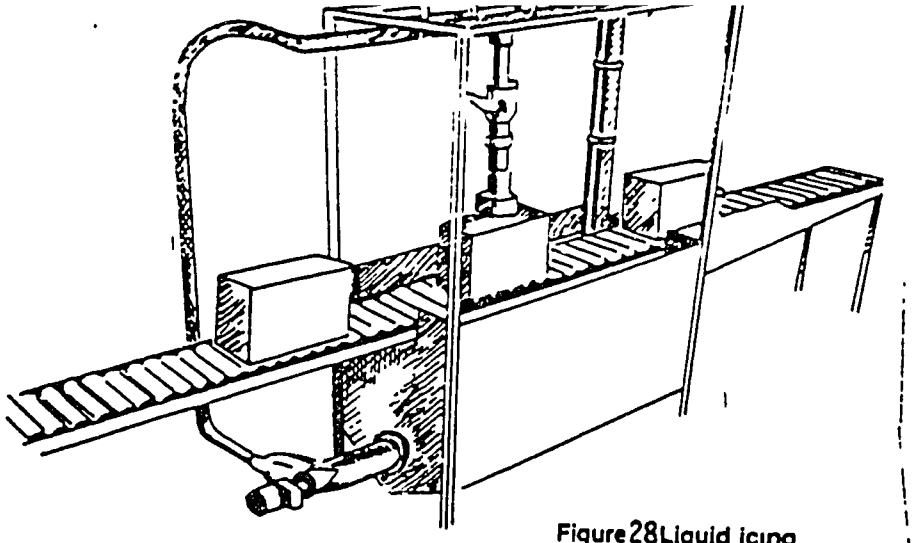
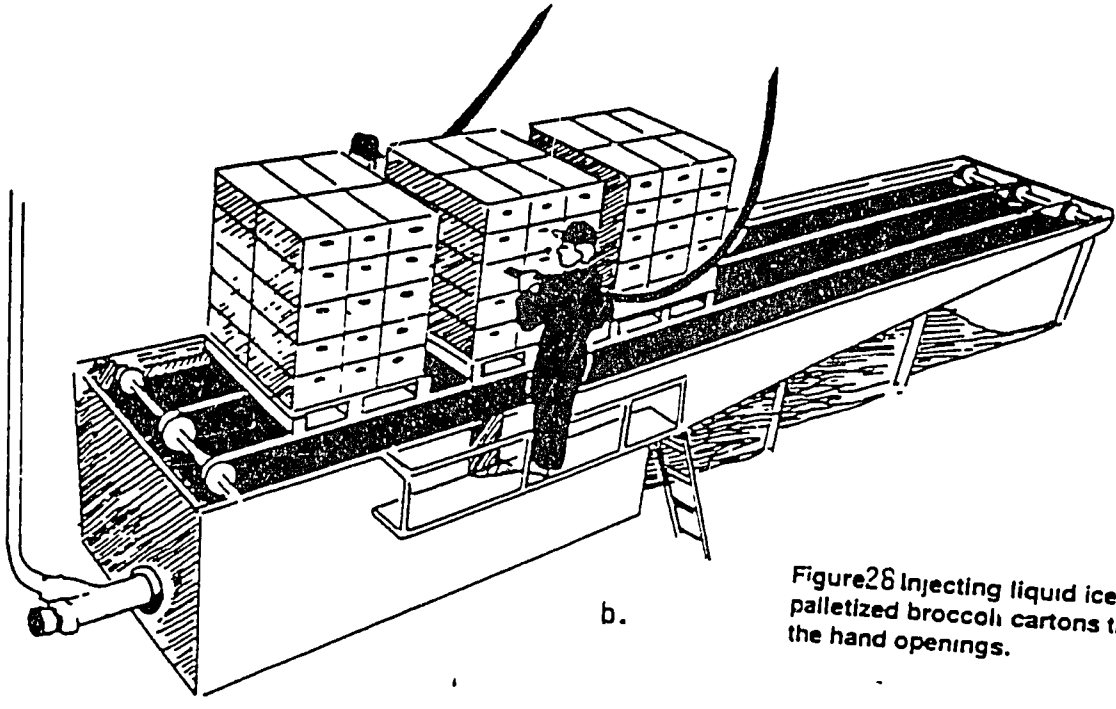


a.

Figure 28 Liquid icing single cartons of produce.



b.

Figure 28 Injecting liquid ice into palletized broccoli cartons through the hand openings.

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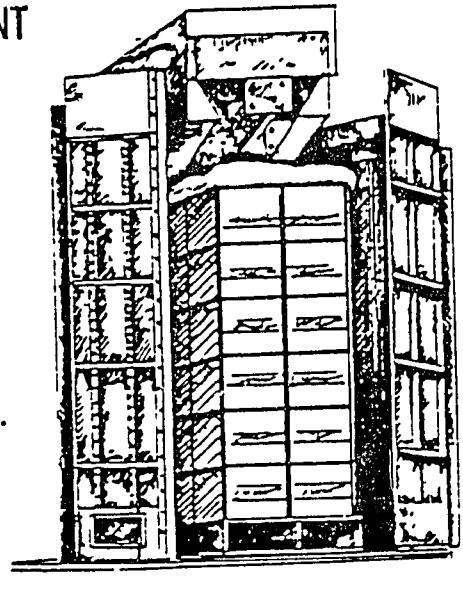
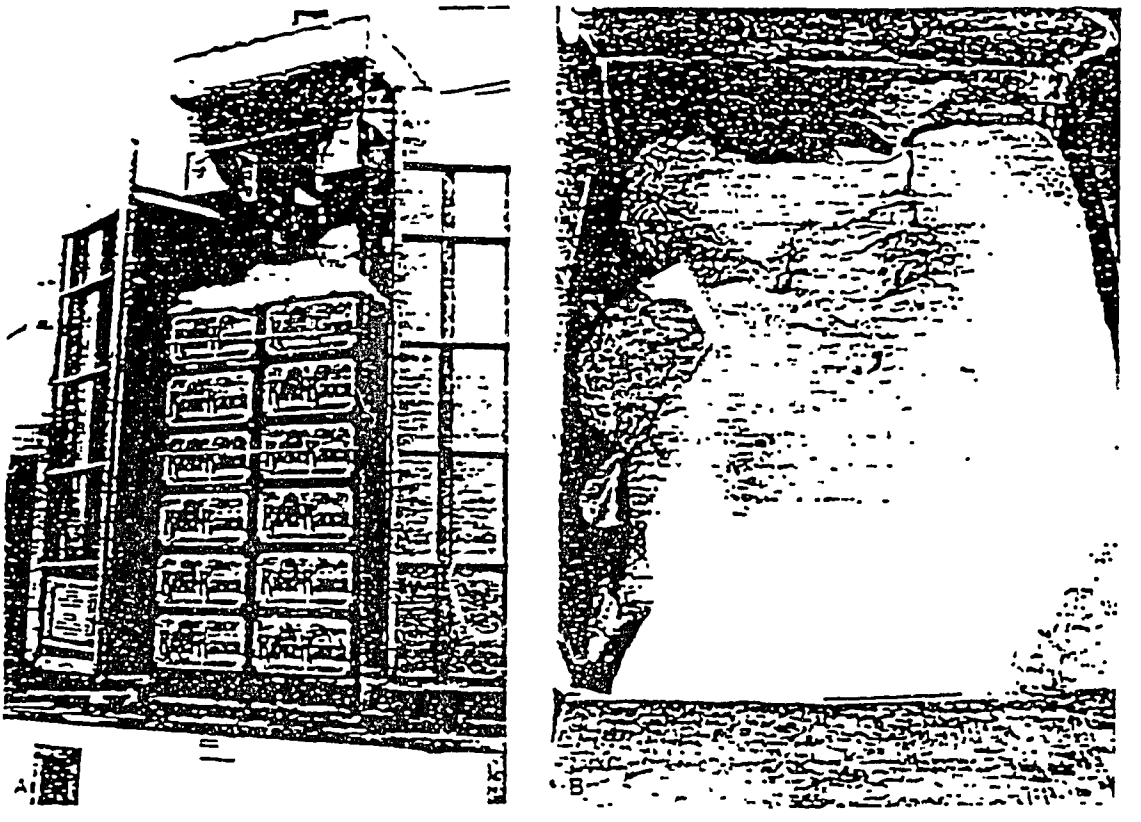


c.

Figure 28 Automated pallet icing.



Liquid icing is a form of package icing that utilizes a slurry of ground ice and water that is pumped into palletized boxes (A). Moving through the ventilation holes in the containers as a liquid, liquid icing has the advantage over older means of ice application in that it moves around all of the individual units of produce, maximizing contact. The water present drains from the slurry upon filling, leaving a relatively solid mass of crushed ice within the container (B). The condition of a box of body-iced broccoli upon reaching the retail market.

Figure 29. .

Pallet liquid-icing machine in operation. The high-volume flow of the ice-water mix is pumped into chamber and flows through container vents to deposit ice throughout the package.

Figure 30. .

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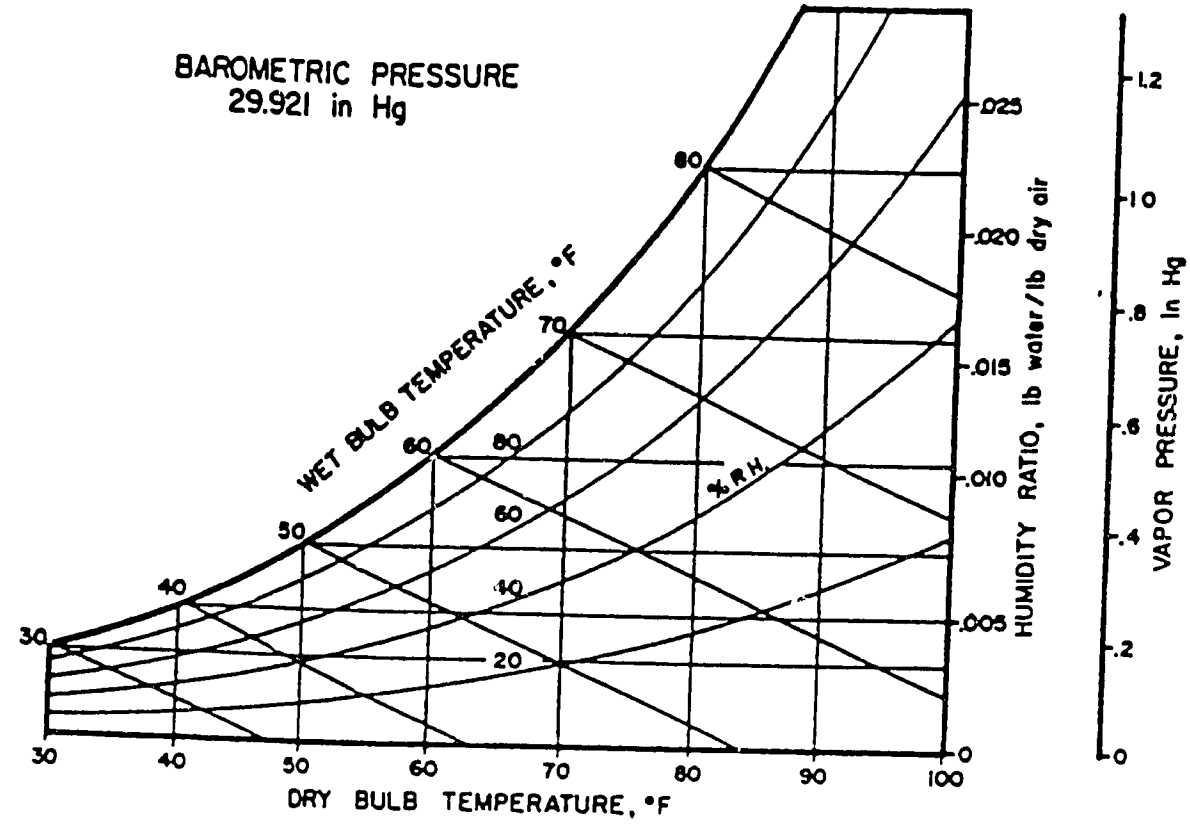


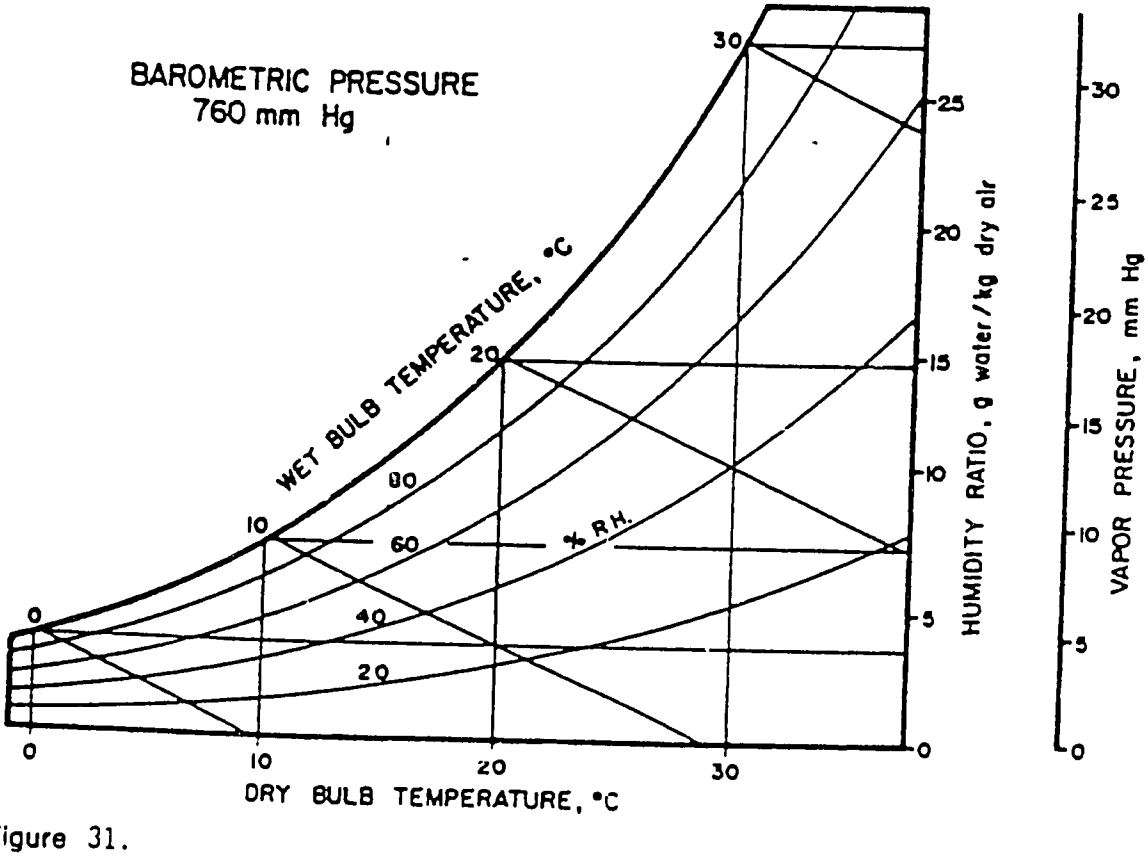


Figure 31.
Psychrometric chart for determining percent relative humidity on the basis of wet-bulb and dry-bulb temperatures

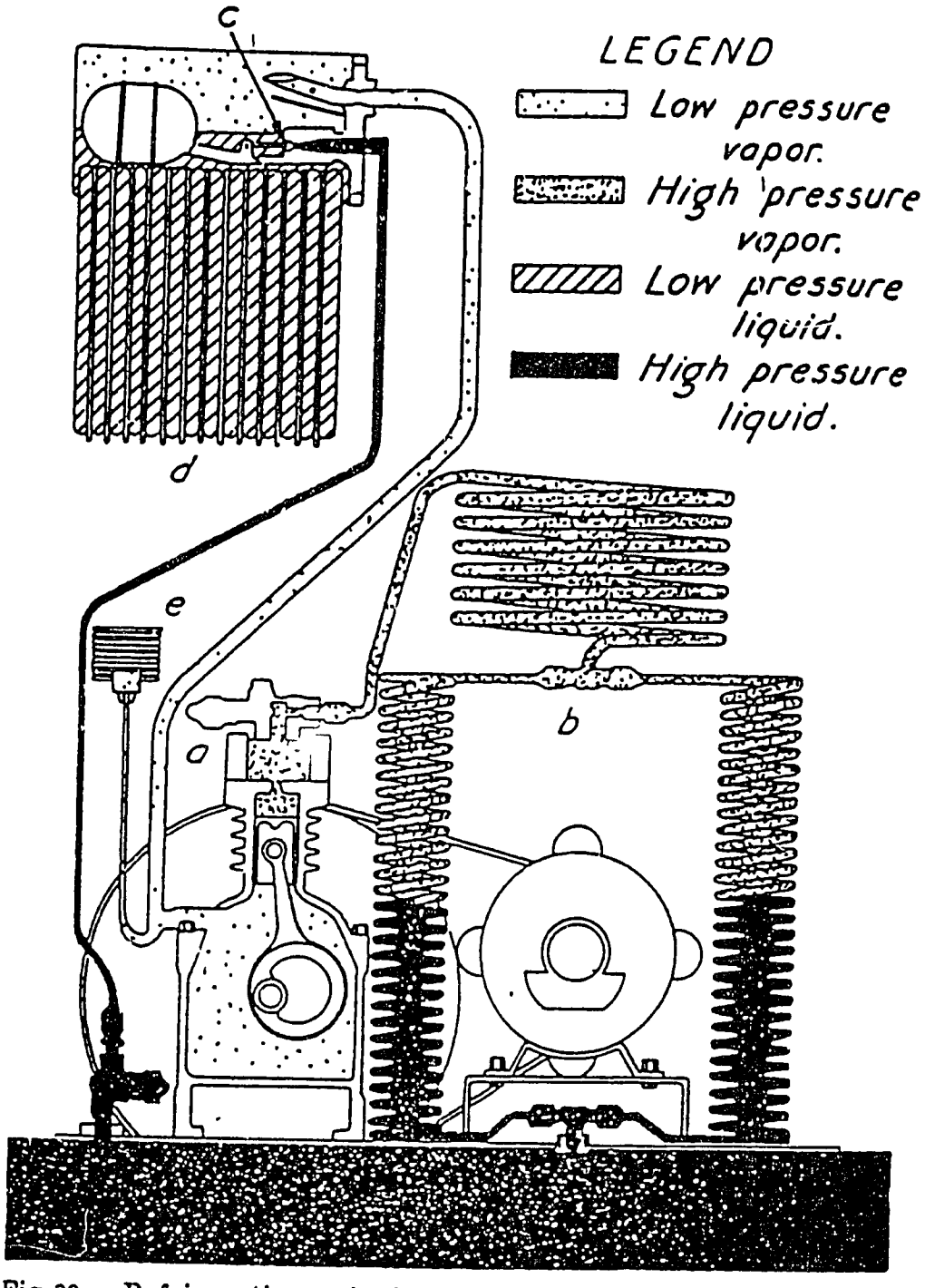


Fig. 32.—Refrigerating unit showing the parts and condition of the refrigerant in each: *a*, compressor; *b*, condenser; *c*, float valve regulating flow of refrigerant into cooling coil; *d*, cooling coil; *e*, sylphon bellows operating motor switch.

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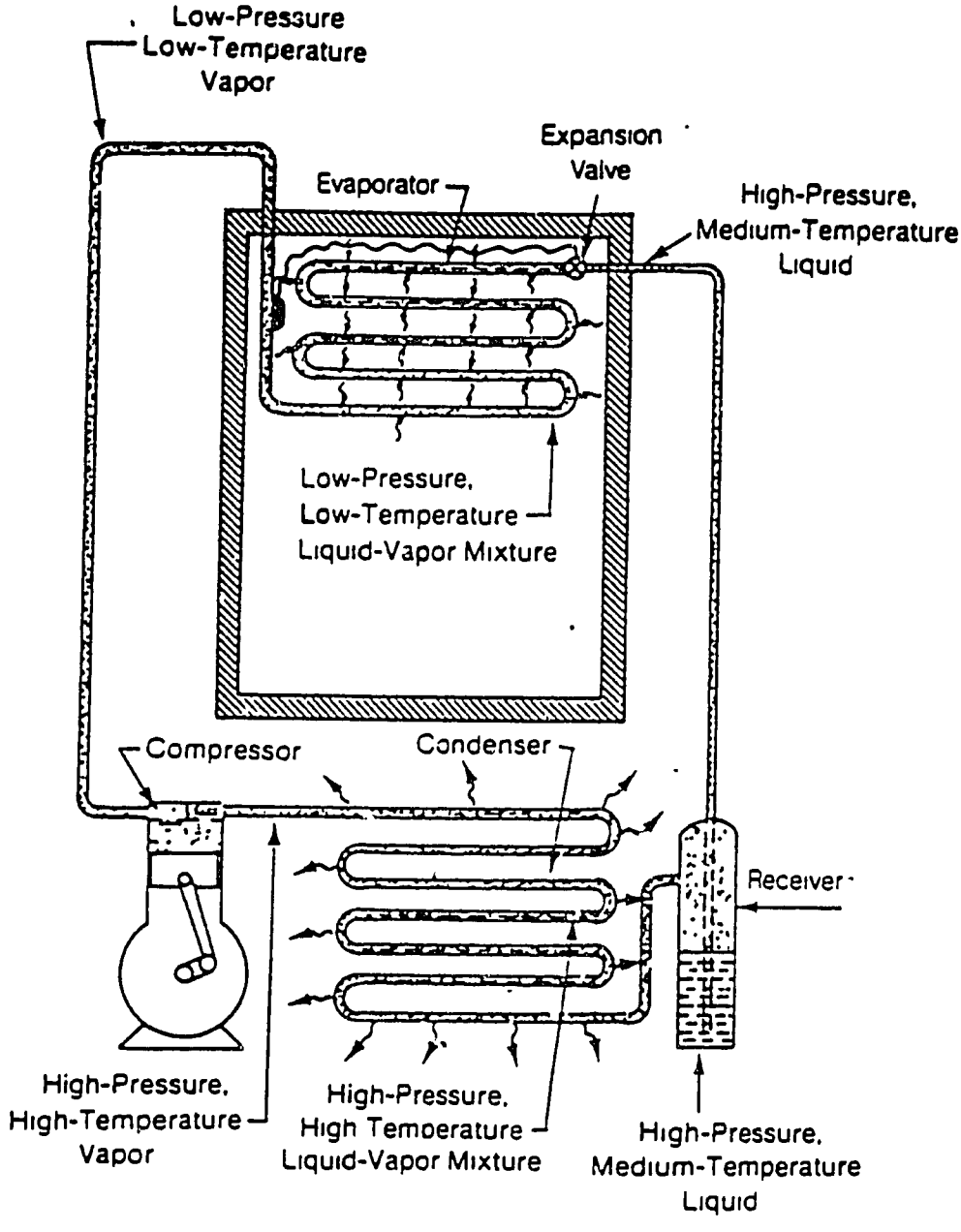


Fig. 33. Schematic of a typical vapor recompression or mechanical refrigeration system.

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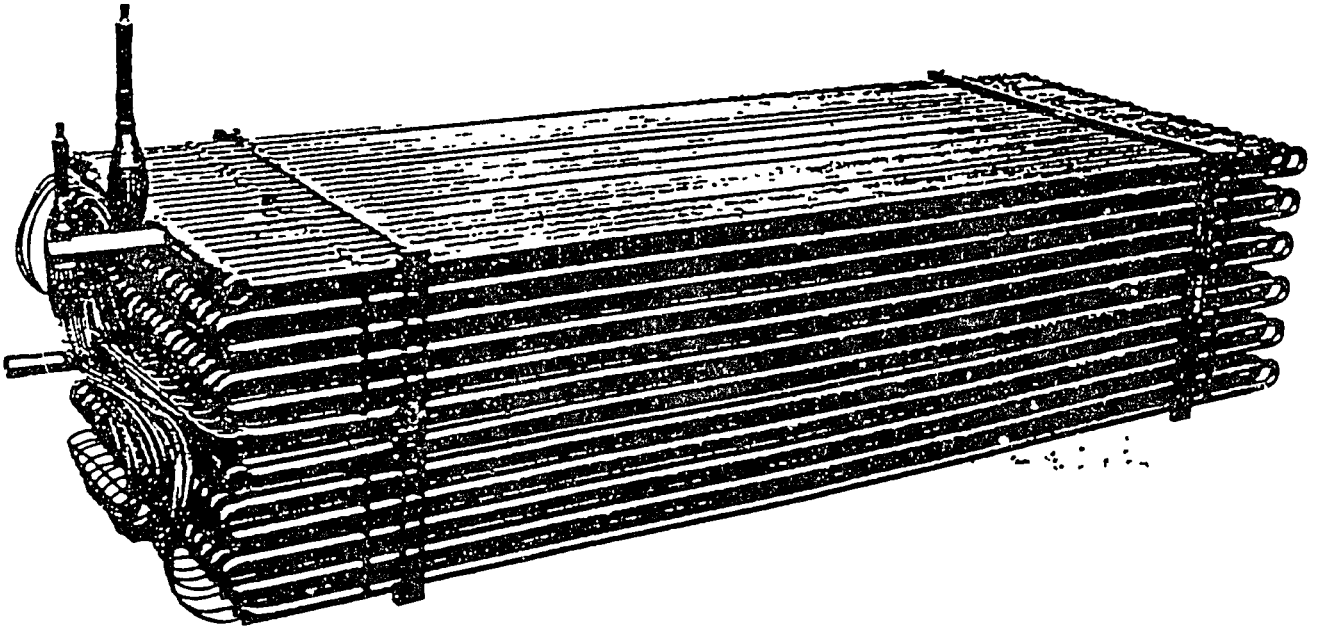

A Hydrocooler refrigeration coil designed specifically for Hydrocoolers.

Figure 34.

Cooling methods suggested for horticultural commodities

| Commodity | Size of operation: Large | Size of operation: Small | Remarks |
|---|---|---|---|
| *Tree fruits* | | | |
| Citrus | R | R | |
| Deciduous | FA, R, HC | FA | Apricots cannot be HC |
| Subtropical | FA, R | FA | |
| Tropical | FA, R | FA | |
| Berries | FA | FA | |
| Grapes | FA | FA | Require rapid cooling facilities adaptable to $SO_2$ fumigation |
| *Leafy vegetables* | | | |
| Cabbage | VC, FA | FA | |
| Iceberg lettuce | VC | FA | |
| Kale, collards | VC, R, WV | FA | |
| Leaf lettuces, spinach, endive, escarole Chinese cabbage, bok choy, romaine | VC, FA, WV, HC | FA | |
| *Root vegetables* | | | |
| with tops | HC, PI, FA | HC, FA | Carrots can be VC |
| topped | HC, PI | HC, PI, FA | |
| Irish potatoes, sweet potatoes | R w/evap coolers HC | R | With evap coolers, facilities should be adapted to curing |
| *Stem and flower vegetables* | | | |
| Artichokes | HC, PI | FA, PI | |
| Asparagus | HC | HC | |
| Broccoli, brussels sprouts | HC, FA, PI | FA PI | |
| Cauliflower | FA, VC | FA | |
| Celery, rhubarb | HC, WV, VC | HC, FA | |
| Green onions, leeks | PI, HC | PI | |
| *Mushrooms* | FA VC | FA | |
| *Pod vegetables* | | | |
| Beans | HC, FA | FA | |
| Peas | FA, PI, VC | FA PI | |
| *Bulb vegetables* | | | |
| Dry onions | R | R, FA | Should be adapted to curing |
| Garlic | R | | |
| *Fruit-type vegetables* | | | |
| Cucumbers eggplant | R, FA, FA-EC | FA FA-EC | Fruit-type vegetables are chilling sensitive but at varying temperatures |
| Melons | | | |
| cantaloupes, muskmelons, honeydew casaba | HC FA, PI | FA FA-EC | |
| crenshaw | FA, R | FA FA-EC | |
| watermelons | FA, HC | FA R | |
| Peppers | R, FA, FA-EC, VC | FA, FA-EC | |
| Summer squashes, okra | R, FA, FA-EC | FA, FA-EC | |
| Sweet corn | HC, VC, PI | HC, FA, PI | |
| Tomatillos | R, FA, FA-EC | FA FA-EC | |
| Tomatoes | R, FA, FA-EC | | |
| Winter squashes | R | R | |
| *Fresh herbs* | | | |
| not packaged | HC, FA | FA, R | Can be easily damaged by water beating in HC |
| packaged | FA | FA, R | |
| *Cactus* | | | |
| leaves (nopalitos) | R | FA | |
| fruit (tunas or prickly pears) | R | FA | |
| *Ornamentals* | | | |
| Cut flowers | FA R | FA | When packaged, only use FA |
| Potted plants | R | R | |

R = Room Cooling FA = Forced-Air Cooling, HC = Hydrocooling VC = Vacuum Cooling WV = Water Spray Vacuum Cooling, FA-EC = Forced-Air Evaporative Cooling, PI = Package Icing

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# An evaporative cooler for vegetable crops

James F. Thompson □ Robert F. Kasmire

*The low cost of this cooling system makes it especially suitable for small farmers and roadside merchants. It also can be used for short-term storage.*

Some vegetable crops are harvested with pulp temperatures too high and under humidity conditions too low for maximum shelf life. Present facilities for cooling produce and providing proper humidity usually consist of a system for rapid cooling as the commodity arrives from the field and a cold room for subsequent storage. Both are expensive to install, and the mechanical refrigeration system for the cooler requires large amounts of energy. The goal of this project was to develop a simple, low-cost, energy-efficient alternative that would be applicable to both large-scale and small-scale operations.

Evaporative cooling is an effective means of providing low air temperature and high relative humidity for cooling produce. Its limitation is that a well-designed system provides air at one to two degrees above the wet-bulb temperature of the ambient air, outside the cooling unit. The mean wet-bulb temperature in California ranges from 50° to 70° F during the harvest season and drops to slightly below 40° F during the winter. These temperatures are acceptable for cooling the chilling-sensitive crops listed in table 1. Crops not listed in the table require a storage temperature near 32° F and would not be suitable for this system.

A small unit was constructed to verify the effectiveness of evaporative cooling (see drawing). The fan was selected to provide about 400 to 600 cubic feet per minute (cfm) at 0.75 to 0.10 inch watergage static pressure. This is enough air flow to cool at least 600 pounds of produce in 1 to 2 hours.

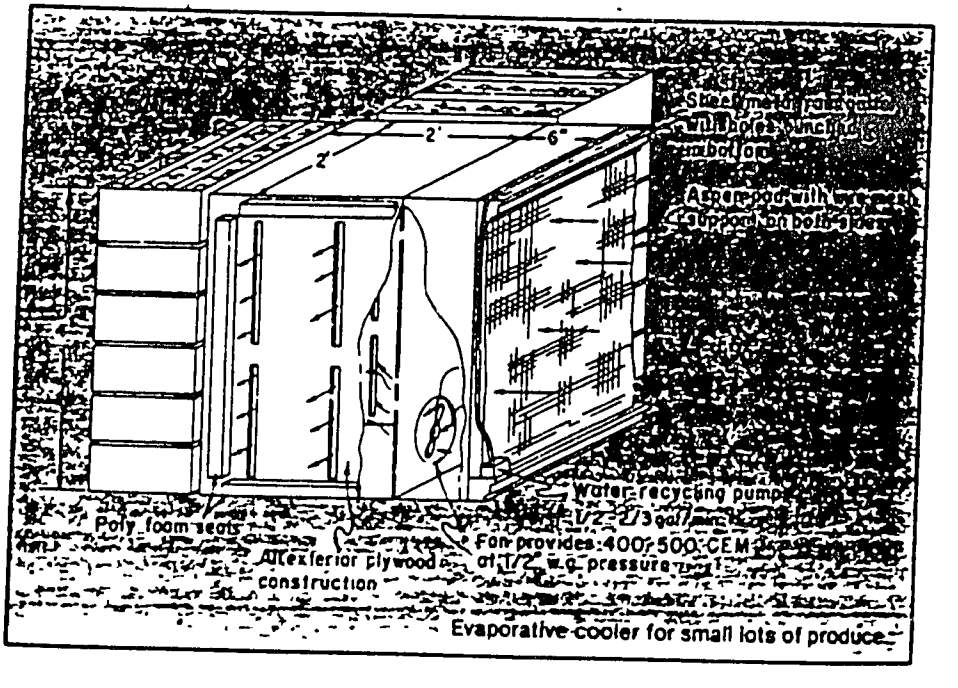
The cooling pad was a commercially available aspen fiber pad designed for evaporative cooling. The total pad area was 8 square feet, which resulted in an average air velocity through the pad of 50 to 75 feet per minute (fpm). The velocity recommended for most evaporative cooling systems is in the range of 100 to 300 fpm. The low velocity was selected to ensure nearly complete saturation of the air, resulting in lowest possible cooling air temperature and a high relative humidity. Also, the large pad area fitted the size of the air plenum required for distributing the cooled air to the vegetable boxes.

A small pump was used to recirculate water from the bottom to the top gutter. The rate of water flow through the pad was 0.42 gallon per minute. The unit consumed less than 0.03 gallon per minute of water through evaporation, and an additional small amount of water was continuously drained away to prevent salt buildup. The unit was built primarily of ½-inch exterior grade plywood. If new materials were purchased, the total unit would cost about $150 to $200.

Table 2 summarizes the data obtained in five cooling experiments. All commodities were packed in commonly used containers. The air flow varied with the amount of produce placed on the cooler, because fan output varies with air flow resistance. The cooling rate for each commodity is primarily a factor of the rate of air flow per weight of produce. The lower air flows of about 1 cfm per pound resulted in ¾ cooling time of about two hours (¾ cooling time is the time required to cool the produce ¾ of the difference between the initial product temperature and the temperature of the cooling air.) Air-flow rates over 3 cfm per pound provided ¾ cooling times of 1½ hours. These cooling rates are rapid enough for most operations.

The graph illustrates the cooling air temperature produced by the unit during a 24-hour period. The fan was producing about 500 cfm. The maximum air temperature produced by the unit was 70° F during the afternoon with a minimum during the early morning of 57° F. In general, the air temperature produced by the unit was about 2° F higher than the wet-bulb temperature. This resulted in a relative humidity of about 90 percent in the air leaving the unit. The temperature of the air through the cooling pad was ½ to 1° F higher than the wet-bulb temperature, and the remainder of the increase was caused by heat from the fan and motor. The test was conducted during August, which typically has the highest wet-bulb temperatures of the year.

The cooling unit was powered by a ¼ horsepower (hp) fan motor and 1/40-hp recirculation pump motor. This energy input produces nearly 11,000 BTUs of cooling (nearly 1 ton of refrigeration) when 500 cfm of air is cooled 20° F. For each unit of energy input, 14 energy units of cooling are produced. A mechanical refrigeration system produces




Evaporative cooler for small lots of produce



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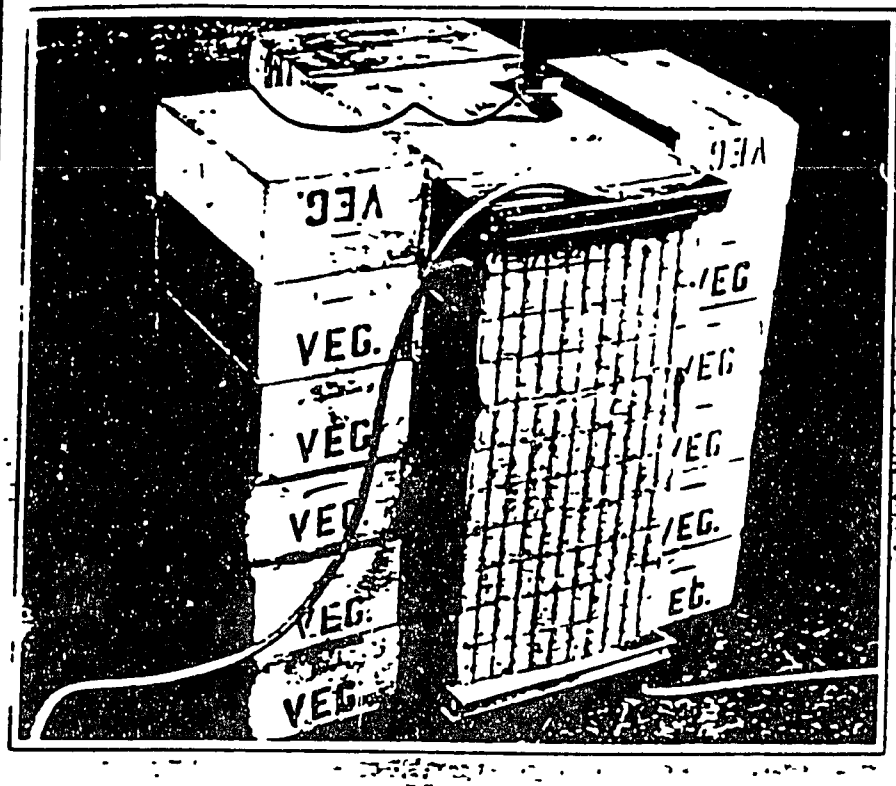
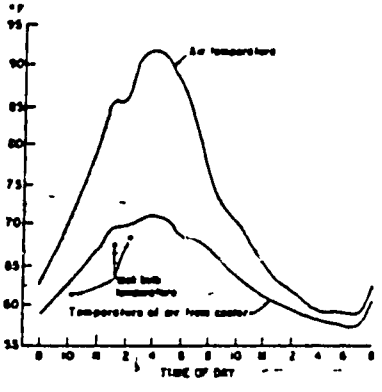



**TABLE 1. Recommended Storage Temperatures and Humidities for Selected Crops**

| Commodity | Temperature | Relative humidity |
|---|---|---|
| | °F | % |
| Avocados | 40-55° | 85-90 |
| Snap beans | 40-45° | 90-95 |
| Cucumbers | 45-50° | 90-95 |
| Eggplant | 45-50° | 90 |
| Most melons | 45-50° | 85-95 |
| Okra | 45-50° | 90-95 |
| Sweet peppers | 45-50° | 90-95 |
| Firm ripe tomatoes | 45-50° | 85-90 |
| Pumpkins, winter squash | 50-55° | 70-75 |
| Sweet potatoes | 55-60° | 85-90 |
| Mature green tomatoes | 55-70° | 85-90 |
| California grapefruit | 60° | 85-90 |
| Lemons | 32-60° | 85-90 |




Air temperature produced by cooler.

**TABLE 2. Summary of Evaporative Cooling Trials**

| | Tomato | Sweet pepper | Zucchini squash Test #1 | Zucchini squash Test #2 | Crooked-neck squash |
|---|---|---|---|---|---|
| Weight cooled (lb) | 540 | 100 | 583 | 168 | 168 |
| Airflow (cfm) | 580 | 385 | 502 | 510 | 510 |
| Airflow/wt (cfm/lb) | 1 1 | 3.9 | 0 85 | 3.0 | 3.0 |
| % cooling time (min) | 120 | 75 | 100* | 75 | 75 |
| Average initial pulp temp (°F) | 74 | 90 | 87 | 84 | 85 |
| Average pulp temp at % cool (°F) | 61 | 63 | — | 69 | 69 |
| Average dry bulb temp (°F) | 65 | 72 | 98 | 80 | 80 |
| Average wet bulb temp (°F) | 52 | 56 | 71 | 64 | 64 |
| Average temp of cooled air (°F) | 55 | 60 | 74 | 67 | 67 |

*Calculated from 1/2 cooling time data.

about 3 energy units of cooling for each unit input (but it produces lower temperatures than evaporative cooling can).

The test unit provided optimum relative humidity and acceptable temperature conditions for cooling most types of chilling-sensitive produce The maximum temperature produced by the unit exceeded recommended temperatures by about 10° F because of high ambient wet-bulb temperatures. During the cooler harvest months and cooler times of the day, the unit can provide nearly optimum temperatures. In any case, most refrigerated transit vehicles or cold storage facilities, if properly utilized, can provide the small amount of additional cooling needed to bring the produce to optimum temperature.

Minimum produce temperature can be obtained by allowing the commodity to remain on the cooler until the wet bulb drops. For example, when the afternoon peak wet-bulb temperature is 10° F above the desired commodity temperature, the product will need to remain on the cooler until early morning This may require additional cooler capacity, but considering how inexpensive the equipment is, this should not be a problem. When wet-bulb temperature is not high, the commodity can be removed from the cooler within a few hours

Another advantage of this system is that the cooler can also be used for short-term storage in place of a relatively expensive mechanically cooled storage room. The system produces cool, high-humidity air that can be forced past the produce, even after it has cooled, without damaging it. To reduce energy use during storage, it would probably be desirable to have a two-speed fan in the unit and use the low speed during storage. With this modification and some temporary shading, any field location with water and electricity could be used for short-term storage

The small investment needed to set up an evaporative cooling system and its low energy requirements make it especially suitable for farmers and roadside merchants who do not have the financial resources to invest in a mechanically cooled storage room or cooling facility. Many of these producers have either ignored product temperature management or depended on a custom cooling and storage facility some distance from their operations. The technology described is inexpensive enough to allow almost any grower to use it to help ensure produce quality

*James F Thompson is Agricultural Engineer, and Robert F Kasmire is Vegetable Specialist, Cooperative Extension University of California, Davis*
*The authors gratefully acknowledge the Committee on the Relationship of Energy to Agriculture for support of this research*



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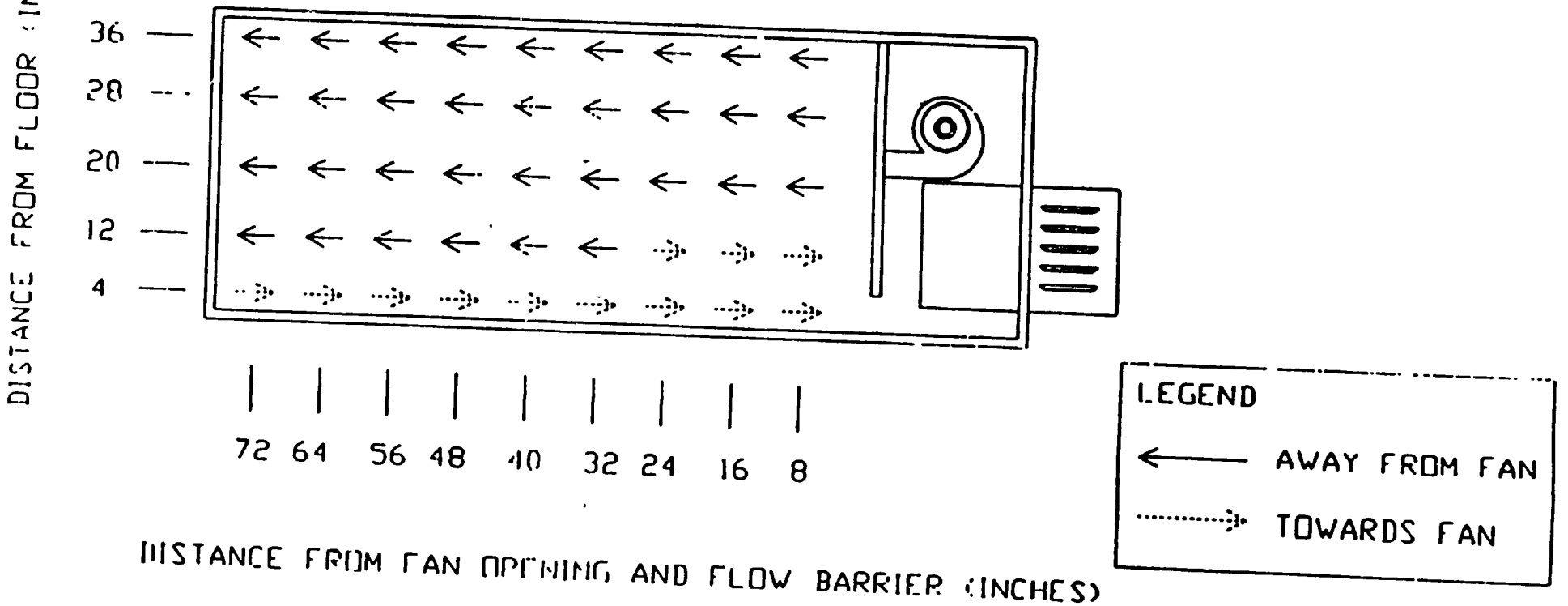
The exact prices of the electrical components are as follows:

**List 1: Electrical Component Price List**

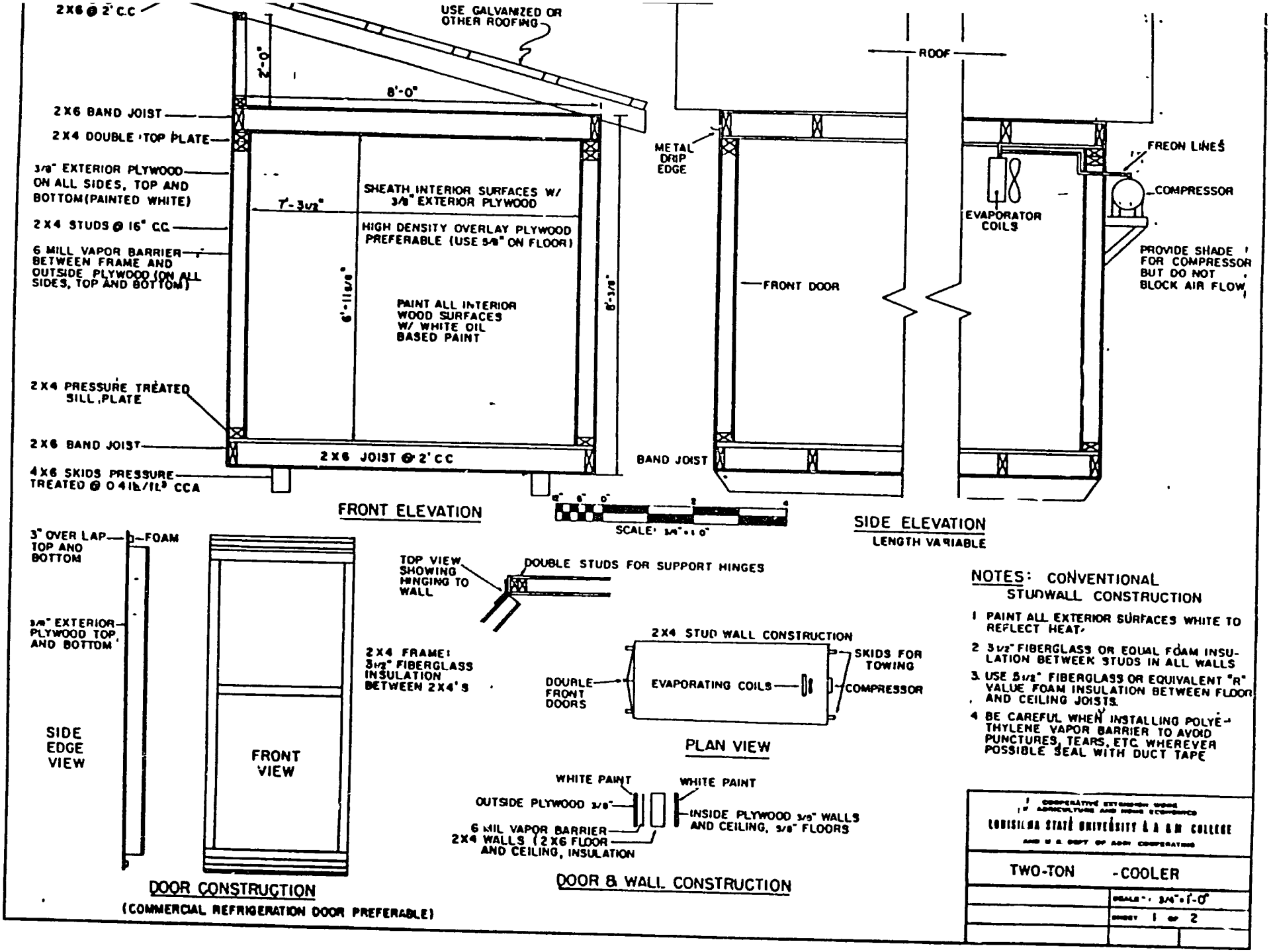
| | | |
|---|---|---|
| 1 - | Thermostat 115 volt, 16 amp, remote bulb, Penn model A19ABC-24 | $44.65 |
| 1 - | 1/3 Hp, PSC, Centrifugal Blower Dayton 4C831 | $132.91 |
| 1 - | Air Conditioner 115 volt, 12 amp, 12,000 btuh Amana | $500.00 |
| 1 - | Cycle Timer 115 volt, 20 amp, SPDT, 1 hr, 60 event, Dayton model 2E357 | $69.51 |
| 2 - | Steel Strip Heaters, 150 Watt, 8 inch, 115 volt, Vulcan model 1208, @ $17.69 each. | $35.38 |
| | TOTAL | $782.45 |

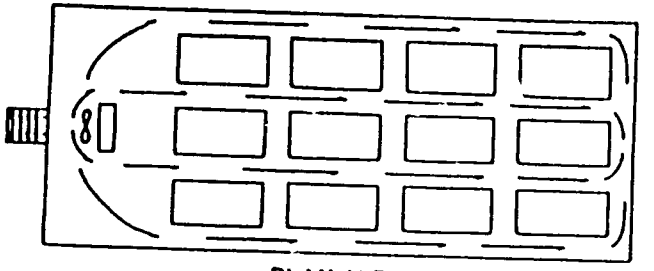
# AIR FLOW PATTERNS IN THE PORTACOOLER

FIGURE 4




PHYSICAL EVALUATION TEAM: JOSEPH ANTHONY, GERALD BERNEY, WILLIAM CRAIG, AND DANIEL SCHOFER


2X6 @ 2' C.C
USE GALVANIZED OR OTHER ROOFING
2'-0"
8'-0"
2X6 BAND JOIST
2X4 DOUBLE TOP PLATE
3/8" EXTERIOR PLYWOOD ON ALL SIDES, TOP AND BOTTOM (PAINTED WHITE)
2X4 STUDS @ 16" CC
6 MIL VAPOR BARRIER BETWEEN FRAME AND OUTSIDE PLYWOOD (ON ALL SIDES, TOP AND BOTTOM)
7'-3 1/2"
SHEATH INTERIOR SURFACES W/ 3/8" EXTERIOR PLYWOOD
HIGH DENSITY OVERLAY PLYWOOD PREFERABLE (USE 5/8" ON FLOOR)
6'-11 1/8"
PAINT ALL INTERIOR WOOD SURFACES W/ WHITE OIL BASED PAINT
8'-3 1/8"
2X4 PRESSURE TREATED SILL PLATE
2X6 BAND JOIST
2X6 JOIST @ 2' CC
4X6 SKIDS PRESSURE TREATED @ 0.4 lb/ft³ CCA
FRONT ELEVATION
SCALE: 3/4" = 1'-0"
ROOF
METAL DRIP EDGE
FRONT DOOR
BAND JOIST
FREON LINES
COMPRESSOR
EVAPORATOR COILS
PROVIDE SHADE FOR COMPRESSOR BUT DO NOT BLOCK AIR FLOW
SIDE ELEVATION
LENGTH VARIABLE
3" OVER LAP TOP AND BOTTOM
FOAM
3/8" EXTERIOR PLYWOOD TOP AND BOTTOM
SIDE EDGE VIEW
FRONT VIEW
DOOR CONSTRUCTION
(COMMERCIAL REFRIGERATION DOOR PREFERABLE)
TOP VIEW SHOWING HINGING TO WALL
DOUBLE STUDS FOR SUPPORT HINGES
2X4 FRAME: 3 1/2" FIBERGLASS INSULATION BETWEEN 2X4'S
2X4 STUD WALL CONSTRUCTION
SKIDS FOR TOWING
DOUBLE FRONT DOORS
EVAPORATING COILS
COMPRESSOR
PLAN VIEW
WHITE PAINT
WHITE PAINT
OUTSIDE PLYWOOD 3/8"
INSIDE PLYWOOD 3/8" WALLS AND CEILING, 3/8" FLOORS
6 MIL VAPOR BARRIER
2X4 WALLS (2X6 FLOOR AND CEILING, INSULATION
DOOR & WALL CONSTRUCTION
NOTES: CONVENTIONAL STUDWALL CONSTRUCTION
1 PAINT ALL EXTERIOR SURFACES WHITE TO REFLECT HEAT.
2 3 1/2" FIBERGLASS OR EQUAL FOAM INSULATION BETWEEK STUDS IN ALL WALLS
3 USE 5 1/2" FIBERGLASS OR EQUIVALENT "R" VALUE FOAM INSULATION BETWEEN FLOOR AND CEILING JOISTS.
4 BE CAREFUL WHEN INSTALLING POLYETHYLENE VAPOR BARRIER TO AVOID PUNCTURES, TEARS, ETC. WHEREVER POSSIBLE SEAL WITH DUCT TAPE
LOUISIANA STATE UNIVERSITY A & M COLLEGE
TWO-TON -COOLER
SCALE: 3/4" = 1'-0"
SHEET 1 OF 2

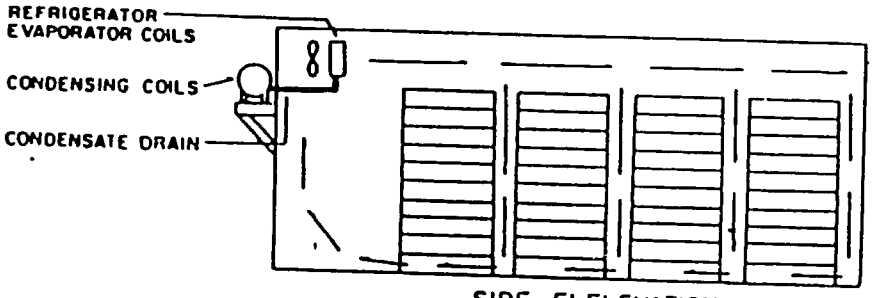


PLAN VIEW

ARROWS SHOW AIRFLOW

COLD STORAGE OPERATION

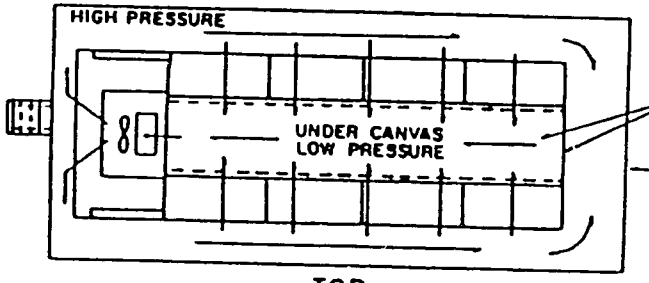
LOW AIR FLOW FROM EVAPORATOR FAN TO REDUCE DEHYDRATION OF PRODUCE




SIDE ELELEVATION

## MATERIAL LIST FOR 12' COOLER

1. 35 WALL STUDS @ 16" O.C. - CUT LENGTH TO 6'-7 1/8"
2. CEILING AND FLOOR JOISTS @ 24" O.C. 7-2X6X8' FOR CEILING AND 7-2X6X8' TREATED FOR FLOOR, CUT LENGTHS TO 7'-3 1/4"
3. BAND JOISTS: 4-2X6X12' (2 FOR FLOOR TREATED) - CUT LENGTHS TO 11'-9 1/4"
4. PLATES:
   6-2X4X12' (CUT LENGTH TO 11'-11/4")
   6-2X4X8' (CUT LENGTH TO 7'-4 1/4")
   USE TREATED FOR BOTTOM PLATES
5. SKIDS 2-4X6X12' PRESSURE TREATED FOR GROUND CONTACT
6. SHEATHING.
   29 SHEETS OF 3/8" PLYWOOD
   3 SHEETS OF 5/8" PLYWOOD
7. INSULATION 192 SQ FT OF R19-22 1/2" WIDTH
8. PAINT: 2 GALLONS OF WHITE OIL BASE
9. ONE TON REFRIGERATION UNIT
   -COULD USE TWO STAGE TO SAVE ON ELECTRICITY
10. 1/4 hp, 8" WHEEL SQUIRREL CAGE FAN (800 cfm @ 0.25 S.P.)
11. 8'X100' 6 MIL VAPOR BARRIER
12. 1-8' METAL DRIP EDGE
13. 1-50' ROLL OF "STICK ON" FOAM RUBBER WEATHER STRIPPING FOR SEALING DOORS
14. 2 PAIR OF HEAVY DUTY DOOR HINGES
    1 DOOR LATCH SET AND LOCK
15. ROOF 8-2X6X12', 144 SQ FT ROOFING, SHEATHING, AND PURLINS




TOP

ARROWS SHOW AIR FLOW

CANVAS STRIP OVER TOP AND END OF TWO ROWS OF BOXS

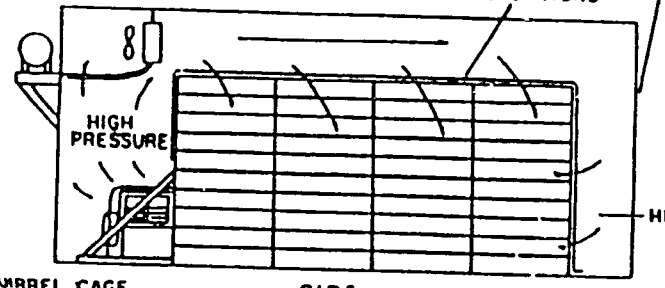
DOOR THIS END

PRE-COOLING OPERATION

HIGH AIR FLOW TO SPEED COOLING

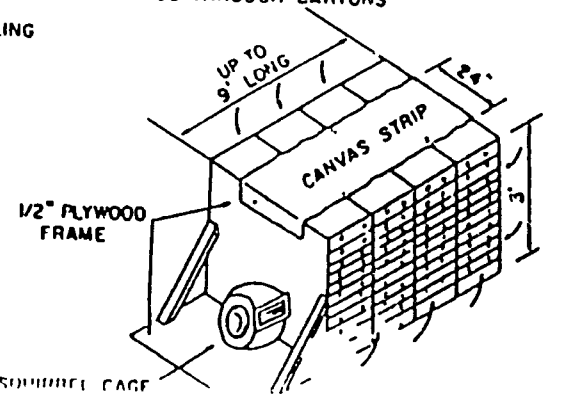
- CONTAINERS STACKED TIGHTLY TO PREVENT AIR LEAKAGE
- NARROW DIMENSION PARALLEL TO AIR FLOW
- CARTON OPENINGS SHOULD BE AT LEAST 4% OF SIDE AREA
- CANVAS STRIP FORCES AIR TO GO THROUGH CARTONS

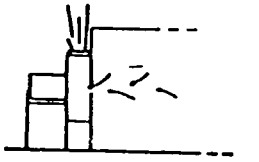
CANVAS STRIP OVER TOP AND END OF TWO ROWS OF PRODUCE CARTONS




SIDE

SQUIRREL CAGE AND PLATFORM SUCTION AIR



AIR FLOW THROUGH STACK AND FAN

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS

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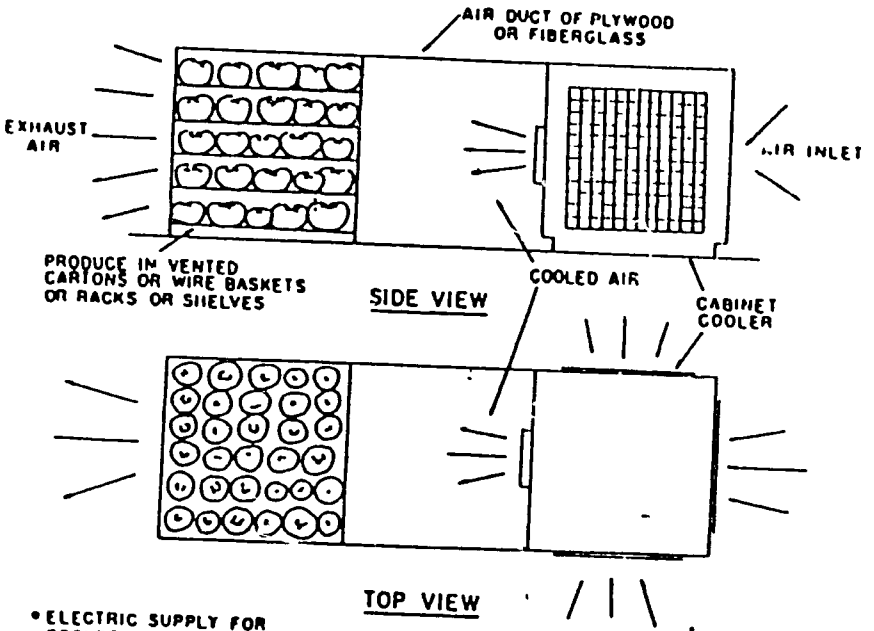
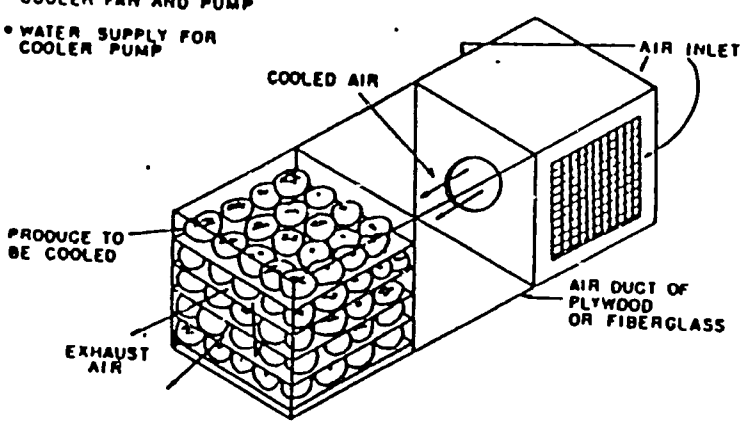
AND U S DEPT OF AGRI COOPERATING

TWO-TON COOLER

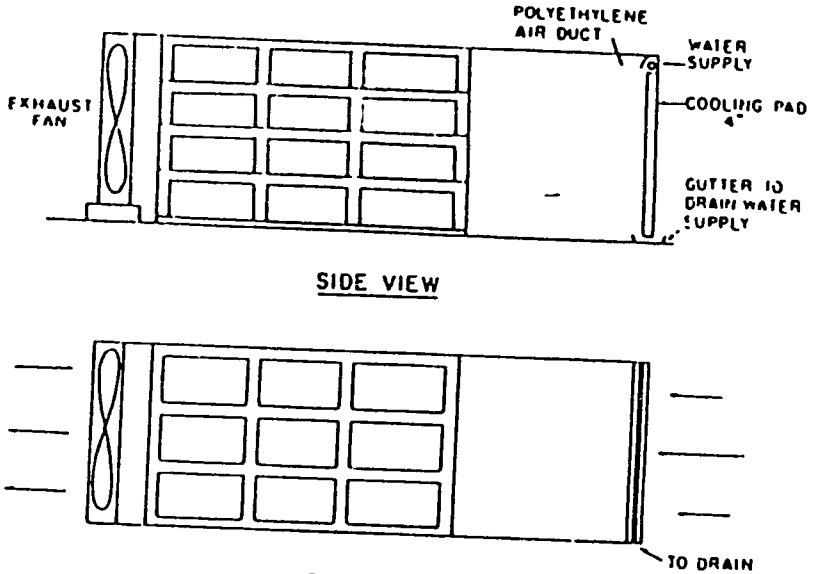
## CABINET COOLER



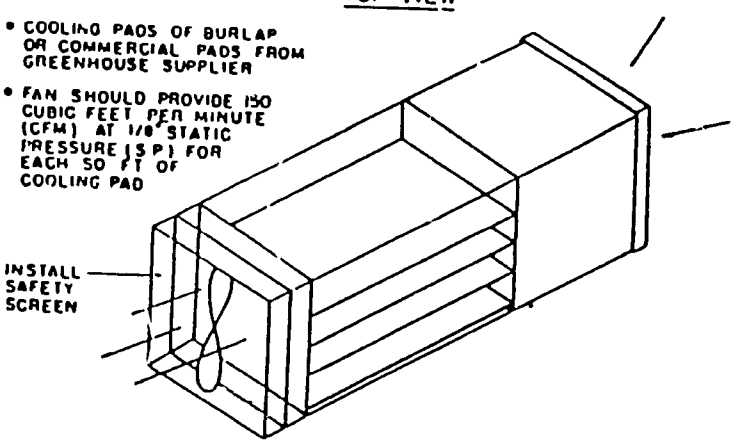

- ELECTRIC SUPPLY FOR COOLER FAN AND PUMP
- WATER SUPPLY FOR COOLER PUMP




## CUSTOM COOLER




- COOLING PADS OF BURLAP OR COMMERCIAL PADS FROM GREENHOUSE SUPPLIER
- FAN SHOULD PROVIDE 150 CUBIC FEET PER MINUTE (CFM) AT 1/8" STATIC PRESSURE (.5 P) FOR EACH 50 FT OF COOLING PAD




- EVAPORATIVE COOLING CAN LOWER TEMPERATURE OF OUTSIDE AIR BY 10-12° F BETWEEN 10 A.M. AND 7 P.M. DURING SUMMER. THIS WILL REMOVE SOME FIELD HEAT FROM PRODUCE AND INCREASE ITS SHELF LIFE
- CABINET COOLERS USUALLY INCLUDE SUMP PUMP AND FLOAT VALVE TO KEEP WATER IN SUMP. IF FLOAT IS INOPERATIVE REGULATE WATER INTO SUMP BY VALVE TO INSURE ADEQUATE WATER SUPPLY AND LET EXCESS WATER DRAIN
- AIR MUST BE FORCED THROUGH PAD AND AROUND PRODUCE TO REMOVE HEAT. DO NOT ALLOW AIR LEAKS BETWEEN PAD AND EXHAUST END

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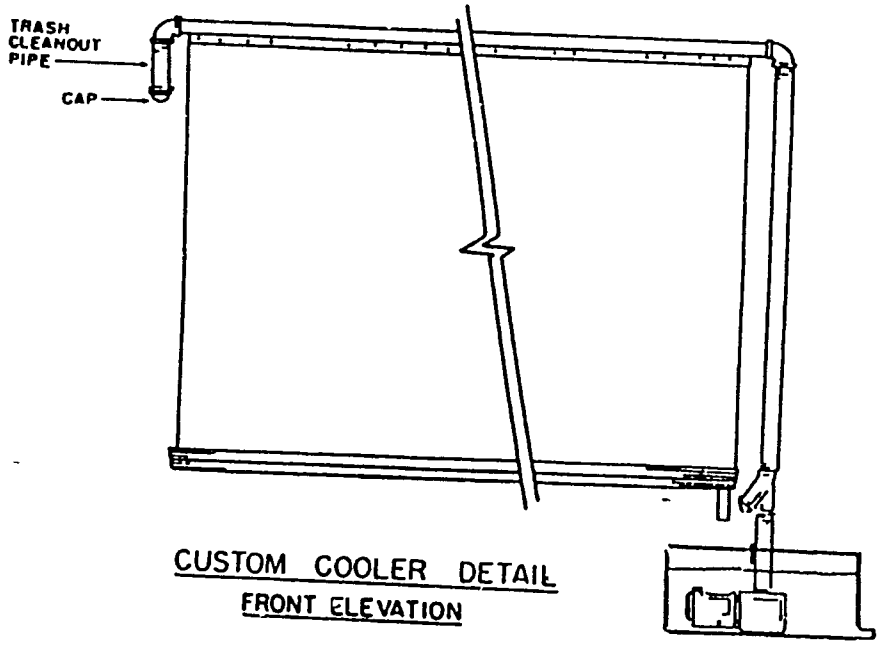
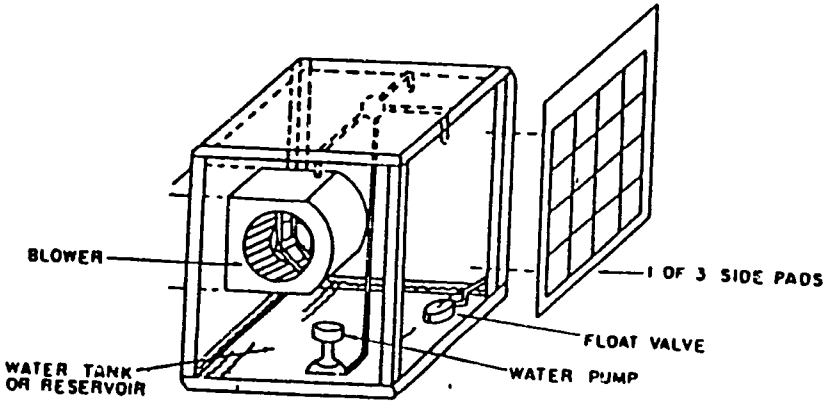
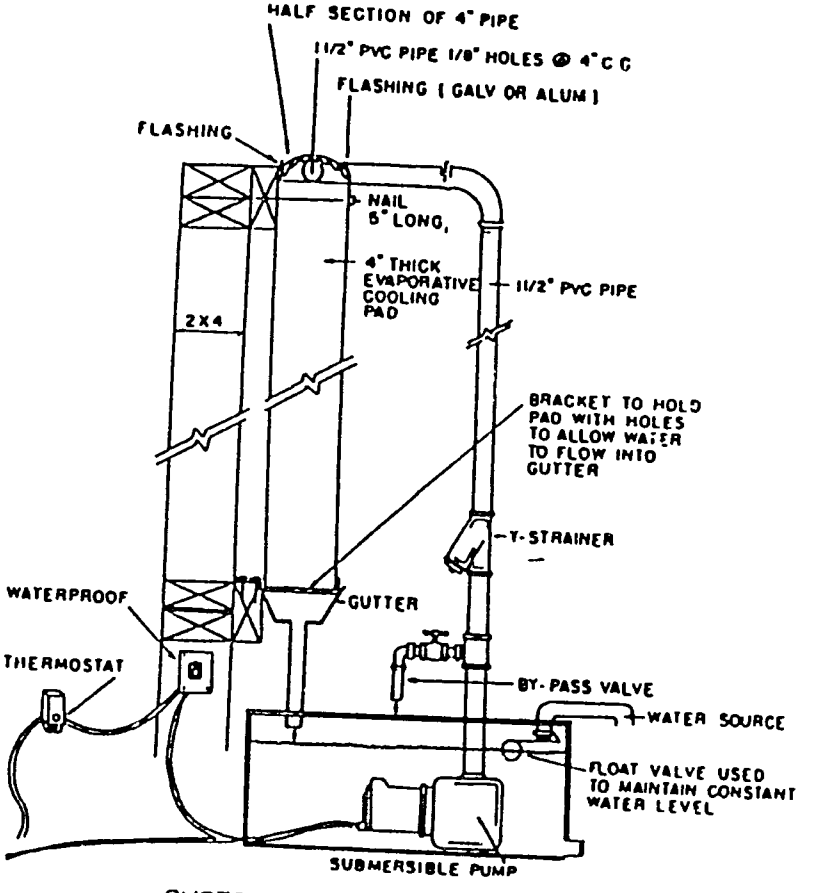
**EVAPORATIVE COOLING FOR FRESH PRODUCE**




CUSTOM COOLER DETAIL
FRONT ELEVATION




CABINET COOLER DETAIL




CUSTOM COOLER DETAIL
SIDE ELEVATION

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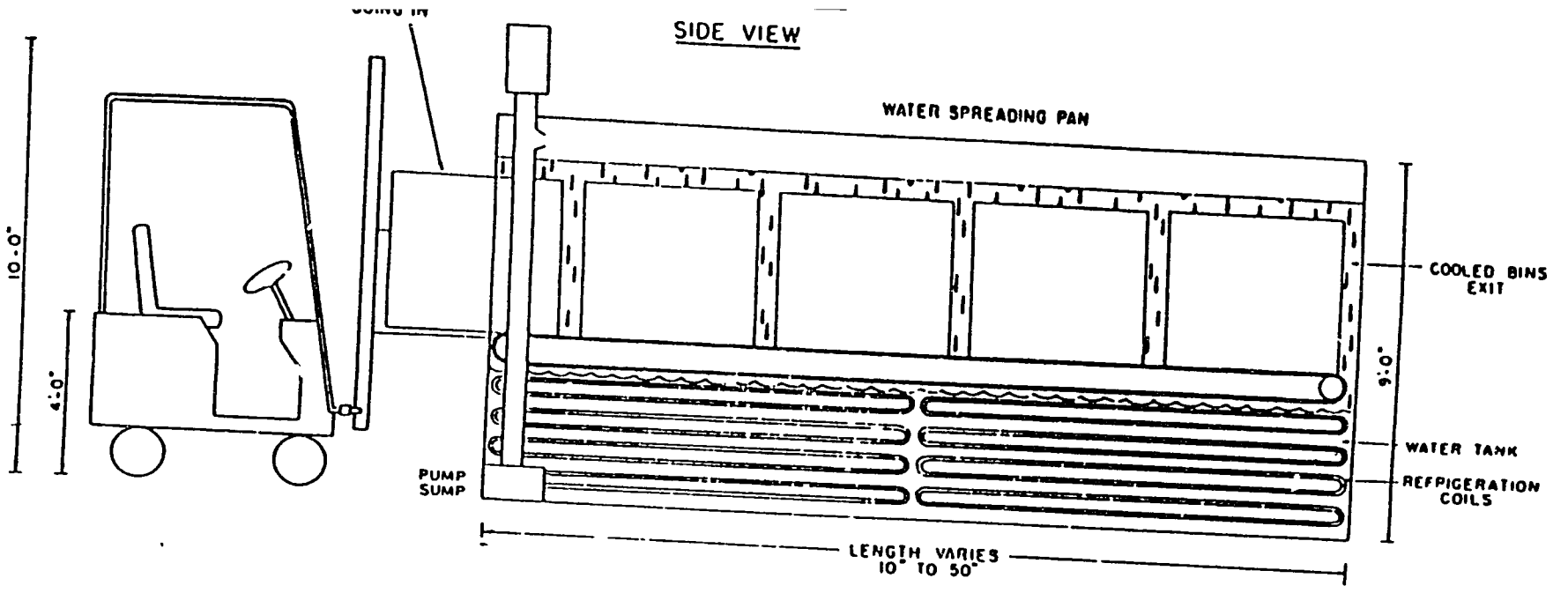
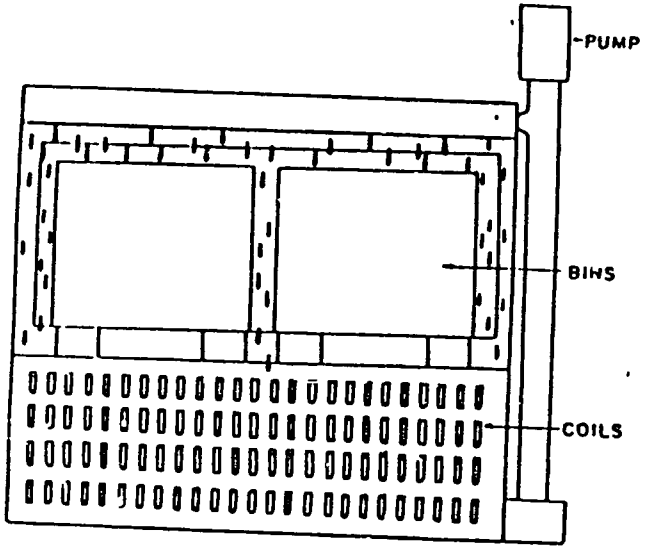
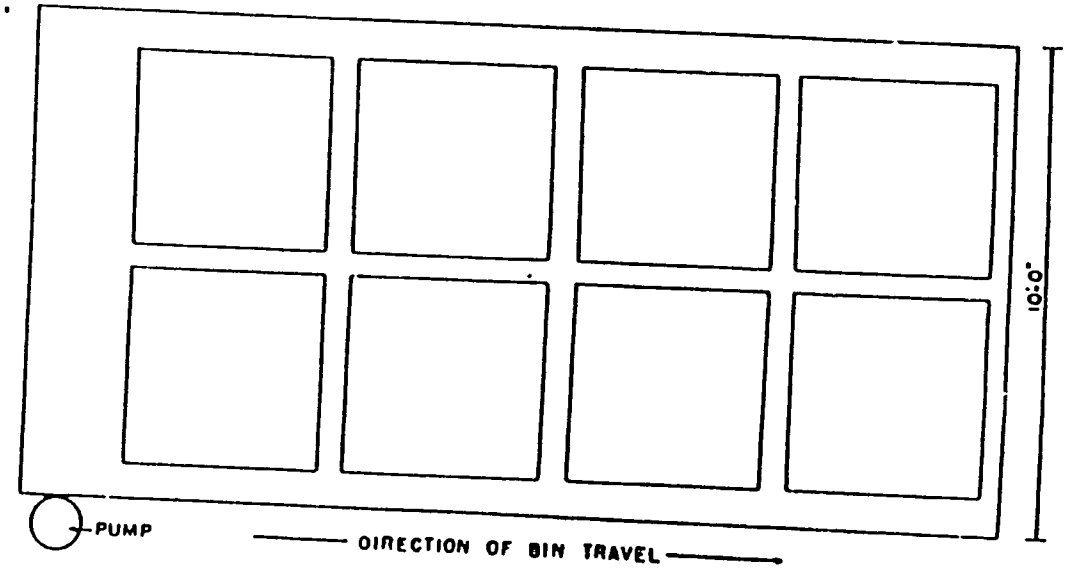
EVAPORATIVE COOLING FOR FRESH PRODUCE




CROSS SECTION




PLAN VIEW

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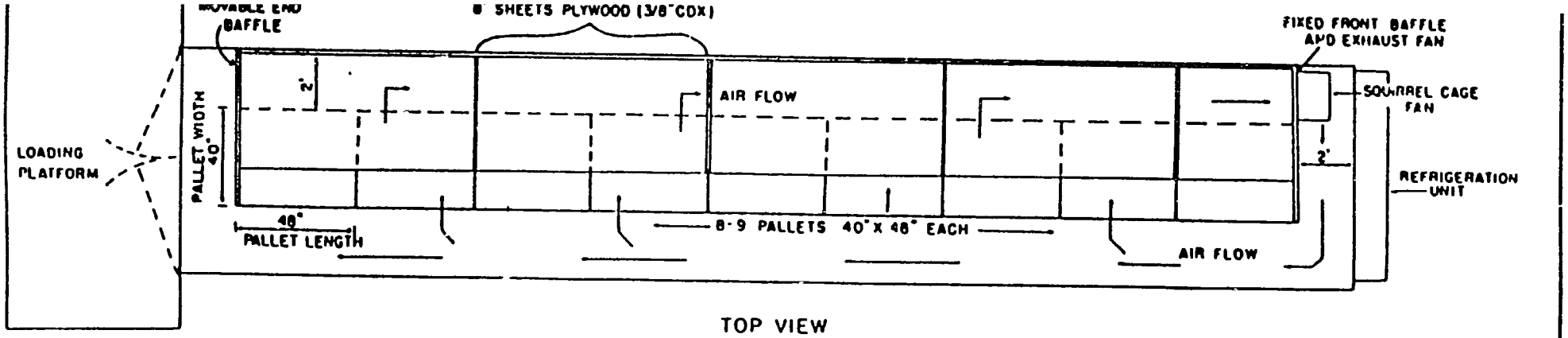
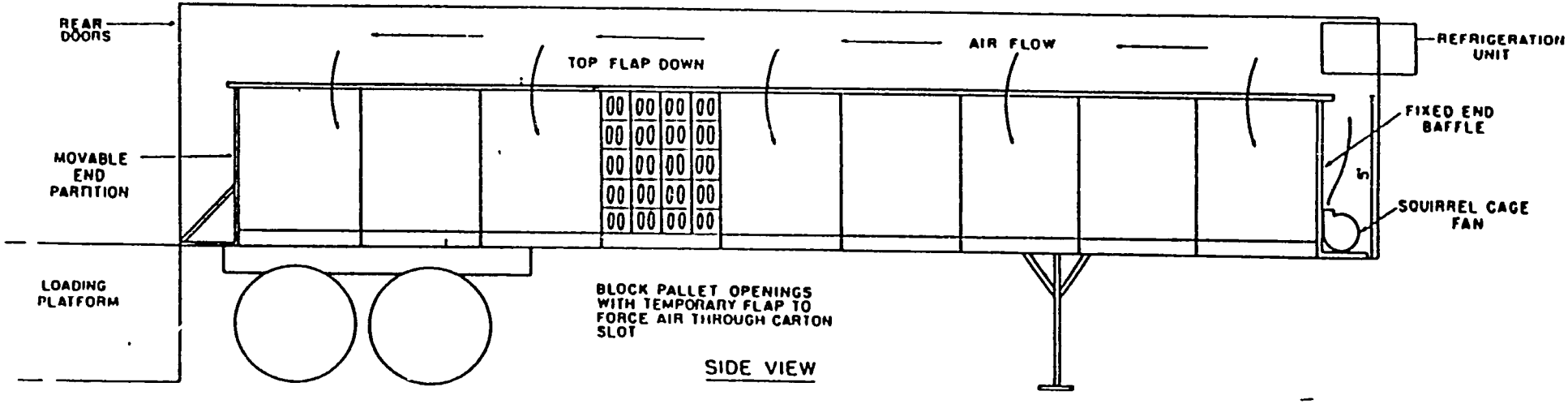
HYDRO COOLER

SCALE 1" = 2'0"




TOP VIEW

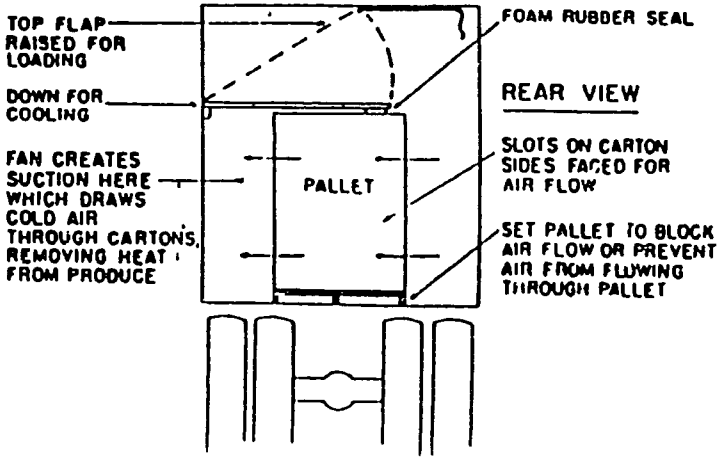



SIDE VIEW

COOLING RATE

WITH ADEQUATE AIR FLOW THROUGH CARTONS 2 TONS OF REFRIGERATION CAN LOWER TEMPERATURE OF:

| POUNDS OF PRODUCE | DEGREES (F) PER HOUR |
|---|---|
| 2,000 | 10 |
| 4,000 | 5 |
| 10,000 | 2 |
| 20,000 | 1 |




REAR VIEW

NOTE:

REFRIGERATION UNITS ARE USUALLY 2-3 TON CAPACITY 1 TON OF REFRIGERATION WILL REMOVE ENOUGH HEAT FROM 10,000 LB. OF PRODUCE TO LOWER TEMPERATURE ABOUT 1° F PER HOUR. IF THERE IS ENOUGH AIRFLOW TO GET THE HEAT OUT OF THE CARTONS AND TO THE EVAPORATOR COILS. 1 CARTON SLOT AREA SHOULD BE AT LEAST 4% OF SIDE PANEL AREA 1/2 CFM AIRFLOW PER LB OF PRODUCE TO BE COOLED, IS REQUIRED AT 0.5" S.P. MINIMUM

EXAMPLE:

5 PALLETS OF CUCUMBERS
10,000 LBS PRODUCE
5,000 CFM @ 1/2" SP
(PROBABLY 1 1/2 HP)

2 TONS REFRIGERATION SHOULD LOWER TEMPERATURE 2°F PER HOUR

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
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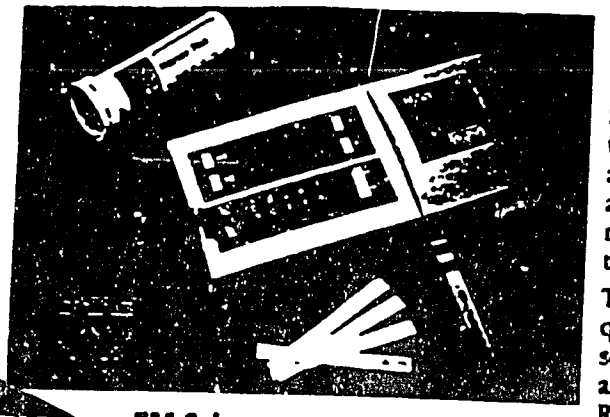
REFRIGERATED SEMI TRAILER PRESSURE COOLER

SCALE 3/8" = 1' 0"

SHEET 1 OF 1



NEW

## EM Science REFLECTOQUANT♦ System

### *Like Having a Lab in the Palm of Your Hand!*

- Error-Proof—Bar Code System Eliminates Data Entry Errors
- Networkable—Stored Measurement Data Downloadable to Computer for Easy Organization, Analysis
- Saves Time and Money—Costs Just Pennies per Test

Now you can get results when and where you need them. The Reflectoquant System is a revolutionary test technology that allows anyone to get accurate analyte concentration measurements anywhere in the lab or in the field.

The system gives you quantifiable results in just seconds for a wide variety of analytes. Just program the RQFLEX♦ hand held meter using the preprogrammed bar codes. Dip the appropriate Reflectoquant Test Strip in your sample. Then insert the strip into the meter and read the concentration directly on the digital display What could be simpler?

The meter can hold five test strip methods in memory to further automate your work. Plus, up to fifty individual test strip measurements can be stored by the instrument and downloaded to your computer for analysis and filing.

Get the only portable test system that combines the speed and convenience of test strips with the accuracy of a lab instrument Order the REFLECTOQUANT System today

| Cat. No. | Description | Each |
|---|---|---|
| EM-16950-1X5 | RQFLEX Meter | $495 00 |

*REFLECTOQUANT Test Strips*

| Cat. No. | Test Strip | Range, ppm | Pk. of 50 |
|---|---|---|---|
| EM-16981-1X5 | Ascorbic Acid | 25-450 | $44 95 |
| EM-16988-1X5 | Chromate | 1-45 | 49 95 |
| EM-16984-1X5 | Copper | 5-200 | 44 95 |
| EM-16979-1X5 | Molybdenum | 1-45 | 55.55 |
| EM-16971-1X5 | Nitrate | 5-225 | 44 95 |
| EM-16995-1X5 | Nitrate | 3-90 | 44 95 |
| EM-16973-1X5 | Nitrite | 0 5-25 | 44 95 |
| EM-16975-1X5 | Peracetic Acid | 1-22.5 | 44.95 |
| EM-16974-1X5 | Peroxide | 0 2-20 | 44 95 |
| EM-16996-1X5 | pH | 4-9 | 44 95 |
| EM-16980-1X5 | Silver (Fixing Bath) | 0.2-5 g/L | 44 95 |

**See Page 8 for a technical discussion of the applications of the REFLECTOQUANT System.**

# 6 ENVIRONMENTAL, TEMPERATURE/CONDUCTIVITY

NEW

## Oakton♦ Soil pH Test Kit

### *Eliminate Tiresome Chemical Analysis*

Here's a new approach to measuring soil pH for you. Combines the reliability of a microprocessor-based pocket-size pHTestr 1♦ with the portability of a soil pH test kit. Goes anywhere you need to take fast, repeatable readings

Dimensions: 7.75"L x 6"W x 2 75"H
Weight: 1 9 lbs

Comes as a complete kit so you're ready to start testing right away

| Cat. No. | Each |
|---|---|
| 34100-214X5 | $85 00 |

NEW

## Oakton♦ Conductivity/ Temperature Meter

### *Displays Temperature & Conductivity Together So You Can Work Faster, Better*

The Oakton Conductivity Meter is rich in features, yet modestly priced. Offers the five most useful measurement ranges with manual or auto ranging for fast response. You can calibrate to any conductivity standard value you choose and store up to five calibration points for highest accuracy in all ranges

Size 7 5"L x 3 5"W x 1 75"H
Weight 1 lb

When you want top value for your money in a conductivity meter, choose VWR Showcase Express

| Cat. No | Each |
|---|---|
| 34100-238X5 | $350 00 |

NEW

## Oakton pH/mV/°C Meter Kit

### *Organizes, Speeds Your Field Measurements*

Great for measurements in and out of the lab Puts everything you need, all in one place so you're ready to go at a moment's notice. Includes the Oakton pH/mV/°C meter, pH electrode, temperature probe, three buffer mixing bottles, squeeze bottle, two each of pH 4, 7 and 10 buffer capsules, batteries, two electrode holders and and a protective field case. Kit Size 15 5"L x 11"W x 4.5"H.
Weight: 4 5 lbs

Get the go-anywhere, use-anytime system so you're always ready to take professional measurements

| Cat. No | Each |
|---|---|
| 34100-232X5 | $360 00 |

AVAILABLE

NEW

## Hanna CHECKER pH Tester

### *Get High Accuracy with 0.01 pH Resolution in a Pocket-Size Unit*

Represents the latest generation of pH testers Just immerse in your sample and read the pH value Unlike other pH testers, you can change the electrode to the size and shape that are perfect for your application. Electrode must be purchased separately Range: 0.00 to 14 00 pH Size 2.6" x 2 0" x 1" Weight: 2.2 oz.

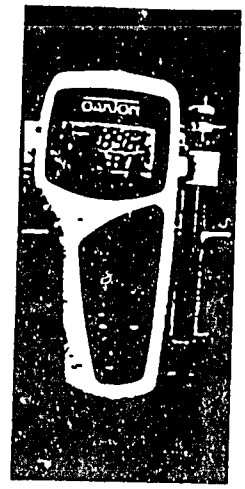
For the cost of a few rolls of litmus paper, you can have the industry's most advanced pH tester!

| Cat. No. | Description | Each |
|---|---|---|
| 34100-300X5 | CheckerVWR w/built-in screw connector | $35 00 |
| 34100-405X5 | CheckerB w/built-in BNC connector | 23 00 |
| 34100-407X5 | Screw type, epoxy body, gel filled electrode for 34100-300X5 | 13 65 |

NEW

## Oakton♦ Conductivity/TDS/ Temperature Meter with RS-232

### *Download Readings Straight to Your PC or Printer*



This Oakton unit gives you more features and better performance than any meter in its price range You can switch accurately and immediately from conductivity to TDS readings with temperature.

Memory function stores and recalls up to 16 sets of measurements And the RS-232 interface lets you download data to virtually any PC for analysis or to your printer for hardcopy records Size: 7.5"L x 3 5"W x 1.75"H. Weight. 1 lb.

You can count on this meter from Oakton when you need superior data management of your conductivity and TDS readings

| Cat. No. | Each |
|---|---|
| 34100-242X5 | $625 00 |

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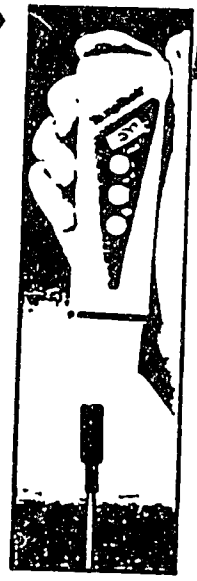
Call today to be placed on the list for your FREE copy of the 94-95 VWR Scientific General Catalog. It's the comprehensive source book for all your laboratory needs. Call now to reserve your copy - available this Spring.

NEW

## Oakton♦ TempTestr♦ Thermometer

### *Fast, Stable Readings in a Pocket-Size Unit*



Remarkable accuracy and a whole range of "easy-use" features are made possible because of the TempTestr's microprocessor Accuracy is ±1° Features include °F/°C selectable scale, hold function, push button calibration, auto-off and self-diagnostics Size 5.9"L x 1 6"W x 0 94" H Weight: 3 25 oz.

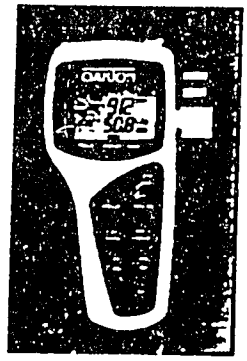
Choose Oakton for the "next generation" in temperature testing

| Cat. No. | Each |
|---|---|
| 34100-228X5 | $35 50 |

NEW

## Oakton♦ Conductivity/TDS/ Temperature Meter

### *Gives You Three Meters in One*



Let's you switch from conductivity to TDS measurement with temperature accurately and easily with the touch of button

Use the auto-ranging feature or select manually between five conductivity ranges Meter auto-ranges in the TDS mode Simple to calibrate 1% FS accuracy Dimensions 7 5"L x 3 5"W x 1 75"H Weight 1 lb

Get the most advanced meter in its class from VWR Express

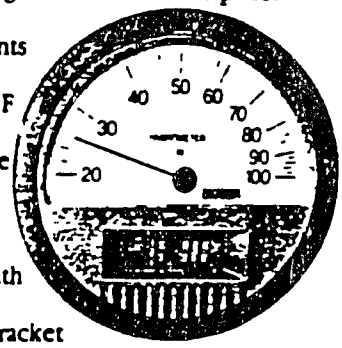
| Cat. No. | Each |
|---|---|
| 34100-240X5 | $475 00 |

NEW

## Oakton♦ Thermohygrometer

### *A Reliable, Economical Selection for Environmental Monitoring*

Monitor both the humidity and temperature of your office, laboratory, greenhouse or computer room environments Switch-selectable °F or °C temperature readout Accurate and stable Supplied with battery and mounting bracket



Order before noon, we'll ship your thermohygrometer today You could have it tomorrow

| Cat. No. | Each |
|---|---|
| 35521-050X5 | $120 00 |



AVAILABLE DOCUMENT

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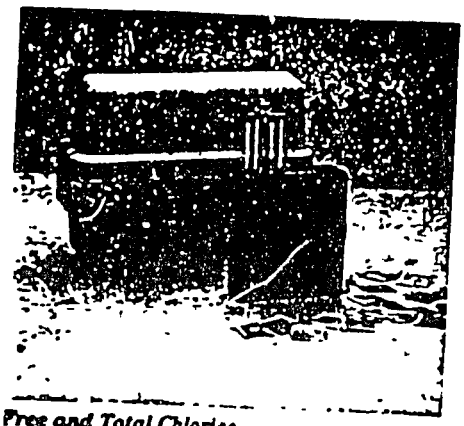
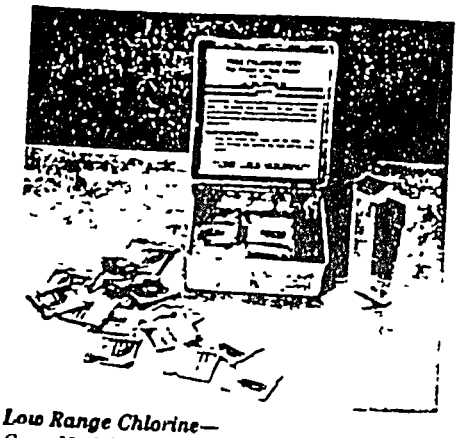


*Free and Total Chlorine—Model CN-66, Cat. No 2231-01*



*Low Range Chlorine—Cube Model, Cat. No 20603-00*

*Chloride—CD-51, Cat. No. 2086-01*

**Chloride.** Found in nearly all natural waters, chloride affects human taste above 250 mg/L. High levels inhibit plant growth, and many industrial processes need to limit chloride concentration. Test kits use either silver or mercuric nitrate titrant and the Model CD-DT, a multi-range kit, is supplied with a demineralizer bottle for high-range sample dilution

**Chlorine.** The most widely used disinfectant for drinking water, chlorine is also important for sanitizing swimming pools, cooling towers and other industrial equipment, and in the treatment of municipal wastewater Its measurement and control are vital for both safety and economic reasons

Many Hach chlorine tests have been approved by the U S Environmental Protection

| Test | Cat. No. | Model | Range (mg/L) | Smallest Increment (mg/L) | Method/Chemistry | Approx. No. of Tests | Case Style (See p. 194) | Ship. Wt. (lb) | Price |
|---|---|---|---|---|---|---|---|---|---|
| **Chloride** | | | | | | | | | |
| As Cl- | 1440-01 | 8-P | 5-100 | 5 | Drop count titration/ Silver nitrate | 100 | B | 1 | $25.00 |
| | 2086-01 | CD-51 | 20-400<br>500-10,000 | 20<br>500 | Drop count titration/ Silver nitrate | 100 | B | 1 | 62 50 |
| As Cl- | 20635-00 | CD-DT | 5000-100,000<br>10-8000 | 5000<br>0 1-20 | Digital Titrator/ Mercuric nitrate | 100 | F | 4 | 150 15 |
| **Chlorine, low range** | | | | | | | | | |
| As free $Cl_2$ | 20603-00 | Cube | 0-2 5 | 0 5 | Color cube/ DPD | 50 F | A | 0 5 | 12 50 |
| As total $Cl_2$ | 20604-00 | Cube | 0-2 5 | 0 5 | Color cube/ DPD | 50 T | A | 0.25 | 12 50 |
| As free $Cl_2$ | 2231-02* | CN-66F | 0-3 5 | 0.1 | Color disc/ DPD | 100 F | B | 1 | 32 50 |
| As total $Cl_2$ | 2231-03* | CN-66T | 0-3 5 | 0.1 | Color disc/ DPD | 100 T | B | 1 | 32.50 |
| s free & otal $Cl_2$ | 2231-01* | CN-66 | 0-3 5 | 0 1 | Color disc/ DPD | 50 F + 50 T | B | 1 | 32 50 |
| s free & otal $Cl_2$ | 14542-00* | CN-70 | 0-0 7<br>0-3 5 | 0.02<br>0 1 | Color disc/ DPD | 100 F + 100 T | D | 2 | 45.75 |
| s free $Cl_2$ | 14542-01* | CN-70F | 0-0 7<br>0-3.5 | 0 02<br>0.1 | Color disc/ DPD | 200 | D | 2 5 | 45 75 |
| s total $Cl_2$ | 14542-02* | CN-70T | 0-3.5<br>0-0 7 | 0.1<br>0.02 | Color disc/ DPD | 200 | D | 2.5 | 41.45 |
| s free & otal $Cl_2$ | 21290-00* | CN-80 | 0-0.7<br>0-3 5 | 0,02<br>0 1 | Color disc/ DPD | 100 F + 100 T | D | 2 5 | 75.50 |
| -10 mg/L: T only) | | | 0-10T | 0 5 | | | | | |
| free & tal $Cl_2$ | 41100-02† | DR 100 | 0-2<br>0-3.5 | 0.02<br>0.1 | Colorimeter/ DPD | 100 F + 100 T | F | 3.5 | 245 00 |
| AccuVac Ampuls as free $Cl_2$) | 25020-25† | AccuVac | 0-2 | Pkg of 25 *free* chlorine reagent ampuls (resupply for Cat No 41100-02) | | 25 | | | 12.95 |
| AccuVac Ampuls as total $Cl_2$) | 25030-25† | AccuVac | 0-2 | Pkg of 25 *total* chlorine reagent ampuls (resupply for Cat No 41100-02) | | 25 | | | 12.95 |
| free & al $Cl_2$ | 46700-00† | Pocket Colorimeter | 0-2<br>0-4 5 | 0 01<br>0 1 | Colorimeter/ DPD | 100 | D | 2.5 | 295 00 |

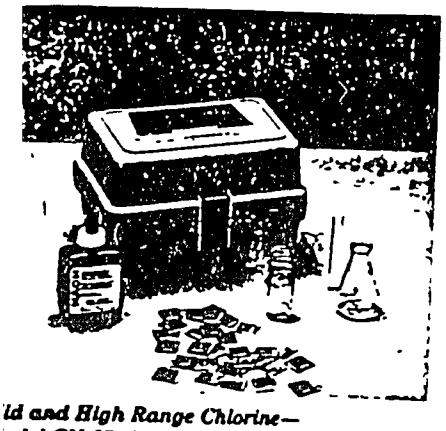
proved by some states for potable water reporting under specified conditions Check with your regulatory agency
EPA-approved for analysis of wastewater and potable water



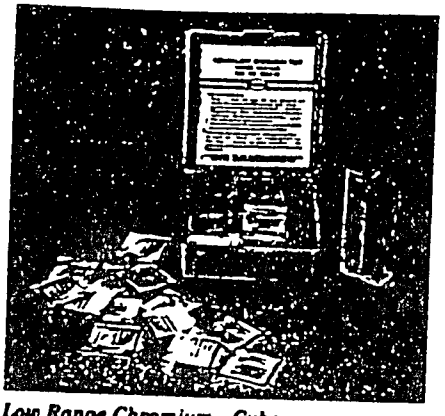
BEST AVAILABLE DOCUMENT



70



*ld and High Range Chlorine—odel CN-65, Cat. No 2254-01*



*Low Range Chromium—Cube Model, Cat. No. 12527-00*

*Low Range Chromium—DR 100 Colorimeter, Cat. No. 41100-03*

gency for reporting purposes. pproved tests are indicated in e chart on page 152.

st kits containing DPD lorimetric reagent are used ost often for monitoring table water, swimming pools d waste effluent. Powder DPD cts with chlorine more ckly than tablet-form DPD, ing more accurate results wder DPD also has a siderable advantage over orthotolidine, a hazardous substance sometimes used as a chlorine test reagent.

Kits for determining higher levels of chlorine use thiosulfate to measure chlorine titrimetrically. All chemicals used in Hach test kits are manufactured by Hach Company to ensure compliance with stringent quality control standards.

**About $Cl_2$, $Br_2$ and $I_2$ testing**—All of our total chlorine test kits can be used to measure iodine or bromine in the absence of chlorine or other oxidants. For iodine concentration, multiply test results by 3.58; for bromine, multiply by 2.25. Kits also are available for the direct measurement of bromine and iodine. See alphabetical list on page 146.

**Chromium.** Widely used as a corrosion inhibitor in cooling towers and engine cooling systems, chromium is also used in surface finishing, leather tanning and other industries. The most widely used form, hexavalent chromium, is very toxic and strict limits are placed on discharges.

TEST KITS

| st | Cat. No. | Model | Range (mg/L) | Smallest Increment (mg/L) | Method/Chemistry | Approx. No. of Tests | Case Style (See p. 194) | Ship. Wt. (lb) | Price |
|---|---|---|---|---|---|---|---|---|---|
| **lorine, mid and high range** | | | | | | | | | |
| total $Cl_2$ | 2254-01 | CN-65 | 0.2-4<br>1-20 | 0.2<br>1.0 | Drop count titration/ Thiosulfate | 100 T | D | 2 | $49.50 |
| | 24444-00 | CN-21P | 10-200 | 10 | Drop count titration/ Thiosulfate | 100 T | B | 1 | 22.50 |
| | 24711-00 | CN-DT | 20-2000 | 0.2-5.0 | Digital Titrator/ Thiosulfate | 100 T | F | 4 | 153.00 |
| **romium, low range** | | | | | | | | | |
| hexavalent Cr | 12527-00 | Cube | 0-1.0 | 0.2 | Color cube/ Diphenylcarbazide | 50 | A | 0.5 | 12.50 |
| | 1834-00 | CH-8 | 0-1.5 | 0.1 | Color disc/ Diphenylcarbazide | 100 | D | 1 | 35.00 |
| | 41100-03* | DR 100 | 0-0.5 | 0.05 | Colorimeter/ Diphenylcarbazide | 100 | F | 3 | 245.00 |
| cuVac ipuls | 25050-25* | AccuVac | 0-0.5 | Pkg of 25 hexavalent chromium reagent ampuls (resupply for Cat. No 41100-03) | | 25 | | | 13.95 |
| exavalent & l Cr (Trivalent ifference) | 2228-00 | CH-12 | 0-1.5 | 0.1 | Color disc/ Diphenylcarbazide, Hypobromite oxidation | 50 $Cr^{6+}$ + 50 T† | F | 3 | 108.00 |
| **nium, high range** | | | | | | | | | |
| exavalent Cr | 2227-02 | CH-14 | 5-100<br>50-1000 | 5<br>50 | Drop count titration/ Thiosulfate | 100 | D | 2 | 35.00 |
| | 20634-00 | CH-DT | 20-400 | 0.2-2 | Digital Titrator/ Thiosulfate | 100 | G | 7.5 | 154.00 |
| **mium (Hexavalent) in Soils and Water** | | | | | | | | | |
| | 24618-00 | | 0.5-15,000 mg/kg (soil)<br>0-750 mg/L (water) | | Extraction/ Diphenylcarbazide | | Q | 10 | 252.00 |

*Approved for analysis of wastewater. †Kit includes nine Heatab fuel tablets (required for digestion). Each Heatab will provide fuel for five total chromium nations. To order additional Heatabs see page 195.



BEST AVAILABLE DOCUMENT

*Literature Request Form appears on reverse side.*

# FAX/MAIL ORDER FORM

**Address order to: HACH COMPANY, P O Box 608, Loveland, CO 80539-0608**
Use this convenient form, your own purchase orders, or FOR PROMPT PHONE SERVICE CALL 800-227-4224 If ordering by phone, please have information related to items 1-4 (below) ready

**1** If Hach account number is not known, leave the space blank

**2** Most chemicals and apparatus are sold separately ("each"), but others are sold in units Powder pillows, for example, are available in packages of 100 To purchase 100 powder pillows, order 1 unit, not 100 pillows Be sure to order the number of units (packages) you need

**3** Include all numbers given in the catalog description

**4** A one- or two-word description of item

**5** If more than one size of an item is offered, state the size you want

**6** Your shipping charge goes here Figure your simplified freight fee with the table found on page 314

**7** Check one box Tax exempt status must be substantiated with documentation identifying your tax exempt number If taxable, sales tax will be added to the invoice

☐ Check box if "Ship To" information is identical to "Bill To"

**BILL TO**

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DIVISION OF
ADDRESS
CITY STATE ZIP
ATTENTION
PHONE NO ( ) EXTENSION

**SHIP TO**

ATTENTION
COMPANY
DIVISION OF
ADDRESS
CITY STATE ZIP

HACH ACCOUNT NO (if available) **1**

**PAYMENT METHOD:** ☐ Check ☐ MasterCard ☐ VISA ☐ Purchase Order

Card Account No or Purchase Order No  Card Exp Date  Signature

| 2 HOW MANY | 3 CAT NO | 4 DESCRIPTION | 5 UNIT SIZE | UNIT PRICE | TOTAL |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Prices are effective May 1, 1993, and are subject to change without notice **6** Shipping Charge
**7** TAXABLE? ☐ Yes ☐ No
If no, tax exempt document is ☐ Enclosed ☐ On file at Hach
**TOTAL ORDER**

## Check the type of samples (up to five) you test

- ☐ (A25) Drinking Water
- ☐ (B22) Sewage Water
- ☐ (C23) Well Water residential
- ☐ (D24) Surface Water (including lakes rivers rain, etc )
- ☐ (E04) Fisheries Water
- ☐ (F05) Swimming Pool Water
- ☐ (G21) Industrial Wastewater
- ☐ (H17) Boiler Water (Power Production)
- ☐ (I19) Boiler Water (HVAC)
- ☐ (J18) Boiler Water (Industrial Process Heating)
- ☐ (K20) Cooling Water
- ☐ (L10) Ultrapure Water
- ☐ (M12) Meat, Poultry Fish (including pet food)
- ☐ (N13) Cheese Dairy
- ☐ (O14) Cereals Snack Foods
- ☐ (P16) Beverages
- ☐ (Q08) Brine Water (Chlor alkali)
- ☐ (R06) Brine Water (Oilfield)
- ☐ (S07) Metal Finishing Baths
- ☐ (T09) Dialysis Water/Clinical
- ☐ (U15) Animal Feed
- ☐ (V03) Soil, Plant, Fertilizer
- ☐ (W01) Sludge
- ☐ (Y02) Petrochemical Refinery Samples
- ☐ (Z26) Other _____

## Check *ONE* box best describing the principal product manufactured or service performed.

**AGRICULTURE/FISHERIES**
- ☐ 0100 Farms Crops
- ☐ 0200 Farms Livestock
- ☐ 0700 Soil Crop Landscape Services
- ☐ 0800 Forestry
- ☐ 0921 Fish Farming Hatcheries Aquaculture

**MINING**
- ☐ 1000 Ores Coal Nonmetallics
- ☐ 1300 Oil/Gas Extraction & Services

**CONSTRUCTION**
- ☐ 1500 General Building/Other Trades
- ☐ 1629 Industrial Contractors (power water/wastewater plants)
- ☐ 1711 HVAC Contractors
- ☐ 1780 Construction Water Well Drilling

**MANUFACTURING**
- ☐ 2010 Meat/Poultry
- ☐ 2020 Dairy
- ☐ 2040 Grains/Cereals
- ☐ 2080 Beverage/Wine/Brewery
- ☐ 2088 Bottled Water
- ☐ 2090 Other Food and Kindred Products
- ☐ 2600 Pulp & Paper
- ☐ 2800 Chemicals (industrial plastics cosmetics detergents paints misc )
- ☐ 2830 Pharmaceuticals drugs
- ☐ 3300 Metals primary
- ☐ 3400 Metals fabricated
- ☐ 3471 Plating and polishing
- ☐ 3500 Machinery industrial
- ☐ 3600 Electronic electrical equipment
- ☐ 3670 Electronic components
- ☐ 3800 Instruments & related products
- ☐ 3900 Other manufacturing

**PUBLIC/WATER UTILITIES**
- ☐ 4911 Power plant electrical utilities
- ☐ 4920 Natural Gas Production & Distribution
- ☐ 4941 Water Supply Treatment
- ☐ 4952 Sewage Treatment Plants
- ☐ 4939 Combined Utility Service
- ☐ 4953 Refuse Systems

**WHOLESALE/RETAIL TRADE**
- ☐ 5000 Wholesale Goods
- ☐ 5200 Retail Goods
- ☐ 5997 Pool/Spa Sales & Service

**SERVICES**
- ☐ 7011 Hotels & other lodging
- ☐ 7900 Pools Recreational Facilities & Services
- ☐ 7390 Water Conditioning Point-of-Use
- ☐ 28 0 Water Conditioning Industrial
- ☐ 8000 Health Care & Services
- ☐ 8711 Consultants/Engineering Services
- ☐ 8730 Research/Testing Lab Services

**EDUCATION**
- ☐ 8211 Elementary secondary schools
- ☐ 8221 Colleges, universities vocational schools

**PUBLIC ADMINISTRATION**
- ☐ 9431 Public Health
- ☐ 9511 USEPA, regulatory agencies
- ☐ 9512 Land, Mineral Wildlife
- ☐ 9711 National Security Armed Forces

**OTHER**
- ☐ If none of these categories fits your business, please describe here _____

1632

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12

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# FREEZ/SAFE® INSULATED CONTAINERS

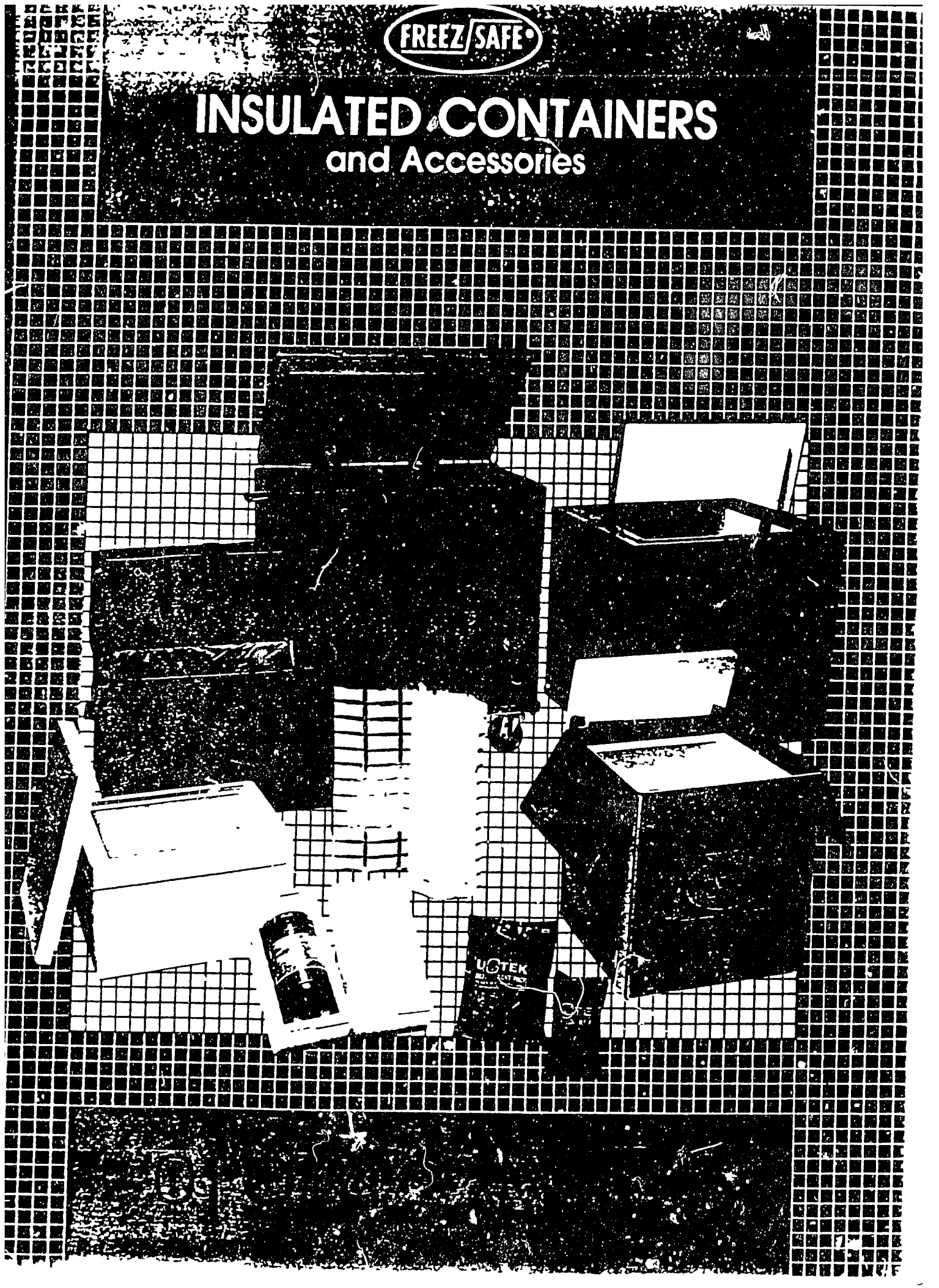
## PRICE LIST NO. 600

| Model No | Description | Interior (bottom) Dimensions in Inches L x W x H | Pack per Case | Case Price |
|---|---|---|---|---|
| | **NYLON-CLAD TRANSPORTERS** | | | |
| 50C | Top-opening cabinet with 2½" thick foam-insulated walls and hinged lid Tough nylon fabric forms washable, removable, inner/outer cover with carrying strap Exterior in red or blue (specify color when ordering), interior in heat-reflective silver UPS | 23⅛ x 14⅛ x 23 | 1 | $121.80 |
| 25C | Same design and construction as Model 50C, but smaller capacity and 2" thick walls In red or blue UPS | 16¾ x 16¾ x 15⅝ | 1 | 91.85 |
| 20C | Same as Model 25C, but 3 inches shorter In red or blue UPS | 16¾ x 16¾ x 12⅝ | 1 | 79 90 |
| NEW! 195 | Same design and construction as Model 50C, but smaller capacity and 1½" thick walls In red or blue Now available in black too! UPS | 17¼ x 10 x 16½ | 1 | 69.85 |
| NEW! 196 | Same as Model 197, but 2½ inches shorter In red or blue Now available in black too! UPS | 17¼ x 10⅛ x 8¼ | 1 | 50.00 |
| NEW! 197 | Same design and construction as Model 50C, but smaller capacity, 1½" thick walls, and adjustable carrying strap for stadium-style vending or hand carrying In red or blue Now available in black too! UPS | 17¼ x 10⅛ x 10⅝ | 1 | 63.90 |
| 198 | Same as Model 195, but smaller Perfect for food deliveries UPS | 11½ x 9¾ x 9¼ | 1 | 45 50 |
| 110C | Same design and construction as Model 50C, but smaller capacity and 2" thick walls In red or blue UPS | 12 x 12 x 11½ | 1 | 57.90 |
| | **FIBERBOARD-CASED TRANSPORTERS** | | | |
| 50FW | Top-opening cabinet with 2½" thick foam-insulated walls, fiberboard exterior with plain foam interior UPS | 23⅛ x 14⅛ x 23 | 1 | 76 00 |
| 25FW | Same construction as 50FW, but smaller capacity and 2" thick walls. UPS | 16¾ x 16¾ x 15⅝ | 1 | 54.85 |
| 20FW | Same as 25FW, but 3 inches shorter UPS | 16¾ x 16¾ x 12⅝ | 1 | 47.05 |
| 15FW | Same construction as 50FW, but smaller and with 1½" thick walls With strap UPS | 17 x 9⅞ x 16⅞ | 1 | 37.45 |
| 110FW | Same construction as 50FW, but smaller capacity, 2" walls With strap UPS | 12 x 12 x 11½ | 1 | 30.65 |
| 175FW | Same construction as 50FW, but with smaller capacity and 1½" thick walls Includes nylon web carrying strap UPS | 18¾ x 11⅞ x 12¼ | 1 | 31.13 |
| 40FW | Same construction as 50FW, but smaller capacity and 1" thick walls UPS | 11¾ x 8½ x 11½ | 8 | 73.95 |
| 38FW | Same construction as 50FW, but smaller capacity and 1½" thick walls UPS | 10¾ x 7½ x 10½ | 8 | 88 55 |
| | **HARD-CASED TRANSPORTERS** | | | |
| 50RRH | Top-opening, seamless, molded polyethylene, foam-insulated cabinet with 1 lid-stay, 2 hinges, 2 latches and 2 handles UPS | 22¾ x 13½ x 21¼ | 1 | 468 45 |
| 50RRHDL | Same as Model 50RRH, but with detachable lid UPS | 22¾ x 13½ x 21¼ | 1 | 475 30 |
| 50RR | Same as 50RRH, but without handles UPS | 22¾ x 13½ x 21¼ | 1 | 425.80 |
| 50RRDL | Same as Model 50RR, but with detachable lid UPS | 22¾ x 13½ x 21¼ | 1 | 432.65 |
| 50RS | Top-opening cabinet with 2½" foam walls Luggage-grade ABS plastic exterior, foam interior With carrying strap UPS | 23⅛ x 14⅛ x 23 | 1 | 263.30 |
| 25RRDL | Top-opening, seamless, molded polyethylene, foam-insulated chest with molded-in handles and detachable lid, 4 latches UPS | 17⅞ x 16⅞ x 16½ | 1 | 316.25 |
| 25RR | Same as 25RRDL but with hinged-lid, 2 latches and molded-in handles UPS | 17⅞ x 16⅞ x 16½ | 1 | 283.90 |
| 20RRH | Top-opening chest with 2" thick foam walls Luggage-grade ABS plastic exterior and interior; 2 handles, 4 latches UPS | 16¾ x 16¾ x 12⅝ | 1 | 303 20 |
| 20RS | Top-opening chest with 2" thick foam-insulated walls Luggage-grade ABS plastic exterior and foam interior Includes nylon web carrying strap UPS | 16¾ x 16¾ x 12⅝ | 1 | 172.65 |
| 170 | Seamless polyethylene, foam-insulated chest Top-opening, with hinges, lid-stay, 2 latches and 2 handles UPS | 15⅛ x 13⅞ x 12½ | 1 | 202.70 |
| 152 | Top-opening chest with 2¼" thick foam-insulated walls Luggage-grade plastic interior and exterior, with top handle, hinges and 2 latches UPS | 16⅝ x 10¼ x 10¾ | 1 | 119.35 |
| 146 | Smaller version of Model 152, but also with rubber feet for table-top use UPS | 11½ x 9¾ x 9¼ | 1 | 112.50 |
| | **HANDLING ACCESSORIES** | | | |
| 500LB | Dolly for Models 50RRH and 50RR UPS | | 1 | 108 95 |
| 50LB | Dolly for Models 50C, 50RS and 50FW UPS | | 1 | 108 95 |
| 25LB | Dolly for Models 25C, 25FW, 20C, 20RRH, 20RS and 20FW UPS | | 1 | 108.95 |
| 25LBR | Dolly for Models 25RRDL and 25RR UPS | | 1 | 108.95 |
| 25LBR-2 | Double Dolly for Models 25RRDL and 25RR UPS | | 1 | 170 00 |
| 50B | Set of 5 stacking baskets of vinyl-coated steel wire for Models 50C, 50RRH, 50RR, 50RRDL, 50RS and 50FW UPS | | 5 | 82 60 |
| 25B | Baskets, same construction as Model 50B, but set of 3 for Models 25C, 25RRDL, 25RR, 25FW, 20C, 20RRH, 20RS and 20FW UPS | | 3 | 46 80 |
| 15B | Baskets, same as Model 50B, but set of 3 for Models 195 and 15FW UPS | | 3 | 45 30 |
| 10B | Baskets, same construction as Model 50B, but set of 3 for Models 195, 197, 196 and 152 UPS | | 3 | 59 40 |
| 50S | Nylon web carrying strap with handles for 50RS and 50FW UPS | | 1 | 7 30 |
| 25S | Strap, same as Model 50S but for 25RR, 25FW, 20RS and 20FW UPS | | 1 | 7 10 |
| 15S | Strap, same as Model 50S, but for 15FW UPS | | 1 | 6 65 |
| 38S | Belt-style nylon web carrying strap for 110FW, 40FW and 38FW UPS | | 1 | 6 65 |

UPS — Indicates that can be shipped via United Parcel Service

FREEZ/SAFE®

# INSULATED CONTAINERS
## and Accessories



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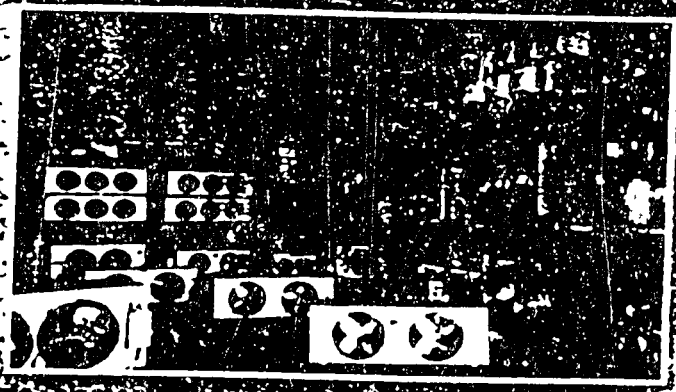

Large Cooler / Freezer Inventory

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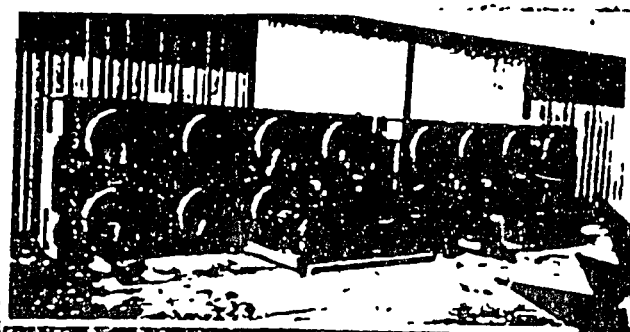
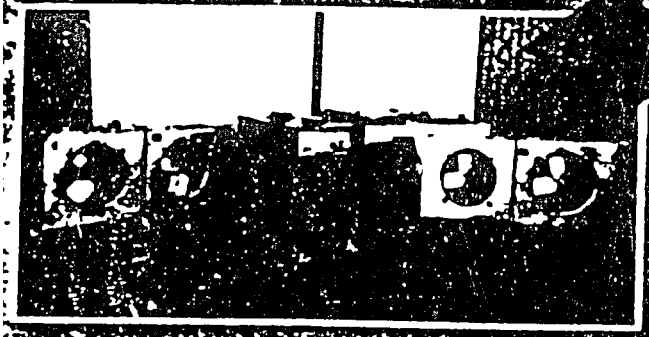
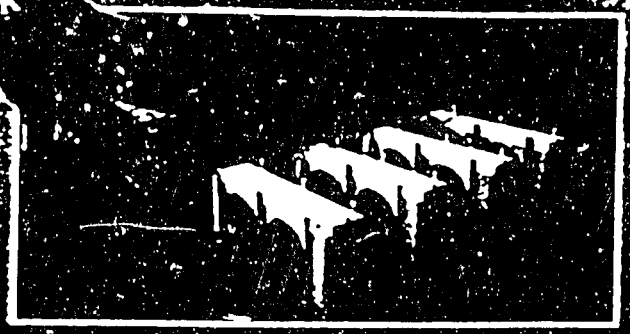


40 HP Low Temp System

100's of Systems in Stock





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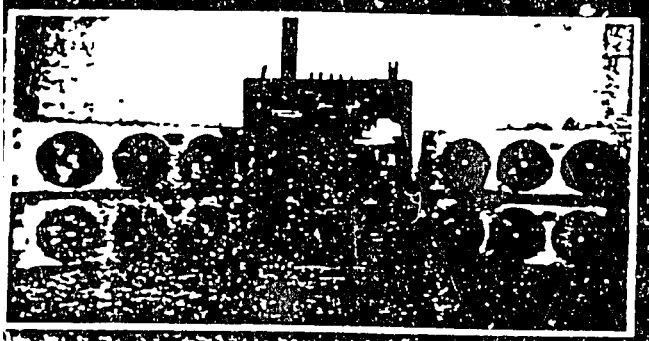
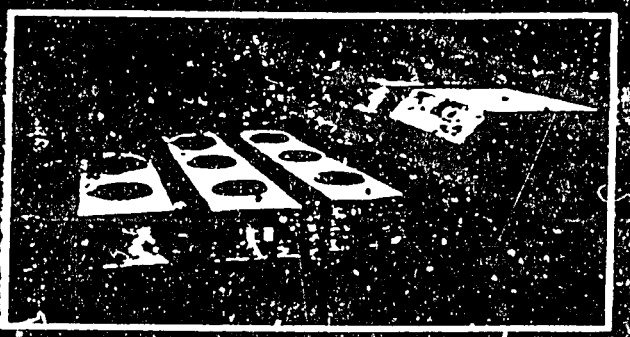
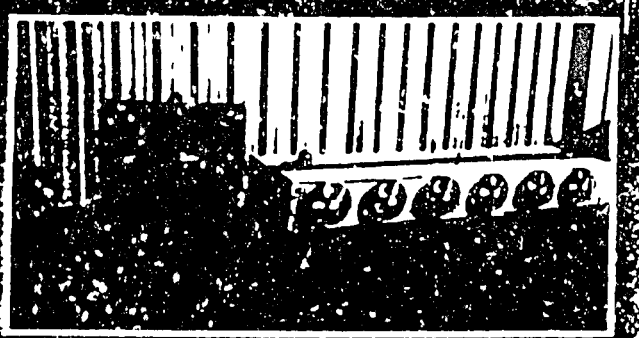
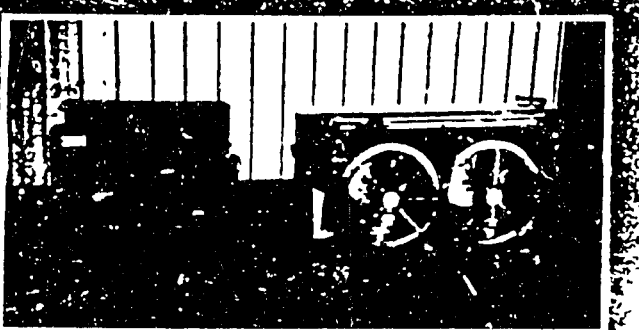




15 HP Low Temp System

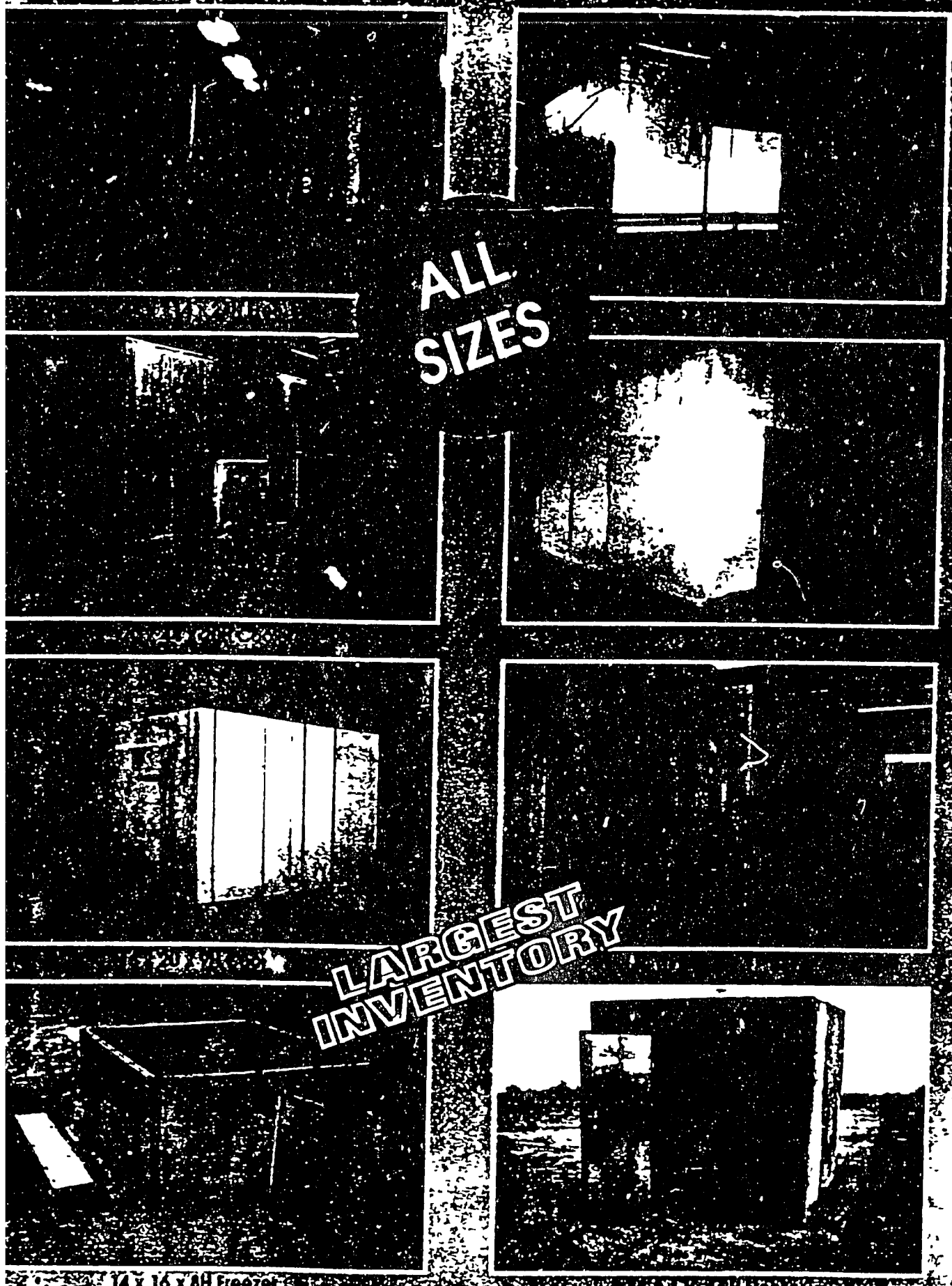


5 HP Low Velocity System



7½ HP Low Temp System

# COOLERS FREEZERS COOLERS FRE



# Monitoring Air Quality and Temperature

## Environmental Temperature Recorders

***For use in poultry houses, animal nurseries, greenhouses, walk-in coolers, long-haul refrigerated trucks and display cases***

Rugged self-contained, reusable units track temperatures with accuracy of +/- 2°F, giving you a reliable *written* record for up to 10 days. Available in two temperature ranges: low (-20° to 100°F) and high (30° to 150°F). Front window lets you scan current and last 24 hours temperature data. Housed in 7½"L x 4"W x 2"H, high-impact ABS plastic case, this reusable recorder can be hung or mounted on wall with mounting bracket (included). Also includes "AAA" battery, solid state quartz motor, and one 36" pressure sensitive strip recording chart. USA made. *Order replacement charts below*

| Temperature Range | Order No. | 1-2 unit | 3+ unit |
|---|---|---|---|
| Low (-20° to 100°F) | 10LF2 | $195.00/ea. | $175.50/ea. |
| High (30° to 150°F) | 10HF2 | $195 00/ea. | $175.50/ea. |

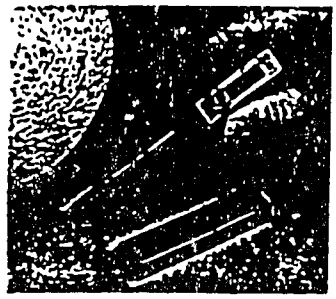
### Replacement Charts

Box of 24 pressure sensitive charts, each providing 10 days of recording.

| | | | |
|---|---|---|---|
| Chart for HIGH Range | DTC4 | $25 95/ea. | $23.35/ea. |
| Chart for LOW Range | DTC5 | 25 95/ea. | 23.35/ea. |

## Speed read temperatures with this handy needle thermometer

***Used in product inspection, potted plant soil checks, liquid checks***



This pocket-size digital probe thermometer provides accurate readings from only 1½ second sampling time Covers temperature range of -40° to 300°F with accuracy of +/- 2°F, eliminating need for several bimetal narrow range thermometers. Stainless steel probe. Easy-to-read digits in both Celsius and Fahrenheit. Memory, pocket cup, protective cover and battery included.

| | 1-9 thermometers | 10+ thermometers |
|---|---|---|
| Order No. DTT2 | $29.95/ea. | $25.50/ea. |

## Low-Cost Thermo-Hygrometer measures temperature & humidity

***. . . use in greenhouses, nurseries or animal confinement buildings***

Handy digital, pocket sized instrument measures temperatures from 32°F to 122°F with +/- 2°F accuracy; humidity from 2%-98% RH with accuracy of +/- 5% RH at temperatures between 59°F and 104°F. Features Min/Max memory for both measurements. Celsius and Fahrenheit scale selectable Battery, pocket clip and carrying pouch included. USA made.

| | 1-2 each | 3+ each |
|---|---|---|
| Order No. DTH2 | $53.50/ea. | $49 95/ea. |

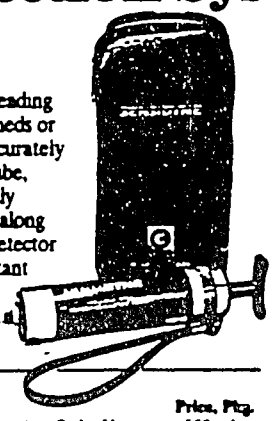
# Gas Detection Systems

## Sensidyne Gas Detection Pump

***Provides instant reading of gas levels***

Here's a simple detection system, providing a quick, point-in-time reading for assessing gas concentrations in confined spaces such as animal sheds or manure pits. Piston-type volumetric pump uses detector tubes to accurately measure more than 200 gases and vapors. Simply snap off ends of tube, insert into the hand-held pump, and pull handle to draw in a precisely measured volume of ambient air The farther the color stain travels along the tube, the higher the concentration of gas. Calibration scale for detector tubes is printed for each production lot. Kit includes corrosion-resistant pump with stroke counter, carrying case, instructions, and spare parts. Five-year warranty *Order tubes separately below*

Order No. 80057 $389 00/kit



### Detector Tubes (10/pack) *for gases found in ag situations*

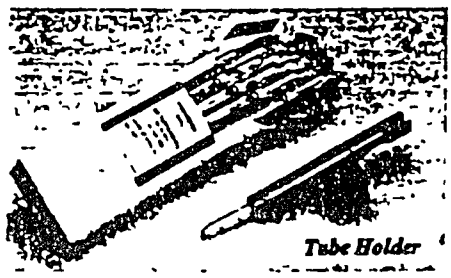
| Gas/Vapor | Chemical Formula | Measuring Range (ppm) | TLV*(ppm) | Order No. | Price, Pkg. of 10 tubes |
|---|---|---|---|---|---|
| Ammonia | $NH_3$ | 1–60 | 25 | 13L | $35 95/pk. |
| Carbon Dioxide | $CO_2$ | 100–11,500 | 5000 | 12LL | 35 95/pk. |
| Carbon Monoxide | CO | 8–1000 | 50 | 11LA | 35 95/pk. |
| Chlorine | $CL_2$ | 0.05–16 | 0.5 | 18LA | 35 95/pk. |
| Hydrogen Sulfide | $H_2S$ | 0.25–60 | 10 | 14LL | 35 75/pk. |
| L.P. Gas | hydrocarbon mixture/pk. | 0.02–0.8% | 1000 | 100A | 43 40/pk. |
| Methyl Bromide | $CH_3Br$ | 1–36 | 5 | 136LA | 39 90/pk. |
| Nitrogen Oxide | $NO+NO_2$ | 0.08–5 | NO=25 $NO_2$=3/pk. | 111L | 37 90/pk. |
| Phosphine | $PH_3$ | 0.15–5 | 0.3 | 17L | 38 00/pk. |
| Propane | $C_3H_8$ | 0.1–2% | | 100B | 43.30/pk. |
| Sulphur Dioxide | $SO_2$ | 0.5–60 | 2 | 15LA | 35 75/pk. |

*TLV=concentrated value for continuous worker exposure with no ill effects (8 hour time-weighted average) as determined by the ACGIH American Conference of Governmental Industrial Hygienists.

## Extension Hose . . . *take readings from a distance when dangerous conditions are suspected*

This 15-ft. extension hose connects between the SENSIDYNE pump *(above)* and the detector tube to allow readings to be taken in a storage pit or tank, or through a window from the outside if dangerous conditions are suspected. Order No. 75422 $129 00/ea

## DOSIMETER TUBES




***Provide time-weighted average readings for certain gases***

Break off end of tube to expose it to gas. Stain will appear along printed scale directly on tube. Divide this tube reading by the number of exposed hours. This is the time-weighted average concentration of the gas. Expose from 15 minutes up to 24 hours. Tubes are packed 10 to a box. Tube holder firmly clips to clothing or can be hung from ceiling and allows reading at a glance *Order holder separately*

| Gas/Vapor | Measuring Range (ppm) | Order No. | Price, Pkg. of 10 tubes |
|---|---|---|---|
| Ammonia | 25–50 | 13D | $38.95/pk. |
| Carbon Dioxide | 0.2–8% | 12D | 38.95/pk. |
| Carbon Monoxide | 50–1000 | 11D | 38.95/pk. |
| Chlorine | 2–50 | 18D | 38.95/pk. |
| Formaldehyde | 1–20 | 191D | 43.50/pk. |
| Hydrogen Sulfide | 10–200 | 14D | 38.95/pk. |
| Nitrogen Dioxide | 1–30 | 99D | 39 95/pk. |
| Sulphur Dioxide | 5–100 | 15D | 38.95/pk. |
| Toluene | 10–200 | 122D | 38.95/pk. |
| TUBE HOLDER | | TH15 | 9.50/ea. |



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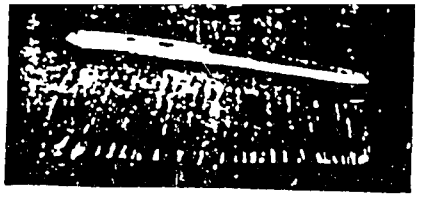

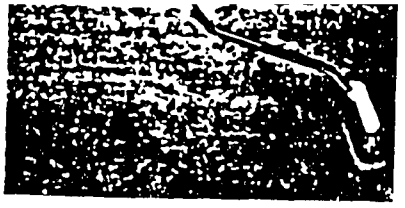

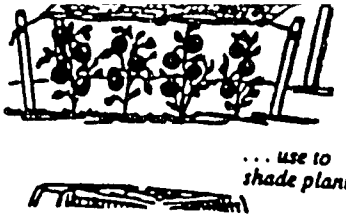


# GEMPLEI

P.O. Box 270, 211 Blue Mounds R
Mt. Horeb, WI 53572

## ORDERING INFORMATI

**Mail Orders.** Please include a check or money or your order. Or you may use VISA, DISCOVER, Express or MasterCard. We also accept UPS-C Business or institutional purchase orders accept minimum order required.

**Telephone Orders.** Call TOLL-FREE 1-800-38 7 a.m. to 6 p.m. central time weekdays, 8 a.m. to Saturdays. To make your ordering easier, please order form and jot down the page number of the before you call. UPS (United Parcel Service) C.( are accepted over the phone for an additional ch

**FAX Orders.** FAX us Toll-Free, 24 hours a d dial 1-800-551-1128.

**Delivery Address.** Please give us a street addre route and box number for UPS.

**Standard Shipping Policy.** For items meeting U Post weight and dimension standards, no matter items or how large your order is, normal ground UPS is used. For shipping charges, look at the pr on the order form.

- For orders shipped outside the 48 continental will be charged the actual shipping charges.
- Items marked with an asterisk (*), priced "F.O.B are freight collect (you pay the actual shipping
- Sorry, no truck C.O.D deliveries .. only UPS
- When standard P&H pricing chart does not ap you're sending in a check, call for a quote so y include the charges in your order

**Damaged Merchandise.** We take special care your orders, but if your package should arrive d UPS, please call us first before refusing or retur will be happy to make an adjustment and let yo to do with the damaged merchandise. In many save you, and us, time and money if you write o For freight-collect shipments, any claims for br damage must be made to the carrier by you.

**Returns & Exchanges.** We'll do whatever it tak you satisfied, it's our GUARANTEE. Once yo your order if there is a need to return or exchan simply follow the instructions on the return for back of your packing slip

**Customer Service.** Call TOLL-FREE 1-800-382

**Package Pickup:** We do not currently have a sto office/warehouse. We would prefer to ship your you, but if it is necessary for you to pick it up, p ahead of time and we'll have it ready for you.

**About GEMPLER'S.** We have been in the agri business for 52 years, though our catalog is only old. Your suggestions, comments and questions

**GUARANTEE**

You must be satisfied – or you get your money back. W quality products described truthfully and tested by us the judge. If for any reason, or no reason, you want item to us, please do so within 30 days of receipt of will gladly exchange it or return your money pro

Name _____
Address _____
City _____ State ____ Zip ____

**GEMPLER'S, Inc.**
211 Blue Mounds Road
P.O. Box 270
Mt. Horeb, WI 53572-0270

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PLACE STAMP HERE

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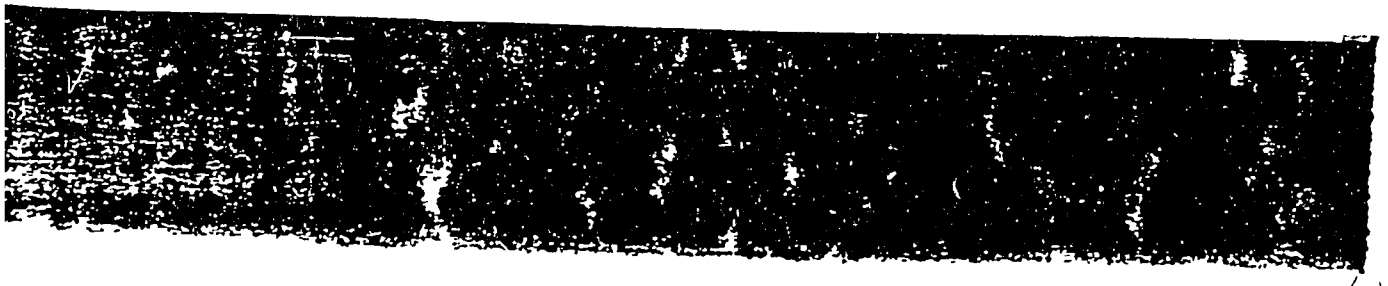
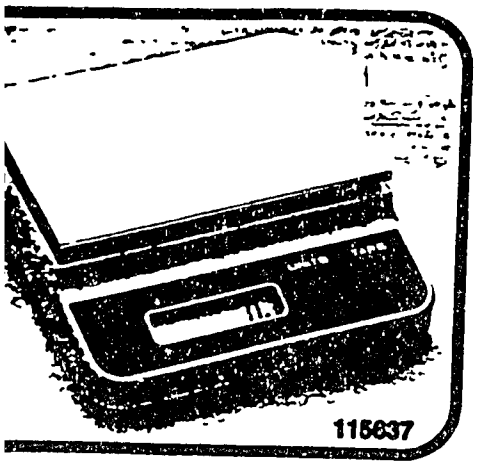


100

# The OHAUS FAMILY OF BALANCES.....

## CT SERIES

### - *MULTI-PURPOSE - PORTABLE*




The Ohaus CT Series balances are extremely versatile with a selectable menu for 7 standard weighing modes g, oz, lb, dwt, oz t, ct and parts counting

In addition, there's a use programmable custom unit mode to accommodate virtually any weighing application.

Standard features include battery or AC power operation *(adapter included)* and easy push button calibration

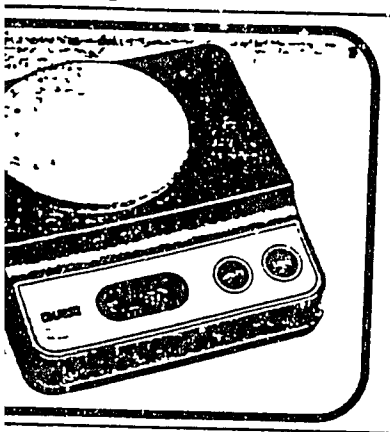
An optional RS-232 bi-directional interface is also available for computer operations

| | Capacity &Readability | Platform Size | Price |
|---|---|---|---|
| 5 * | 200g x 0 01g | 3 0" Diam | $560.00 |
| 8 * | 600g x 0 1g | 4 0" Diam. | 400.00 |
| 4 * | 10g x 0 002g | 1.75" Diam | $505.00 |
| 7 | 1200g x 0 1g | 4 75 x 6 5" | 500 00 |
| 8 | 6000g x 1 0g | 4 75 x 6 5" | 500.00 |

*ration weight included*

**Accessories**

| | | |
|---|---|---|
| P115635I | RS-232 Interface, CT Series | $105.00 |
| P115637W | Calibration weight for 115637 (1000g) | 43.25 |
| P115638W | Calibration weight for 115638 (1 each 1000g, 2000g) | 65.00 |



## PORTABLE PLUS *ELECTRONIC BALANCES*

These balances are consistent and accurate for all weighing requirements up to 500 grams and a readability of 0 1 gram
Both models feature a large 4¾" diameter stainless steel pan, four stabilizing feet, and the weigh below Constructed from durable impact-resistant plastic
User friendly, units feature tare to capacity, LCD display and push-button automatic calibration Complete with AC Adapter
Dimensions 7" x 7 6" x 2 3"

| Cat. No. | Capacity | Readability | Price |
|---|---|---|---|
| P116000 | 300 g / 10 oz | 0 1 g / 0 01 oz | $195 00 |
| P116000-00 | 500 g / 17 oz | 0 1 g / 0 01 oz | 249 00 |

## .YTICAL
## IDARD BALANCE

This is the low cost alternative for your precision weighing applications you've been waiting for This versatile balance has a large weighing chamber and stainless steel platform which allows sizable sample containers to fit easily - with room to spare The capacities range from 62 to 202 grams with readability to 0 1mg Easy two button operation - All models are programmable to compensate for environmental conditions, have a menu lock-out capability to eliminate tampering, and are protected against spills and overloads This unit will maintain stability and quick response even when drafts and vibrations are present. Standard features four selectable averaging levels, stability indicator, auto-zero tracking, auto calibration, analytical draft shield, sealed front panel diecast metal case, leveling feet and bubble and is UL listed Comes with AC adapter 30 month warranty RS232 bidirectional interface available Model 115708 has a Moveable FineRange™ which provides a 62g weighing range that is ten times more accurate than the coarse weighing range of 202g

| Model | P115706 | P115707 | P115708 | P115709 |
|---|---|---|---|---|
| Capacity(g): | 62 | 122 | 62/202 | 202 |
| Readability(mg): | 0 1 | 0 1 | 0 1/1 | 0 1 |
| Linearity(mg): | ±0.2 | ±0.2 | ±0 2 | ±0.2 |
| Tare Range. | | To capacity by subtraction | | |
| Stabilization Time | | 4 seconds | | |
| Sensitivity Drift: | | 2ppm/°C Zero Point Drift 3ppm/°C | | |
| Platform Size: | | 3¾ x 9 Diameter | | |
| Dimensions: | | 8 3"W x 14 5"H x 14 5"D | | |
| Net Weight. | | 15lb | | |
| Price | $1,695.00 | $1,895.00 | $2,050.00 | $2,395.00 |

J & H BERGE INC.

(908) 561-1234

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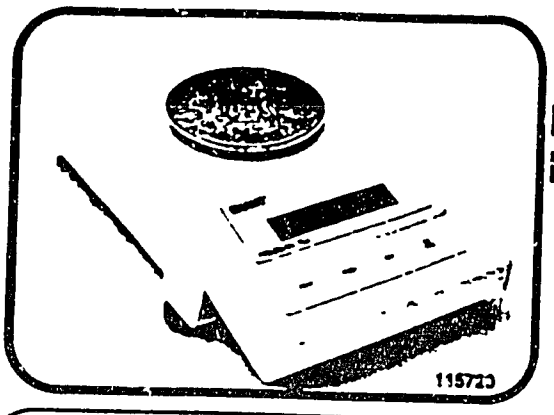
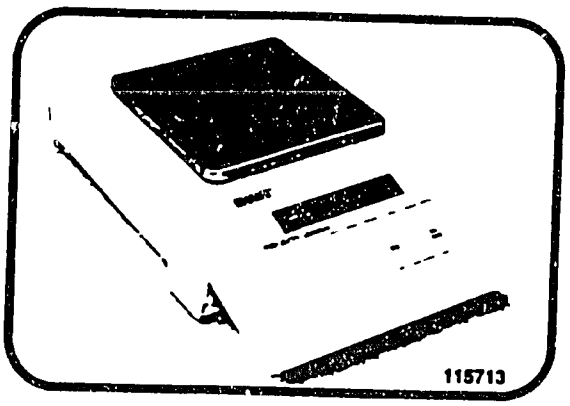
# NOW with a 5 YEAR WARRANTY!!!




## PRECISION BALANCES




***Standard Model & Plus Models*** Each PRECISION balance is built to last incorporating advanced construction and rugged design to deliver added durability over time Die-cast metal cases, large stainless steel platforms and shock absorbing pan supports are just a few of the quality features you'll find in these balances PRECISION toploaders also offer outstanding readability from large 6" LCD displays and auto calibration with full capacity tare by subtraction

The PRECISION Standard balances weigh in grams only Operating temperature for all PRECISION balances is 50 - 104°F (10 - 40°C) Bi-directional RS232 interfacing with selectable baud rates is standard on most models and allows integration of the PRECISION toploaders with your computer system or any other peripheral device An AC adapter is included with each model

With the PRECISION line you'll have the power to compensate for various environmental conditions specific to your application A variety of weighing modes is available on the PRECISION Plus toploader line, and can be activated upon demand The weighing modes are g, lb, oz, lb, ct, dwt, taels, oz, t, gn, momme, 1 custom unit, parts counting, %

The PRECISION Plus models have four user selectable stability and four averaging levels along with programmable auto zero tracking Draft shields are also available on select units All models are UL and FCC approved

* ***Models No. 115710, 115711, 115720 and 115722 come with a draft shield.***

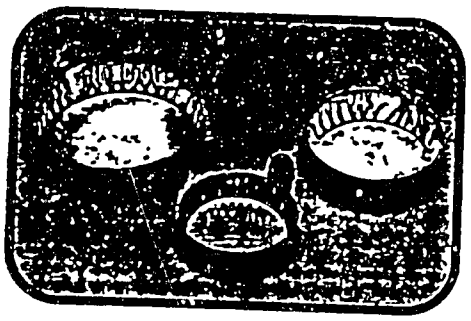
***PRECISION Standard Specifications & Ordering Information:***

| Cat. No. | P115710 * | P115711 * | P115712 | P115713 | P115714 |
|---|---|---|---|---|---|
| Capacity (g) | 120 | 400 | 400/40 | 4000 | 4000/400 |
| Readability (g) | 001 | 01 | 01/ 001 | 1 | 1/ 01 |
| Precision/Reproducibility (g) | 001 | 007 | 007/ 001 | 07 | 07/ 01 |
| Linearity (g) | 001 | 01 | 01/ 001 | 1 | .1/ 01 |
| Pan Size (in) | 4 75 dia | 4 75 dia | 4 75 dia | 6 0L x 6 5W | 6 0L x 6 5W |
| **Price** | **$980.00** | **$790.00** | **$1080.00** | **$980.00** | **$1100.00** |

***PRECISION Plus Specifications & Ordering Information:***

| Cat. No | P115720 * | P115721 | P115722 * | P115723 | P115724 | P115725 | P115726 |
|---|---|---|---|---|---|---|---|
| Capacity (g) | 200 | 400 | 400/80 | 600 | 2000 | 4000 | 4000/800 |
| Readability (g) | 001 | 01 | 01/ 001 | 01 | 01 | 1 | 1/ 01 |
| Precision/Reproducibility (g) | .001 | 007 | .007/ 001 | 007 | 01 | 07 | 07/ 01 |
| Linearity (g) | 002 | 01 | 01/ 002 | 01 | 02 | 1 | 1/ 02 |
| Pan Size (in) | 4 75 dia | 4 75 dia | 4 75 dia. | 4 75 dia | 6 0L x 6 5W | 6 0L x 6 5W | 6 0L x 6 5W |
| **Price** | **$1450.00** | **$1050.00** | **$1450.00** | **$1250.00** | **$1450.00** | **$1175.00** | **$1400.00** |

## ALUMINUM WEIGH DISHES



### *DISPOSABLE* *PREMIUM QUALITY AT GENERIC PRICES*

Designed for weighing, dispensing and storing Can also be used as evaporating dishes or dust covers No coating and free of oil Withstand temperatures to 1,250°F Smooth bottom Crimped sides for better rigidity Inexpensive enough for single use Finger-grip handle large enough to imprint sample numbers Stack and nest easily Used with some moisture balances employing infrared lamps

| Cat. No | Size | Top I.D | Quantity | Price | Quantity | Price |
|---|---|---|---|---|---|---|
| P217243 | 20ml | 44 mm | 100/pack | $7 50 | 10 packs/case | $60 00 |
| P217257 | 50ml | 60 mm | 100/pack | 9 00 | 10 packs/case | 72.00 |
| P217270 | 70ml | 70 mm | 100/pack | 14.00 | 10 packs/case | 112.00 |

**FAX (908) 561-3002**

BEST AVAILABLE DOCUMENT



102

# pH

## MICRO COMBINATION pH ELECTRODE

*Measure pH in a single drop!*

**Designed to measure samples in 96 well plates, micro centrifuge tubes or any volume down to 20 microliters**

This revolutionary electrode plugs into any pH meter and features a solid state sensor and a Teflon capillary tube making it virtually unbreakable guaranteed for the life of the probe

Why use glass? Since the sensor is totally non-glass it will resist degradation due to protein binding The probe has a much lower input impedance than glass probes and will rapidly give a more stable pH reading, and is compatible with all the major brand pH meters (specify meter when ordering)

Two ranges of immersion depths are available Also available is a micro probe for oxidation-reduction measurement

All probes are available with radiometer connectors

| Cat. No | Description | Price |
|---|---|---|
| **Immersion Depth of 1mm (pH range of 1 to 12)** | | |
| P362117-00 | Micro Comb pH (US std conn) | $329 00 |
| P362117-01 | Micro Comb pH (BNC conn) | 329.00 |
| **Immersion Depth of 0 1** | | |
| P362117-02 | Micro pH Mono Probe (US std ) (needs reference probe) | 249.00 |
| P362117-03 | Micro Reference with Pinjack | 169 00 |
| **Oxidation Measurement** | | |
| P362117-04 | Micro Redox Probe | 249.00 |

| Cat. No. | Well Plates | Depth x Diam. | Volume | Growth Area | Price |
|---|---|---|---|---|---|
| P217353 | 96 Well,Round Bottom w/lid | 10 8x5 9 mm | 0 37mL | - | 142 00/50 |
| P217354 | 96 Well,Round Bottom Untreated, without lid | 10 8x6 9mm | 0 37mL | - | 87.50/50 |
| P217355 | 96 Well,Flat Bottom w/lid | 10 8x6 4mm | 0 37mL | 0 32cm | 122.50/50 |
| P217356 | 96 Well,Flat Bottom w/lid Bulk Pack | 10 8x6 4mm | 0 37mL | 0 32cm | 110.00/50 |
| P217357 | 96 'Half Well',Flat Bottom w/lid | 11 3x4 5mm | 0 37mL | 0 16cm | 132.50/50 |

## CHECKER pH METER

**This pH Meter is compact in size, designed for pH measurement in tight spaces.**

Features a large, easy to read display, with a resolution of 01 and an accuracy better than 0 2 It has a wide range of 0 to 14 pH with a 0 01 reading There are two versions available, for a screw cap electrode, or equipped with a BNC connector

Checker is supplied complete and ready-to-use with a rugged pH epoxy electrode and batteries, or without electrode The Checker can be used with any shape and size pH electrode best-suited for your application

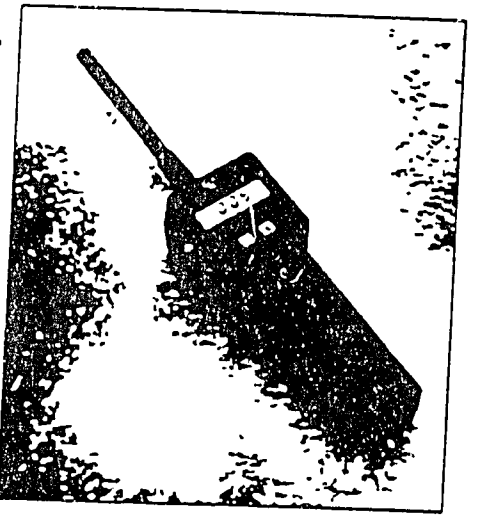
| at. No. | Description | Price |
|---|---|---|
| 168890 | Checker w/ a rugged epoxy body pH electrode | $31 00 |
| 168891 | Checker without an electrode | 27.50 |
| 163892 | Replacement electrode | 14 00 |

## HAND HELD SALT ANALYZER

**This portable salt analyzer measures % concentration of NaCl to a maximum of 20% salt concentration.**

Selectable "Fixed" or "Variable" calibration modes permit user to read factory calibrated NaCl concentration or the concentration of salts with similar conductivity vs % concentration relationships

Platinum RTD temperature adjusts readings for increased accuracies



| Range | Accuracy | Resolution | Temp Compensation |
|---|---|---|---|
| 0-2% | 03% NaCl | 001 | 0-82°C |
| 0-20% | 3% NaCl | 01 | 0-82°C |

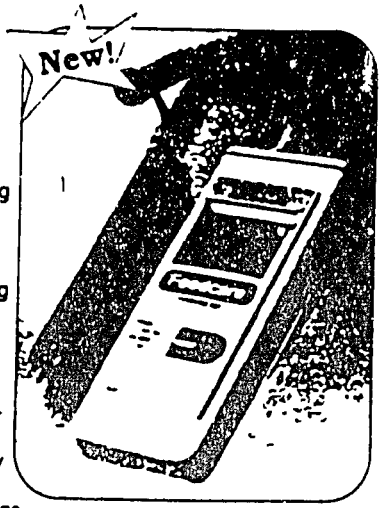
P364975 Portable Salt Analyzer $560 00

EST AVAILABLE DOCUMENT

J & H BERGE INC.

(908) 561-1234

## PORTABLE RELATIVE HUMIDITY METER



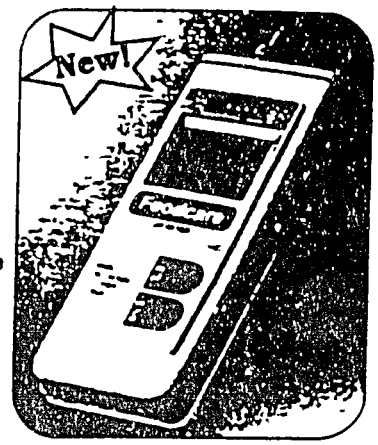

This heavy-duty hygrometer designed for the food industry, provides high accuracy under tough conditions without risk of damaging circuitry Easy to operate with single On/Off key and large, easy-to-read LCD Offers a long battery life and a low voltage indicator, which when displayed, gives approximately 20 more hours of operation Battery Error Preventative System shuts off display when low voltage could cause inaccurate readings
Electronic circuitry inside the humidity probe guarantees an immediate conversion and compensates for any temperature effect A perforated cap allows good air circulation while protecting the sensor
The probe has a 1 meter long (3 3 feet) cable to access those hard-to-reach places The probe can be detached and changed easily

### Specifications:

| | |
|---|---|
| **Range** | 5 0 to 95 0% RH |
| **Resolution** | 0 1%RH |
| **Accuracy** | ± 2% of full scale |
| **Calibration** | 2 points, through trimmers on RH probe |
| **Battery** (included) | 4 x 1 5V AAA 100 hrs of continuous use |
| **RH Probe** | Diam 6 7" x 1" w/1mm 3 3' spiral cable) |
| **Temperature Effect** | Negligible from 0 to 50° C (32 to 122° F) |
| **Operating Conditions** | 0 to 50°C (32 to 122°F), max 95%RH |
| **Dimensions** | 7 7"L x 3 1"W x 2 2"H |

| Cat. No | Description | Price |
|---|---|---|
| P440108 | Portable Relative Humidity Meter | $395 00 |
| P440108-1 | Replacement RH Probe | 195 00 |

## WATER RESISTANT pH METER *for* FOOD STORAGE *or* MANUFACTURE




A heavy-duty pH meter, designed to be rugged in humid and wet environments, is easily operated by pressing ON/OFF button to read pH value Two innovative features include user selectable 1 or 2 point calibration trimmers which are sealed behind a protective plastic cover to prevent any accidental interference, and also only one pH electrode with a direct cable with no extra temperature probe or cable 1200 hours of battery life guarantees long, trouble-free operation Battery Error Preventive System will be activated (approximately 20 hours after the "V" is displayed) by shutting off the display when low voltage could result in erroneous readings
The 170110-1 is a Kynar® body refillable combination electrode that is impervious to most aggressive chemicals unlike conventional plastic/epoxy body electrodes and comes with the meter This electrode incorporates the latest silverchloride-free double-junction technology which gives faster readings and above all greatly reduces the chance of sample contamination by silver 120mmL x 12mmD
The 170110-2 is a glass body refillable combination electrode and may be purchased separately This cost-effective electrode has a single junction and a small 6mm ( 25") diameter sensor which facilitates easier cleaning and allows measurements in smaller samples 70mmL x 12/6mmD

### Specifications:

| | |
|---|---|
| **Range** | 0 00 to 14 00 pH |
| **Resolution** | 0 01 pH |
| **Accuracy** | ±0 02 pH |
| **Calibration** | 2 Point, offset and slope |
| **Temp Compen** | Manual from 0 to 100°C (32 to 212°F) through trimmers on the casing |
| **Battery** (included) | 4 x 1 5V AAA 1200 hrs of continuous use |
| **Operating Conditions** | 0 to 50°C (32 to 212 F) |
| **Dimensions** | 7 7"L x 3 1"W x 2 2"H |

| Cat No | Description | Price |
|---|---|---|
| P170110 | Water Resistant pH Meter | $320 00 |
| P170110-1 | Kynar® Electrode *Replacement* | 90 00 |
| P170110-2 | Glass Body Electrode *Optional* | 108 00 |

## PICCOLO 2 & PICCOLO PLUS

**The Piccolo 2 (365750)** is a revolutionary all in one pH meter with an "Electrode + Amplifier" design It has an interchangeable pre-amplified pH electrode that transmits a low impedance signal to the meter, not allowing the electrode, connector, cable or meter to become susceptible to noise and unstable readings

### Specifications

| | Piccolo 2 365750 | Piccolo Plus 365751 |
|---|---|---|
| Range pH | 1 00 to 13 00 | 1 00 to 13 00 |
| Range Temperature | – | 0 to 70 °C |
| Resolution pH | 0 01° | 0 01 |
| Resolution Temperature | – | 0 1°C |
| Accuracy pH | ±0 01 | ±0 01 |
| Accuracy Temperature | – | ±1°C |
| Calibration | Two Point through Offset and Slope Trimmers | |
| Temperature Compensation | Automatic from 0 to 70°C (32 to 158°F) | |
| Environment | 0 to 50°C (32 to 122°F), 95% RH | |
| Battery Type | 3 x 1 4 Volts | |
| Battery Life | 100 hours of continuous use | |

N E W

**The Piccolo Plus (365751)** is a hand-held stick pH meter that incorporates a thermometer for highly accurate temperature measurement The additional capability of measuring and displaying actual temperature makes it the most versatile stick pH meter available
The Piccolo Plus also features a replaceable electrode tha has a durable design to give maximum protection, and it incorporates a sealed amplifier - a unique feature which makes it impervious to dirty and humid environments resulting in a "go anywhere", easy to use meter

| Cat No | Description | Price |
|---|---|---|
| P365750 | Piccolo 2 | $139 00 |
| P365750-1 | Replacement Electrode for Piccolo 2 | 51 45 |
| P365751 | Piccolo Plus | 155 00 |
| P365751-1 | Replacement Electrode for Piccolo Plus | 72 45 |

## pH METER

*NEW!*

Featuring one rugged electrode for both pH and Temperature, this meter has automatic temperature compensation Easily made switches from pH to temperature at the touch of a button are made on the display It has automatic buffer recognition and calibration Includes a specially designed casing with wrist-strap, and a 2 year warranty on the meter and 6 month warranty on the 3-in-1 pH electrode (included) incorporating a built-in temperature probe

**Specifications**

| | |
|---|---|
| Range | 0 00 to 14 00pH / 0 0 to 70 0 C |
| Resolution | 0 01pH / 0 1 C |
| Accuracy | ±0 01pH / ± 0 5 C |
| Temp Comp | Auto 0 to 50°C (32 to 122°F) |
| Calibration | Auto w/ buffer recog (4, 7, 10) |
| Electrode | Three-in-one pH electrode |
| Battery | 1 x 9V |
| Dimensions | (5 6" x 3.2" x 1 5") |

| Cat. No. | Description | Price |
|---|---|---|
| P170100 | pH Meter | $310.00 |
| P170101 | Replacement 3-in-1 electrode | 96 00 |

## FLOWMETER KIT

A combination of versatility and portability, this flowmeter kit is designed to fill your requirements for a wide variety of liquid or gas flowing monitoring The kit contains one (1) flowmeter frame, four (4) 150mm flow tubes, three (3) valves and a flowmeter stand, along with all necessary tools for tube and valve conversions Housed in a rugged polypropylene, molded carrying case, the kit allows measurement ranges from 4cc/min to 45Lmn (air) and 0 01cc/min to 1300cc/min (water) All kits are supplied with a wide variety of calibration curves for both air and water

**Specifications**

*new*

| | |
|---|---|
| Operating Pressure Max | 250 psig |
| Temperature Max | 250°F |
| Accuracy | ±2% full scale |
| Repeatability | ±0 25% of scale reading |
| Flow Range Approx | 10% to 100% of full scale reading |
| Scale | 0 to 150mm |
| Calibration Curves | Required to determine flow rate of media |

| Cat. No | Wetted Material Flowmeter &Valves | Seals Flowmeter/ & Valves | Price |
|---|---|---|---|
| P369750 | Brass | Buna-N | $440 00 |

## GRINDING MILL *Ideal for Agricultural, Pharmaceutical & Food Laboratories*

Perfect for grinding food fibers, minerals chemicals and more, this disc mill uses no screens and has a detachable magnet for intercepting tramp metal Adjustable grind settings are easily controlled by adjusting gap between grinding discs in steps of 30 microns Output spout for easy attachment of plastic bag for dustproof discharge, also supplied with a 1/2 gallon metal container for collecting ground product. Easily removable toughened grinding discs make this attractive anodized aluminum finished grinding mill easy to clean Set of 2 spare grinding discs also available

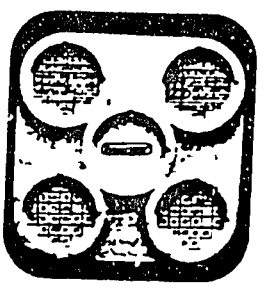
| Cat. No. | | Price |
|---|---|---|
| P428442 | Grinding Mill | $1275.00 |
| P428442-1 | Replacement Discs (Set of 2) | 60 00 |

## REPLICA-PLATING TOOL

**Low-cost, accurate method of colony replication.** This replica-plating tool includes a locking ring which is used to secure sterile velveteen squares onto the cylinder just prior to replica plating For preparation of cotton velveteen squares (approximately 6"x6" or 152mm) they are usually stacked and autoclaved in kraft paper or loose aluminum foil The autoclave drying cycle is useful in removing condensed moisture To make colony replicas the petri dish carrying microbial colonies is inverted and lowered onto the cloth surface and then lifted Subsequently, a fresh sterile nutrient plate is inverted and lowered onto the velveteen and then lifted This replica-plating tool may be disinfected between uses with a brief rinse in 70% ethanol or 0 025% Clorox bleach The aluminum ring is 4" (102mm) in diameter and the PVC cylinder is 2 15 (55mm) high One pack of 12 sterile velveteen squares (P373419-1) are included Extra velveteen squares may also be purchased by the box, with each box containing 3 bags of 12 squares

| Cat. No | Description | Price |
|---|---|---|
| P373419 | Replica-Plating Tool | $50 30/ea |
| P373419-1 | Velveteen Squares | 54.90/36 |

## REPLICA PLATING GRID *NEW*



Flat, white polystyrene plate 13 ½" x 15" It has 5 wells of the exact size to hold a petri dish Two wells are printed with a 24 square numbered grid and two are printed with a 50 square numbered grid The grid patterns aid in precise location The center well is blank and holds the master dish

Samples from the center of each colony in the master are removed with a sterile toothpick and placed in one of the grid-oriented dishes A new sterile toothpick is used for each transfer The position of the relocated sample is easy to identify with its former location in the master plate

P217322 $19 95

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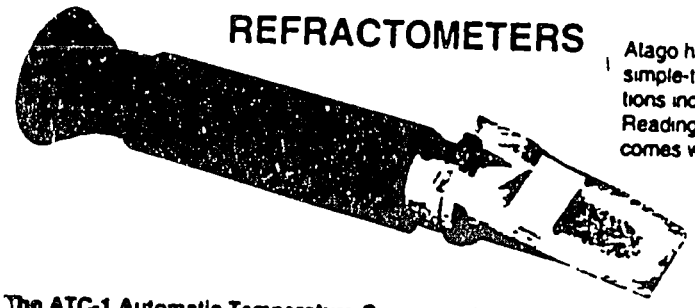
105

## REFRACTOMETERS



Atago hand refractometers, from the world's leading manufacturer, are handy, simple-to-use instruments for measuring solution concentrations Typical applications included determining sugar concentration of food products and cosmetics Readings are taken easily and accurately in only seconds Each refractometer comes with a carrying case

Types N1, N2, N3 and N4 are used for measuring the sugar concentration of fruits, juices, concentrates, wines, syrup and colas Type N10 and N20 are used for measuring concentration of low density aqueous solutions such as cutting oils and tomato juice

The ATC-1 Automatic Temperature Compensating Type has a built in system to eliminate the problem of making temperature compensations The Type 500 is a high contrast refractometer that permits a wide range of measurement, 0-90 Brix N-5000 and N-3000 measure the refractive index of vegetables oil and petroleum.

| Cat. No. | Type | Use | Range | Price |
|---|---|---|---|---|
| P384000-00 | N1 | Sugar Content | Brix 0-32% | $213.65 |
| P384000-01 | N2 | Sugar Content | Brix 28-62% | 222.35 |
| P384000-02 | N3 | Sugar Content | Brix 58-90% | 239 80 |
| P384000-03 | N4 | Sugar Content | Brix 45-82% | 239 80 |
| P384000-04 | N10 | Low Density Oil, Juice | Brix 0-10% | 257 25 |
| P384000-06 | ATC-1 | Automatic Temp Comp | Brix 0-32% | 272 50 |
| P384000-07 | 500 | Wide range-high contrast | Brix 0-90% | 762.00 |
| P384000-20 | N-3000 | Refractive Index | 1 435-1 520 | 319.35 |
| P384000-21 | N-5000 | Refractive Index | 1 333-1 520 | 762.00 |

## HAND PROTOMETER

This hand refractometer provides three functions for the clinical lab Serum protein, urine specific gravity and refractive index, all in one 1¼" diam x 7" Length unit

*Specifications:* 3 Ranges

| Serum Protein | Urine Specific Gravity | Refractive |
|---|---|---|
| 0-12g/100 ml | 1 000-1 050 | 1 333-1 360 |

| Cat. No. | Description | Price |
|---|---|---|
| P384000-25 | Refractometer Clinical | $259 42 |

## *HAND HELD* SALINITY REFRACTOMETER

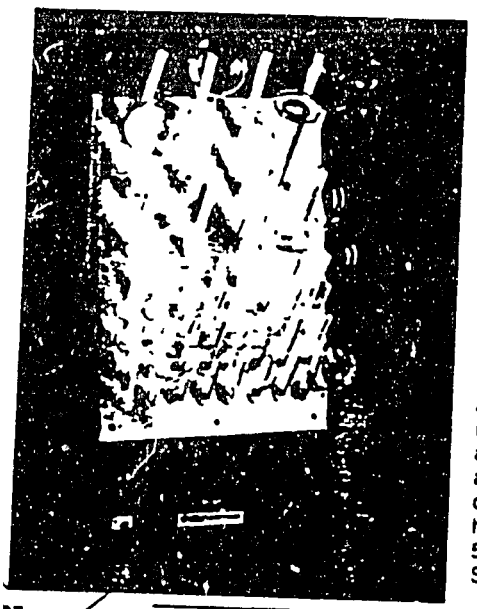
Determines the concentration of dissolved salt in water Applications include Aquaculture, fish processing, Fish & Wildlife Research Auto temp compensation allow changing work environments without re-calibrating

*Specifications:*

| | | |
|---|---|---|
| Accuracy | 1°/PP | 0 001 |
| Salinity Range | 0 - 100°/PPT | 1 000 - 1 070 |
| Min. Division: | 1°/PPT | 0 001 |

| Cat. No | Descriptions/Uses | Price |
|---|---|---|
| P384010 | Quick checks of density or salinity with Automatic Temp Comp | $352 00 |

## LAB-AIRE DUST-FREE DRYERS



Dry laboratory glassware rapidly and safely with this bench or wall-mounted storage unit.

It provides continuous warm air circulation through 44 hollow nylon drying pegs Three sizes of pegs accept glassware with large or small bores Dried labware is not too hot to handle A polyurethane foam filter keeps air dust-free Unit can be hung on wall

A stepless, high/low heat control (time proportional) ranges from ambient to 203°F and has an automatic thermostatic safety control cut-off 6ft 3-wire cord has grounded plug 60/60 Hz. 500 watts 12½"x7"x24"high Ship wt 19 lbs

New

| Cat. No | Description | Price |
|---|---|---|
| P223210 | 115vac | $595.23 |
| P223210F | Replacement Filter | 20 43 |

## SKIN GUARD PROTECTION FOAM

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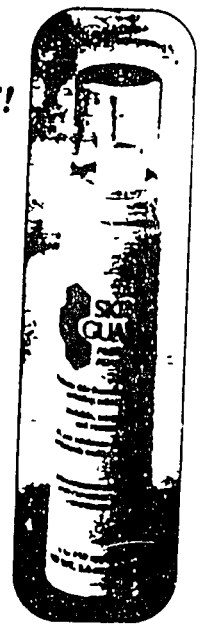

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| Cat No | Description | No. of Applications | Price Per Can |
|---|---|---|---|
| P202430 | 1 7oz (50ml) | 75 | $16 95 |
| P202431 | 3 4oz (100ml) | 150 | 28.95 |

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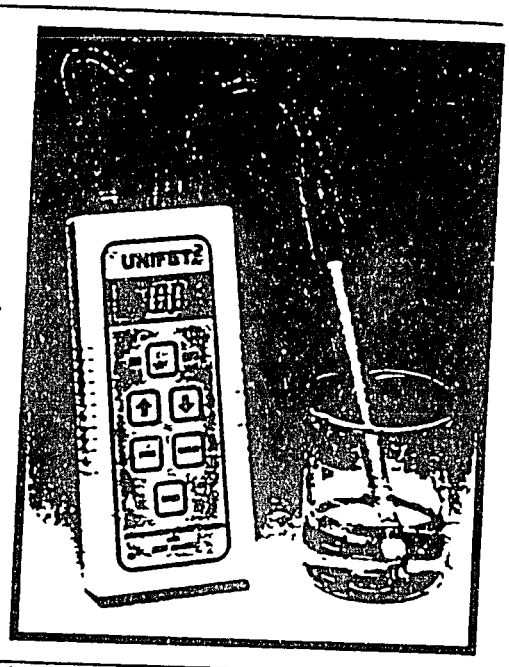
# ɔH

## ›H SYSTEM *UNIQUE NON-GLASS*

*by UNIFET*




ıs handheld microprocessor-based meter has a nearly indestructible solid state pH sensor ıng advanced ion sensitive field effect transistor (ISFET) technology, the sensor has many rantages over glass electrodes, it is unbreakable, can be stored dry, measures samples as all as one drop, and requires no maintenance The compact meter measures pH, mV and ıperature There is automatic temperature compensation, automatic buffer recognition, auto bration at pH 4 00, 7 00 and 10 00, and the user can specify any other buffer value Calibra- ı is retained even after shut-off

ı Microprocessor based pH System includes a 3-in-1 probe with a solid state ISFET pH sen- built-in reference and temperature sensor, battery, AC adapter, buffer bottles and rugged ying case Powered by either a 9 volt battery or the included AC adapter, this protected ument is ideal for laboratory, field or industrial use The probes are a solid state ion sensi- field effect transistor (ISFET) with built-in reference and temperature sensor

| | | |
|---|---|---|
| P168258 | Microprocessor based pH System Complete | $595.00 |
| P168260 | Rainbow Buffer Kit, pH 4 01, 7 0, 10 0 | 15 95 |

***d state pH probes are a patented design to meet your application demands.***
ıse the probe that best fits your needs

I259E is ideal for use with solvents particularly in environmental applications ırs extreme durability and chemical resistance for external and industrial application I259 Superior response and sensitivity to small pH changes for general laboratory ıcations even with mixed & non-aqueous solutions Great for biological buffer systems 259M Same performance as #168259 but in "micro" format for measurement of ımely small sample sizes or depths

| | | |
|---|---|---|
| ı68259 | Replacement Probe | |
| 168259E | Environmental Probe, *superior chemical resistance* | $179.00 |
| 168259M | Micro Probe *For extremely small sample sizes* | 249.00 |
| | | 259.00 |

*SPECIFICATIONS*

| | | |
|---|---|---|
| Range: | 0 to 14 pH<br>0 to 100°C | 0 to ±1999 mV |
| Resolution: | 0 01 & 0.1 pH<br>0 1°C | 1 0 & 0 1 mV |
| Temp Compen.. | Automatic | |
| Dimension· | 6 ¾" x 3" x 1" | |

## IECK-IN pH METER *With* STABILITY INDICATOR

## Ideal for the Food Industry

vhen the pH electrode has stabilized, does the 'NO' signal change to , indicating a correct reading Every print-out indicates time and date in ɔn to the pH value, an invaluable asset in traceability for any Q C sta IS232C compatible

ɪ electrodes come with a universal BNC connector and carry a full 6 warranty The calibration is simple and effective The meter prints out y-step instructions to guide the operator through the calibration proce- t also automatically recognizes pH 4, 7 and 10 buffers Calibration data ned even when the instrument is switched off The unit comes with 5 standard paper, a power cord and dust cover

### rodes For Everyday Use:

ɔe 170121 is a glass body, double junction, Viscolene, combination trode Conic-shaped tip Ideal for taking repeated and accurate mea- nts at short intervals Dimensions 4 7L" x 5"D 12 mm diameter

le 170122 is a glass body, refillable combination pH electrode with ıramic junctions to inhibit clogging The tip is sphere-shaped for a area of contact Dimensions 4 7L" x 5"D 6mm diameter

| | | |
|---|---|---|
| cations: | | |
| | pH | 0 00 to 14 00 pH |
| | °C | -10 0 to +1250°C |
| ion: | pH | 0 01pH |
| | °C | 0 1°C |
| y: | pH | ±0 01 pH |
| | °C | ±0 5C |
| on: | Automatic recognition at pH 4, 7, & 10 | |
| ture Compensation· | Manual from 0 to 100°C | |
| | Automatic from -10 to +125°C | |

| | |
|---|---|
| Power: | 110V, 50/60 Hz |
| Battery (back-up) | A 9V battery for up to 1 year back-up power |
| Printer: | Dot-matrix printer with 44mm standard paper |
| Dimensions | 9L x 6 5W x 3"H |
| Weight: | 2 9 lbs |

| Cat. No. | Description | Price |
|---|---|---|
| P170120 | Check-In pH Meter only | $835 00 |
| P170121 | Glass Body, Double Junction Electrode | 130 00 |
| P170122 | Glass Body Refillable Combination Electrode | 130.00 |

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# A Low-cost, Portable, Forced-air Pallet Cooling System

M. D. Boyette, R. P Rohrbach
Member ASAE Fellow ASAE

**Abstract.** *Many types of produce require thorough cooling immediately after harvest to minimize quality losses. In many instances this is accomplished by forced-air cooling in a refrigerated room. This study was conducted to determine the applicability of residential air-conditioning equipment coupled to an insulated reusable container as a low-cost alternative to traditional room, forced-air cooling. A portable, forced-air precooler for single pallet loads of fresh fruits and vegetables was designed, constructed, and tested. The system utilized an inexpensive reusable cooling and shipping container coupled, during cooling, to a modified 10.38 kW (2.95 t) mobile home air-conditioning unit. Tests with various small fruit indicated acceptable cooling rates. At the completion of cooling, the insulated container provided several hours of protection for storage or transport.* *Keywords. Postharvest, Cooling, Refrigeration, Portable.*

North Carolina has one of the most diversified agricultures of any state in the eastern United States. Although best known for tobacco, sweet potatoes, and poultry, North Carolina is also a leading producer of apples, cucumbers, strawberries, and 'Muscadine' grapes However, in recent years, there has been growing interest in the commercial production of high-value specialty fruit such as strawberries, blackberries, raspberries, and blueberries Much of the small fruit grown in North Carolina is presently being marketed through pick-your-own establishments or roadside stands These commodities are extremely perishable and ordinarily would require immediate postharvest cooling to prevent degradation were it not for the relatively short time between harvest and consumption

A growing demand and expanded markets for these commodities from grocery stores and restaurants in addition to a diversifying agricultural base (Agricultural Statistics Division, NCDA, 1990) has prompted many growers to consider expanding their production to accommodate these opportunities. Expansion into the commercial market usually requires a considerable investment in postharvest cooling and handling facilities and possibly refrigerated transport. Presently, only a few growers have the fruit volumes and financial resources required to invest in these specialized cooling and handling facilities. The risks associated with a new venture and the considerable cost involved prevent many growers from taking full advantage of this opportunity in commercial small fruit production.

Small fruit such as brambles, strawberries, and blueberries are extremely perishable at room temperature and require immediate cooling after harvest to prevent a rapid decline in quality (Kader et al, 1985, Hardenburg et al., 1986). Because of the possibility of adverse effects associated with wetting, the preferred and most commonly utilized cooling method for small fruit is forced-air cooling As commonly employed, forced air cooling utilizes a refrigerated room equipped with fans designed to pull large volumes of cold air through palletized packages of produce The close contact between the moving cold air and the warm fruit effects rapid heat transfer (Parsons, 1972) Large and sophisticated versions of forced-air cooling are utilized extensively in commercial cooling operations throughout the world (Mitchell et al, 1972, Freeman, 1984, Morey, 1988). Although favored by economies of scale, Kasmire and Thompson (1988) estimate that the capital cost of these facilities often exceeds $1 65/cooled kg/day ($0.75/cooled lb/day) In addition, they estimate the gross cooling efficiency of such facilities may be less than 50%

Although instances where a grower receives a price premium for cooled produce is not unusual, often the benefits of cooling are more indirect. These indirect benefits may include better appearance, a much longer shelf life, and the pride that comes from marketing a high-quality product. However, the most important indirect benefit is the marketing advantage cooled produce has over non-cooled. In a buyer's market, with other factors being equal, cooled produce will always sell before uncooled produce because buyers associate cooling with quality. North Carolina growers, attempting to compete with refrigerated prodce from out of state, have little choice but to cool.

## Prior Studies

Small portable cooling units designed to "plug-in" to small insulated shipping containers have been utilized by the world's airlines and oceanfreight carriers on a limited

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Paper No. BAE 90-04 of the Journal Series of the Dept of Biological d Agricultural Engineering, North Carolina State University, Raleigh

e use of trade names throughout this article does not constitute an dorsement by North Carolina State University or the authors

The authors are Michael D. Boyette, Assistant Professor, and Roger Rohrbach, Professor, Dept of Biological and Agricultural gineering North Carolina State University Raleigh

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basis for more than 20 years (Mitchell, 1989, personal communication) These units typically have been utilized for in-transit maintenance cooling of precooled highly perishable produce or during extended stopovers or delays These units are not designed for, nor intended to assume, the entire postharvest cooling load

A small insulated cooling and shipping container has been patented and tested in Georgia on a variety of crops (Magee, 1989). The container is cooled by a thin block of ice contained in the lid. As the ice melts, the chilled water drips on and cools the produce below. In North Carolina, investigations of low-cost, portable cooling alternatives for small fruit have been underway for several years. Rohrbach et al. (1984) successfully designed and tested a pallet sized forced-air cooling chamber utilizing liquid $CO_2$ for grapes and blueberries. Beasley (1982) designed and tested a small evaporative cooler/forced-air cooling fan combination to be used at roadside markets.

## OBJECTIVES

The objectives of the investigation described in this article were to

- Design a forced-air cooling system to rapidly and uniformly cool single-pallet loads of up to 400 kg (880 lb) of prepackaged small fruit.
- Determine the applicability of a residential air-conditioning unit to serve as both the source of cooling and air-handling.
- Design a low-cost, reusable, insulated pallet-sized container for cooling, storage, and transportation of packaged produce
- Evaluate the system's overall cooling effectiveness under varying field conditions.

## EQUIPMENT

### COOLING CONTAINER

The cooling container shown in figure 1 consists of a bottom, and four side panels of 51 mm (2 in) thick sheets of Dow extruded polystyrene insulation commonly referred to as blueboard This insulation material, normally supplied in full-sized panels measuring 122 × 244 cm (4 × 8 ft), is safe for use as food packaging, reasonably durable, and has an advertised thermal resistivity of 0.67 $m^2$ K/W cm (5 $ft^2$ F/in.). One sheet of 6.4 mm (1/4 in.) CDX grade plywood was bonded to the insulation material for added rigidity and protection from mechanical damage. The adhesive selected was "Elmer's Gluall", a waterproof glue compatible with both the wood and the polystyrene insulation material. Before the plywood was applied, the glue was evenly spread on the insulation board in a layer approximately 1 mm (0.04 in.) thick. As each opposite panel was completed, it was stacked one upon the other on the floor Five full-sized panels are required for each container (four for the sides and one for the top and bottom).

In commercial markets, small fruit such as strawberries, raspberries, and blueberries are normally packed and delivered to the consumer in half-pint, pint, or quart pulp or plastic containers. These containers may or may not have a cellophane or mesh cover Twelve half-pint or pint containers are aggregated into a corrugated fiber board master. Eight one-quart containers fill a quart master

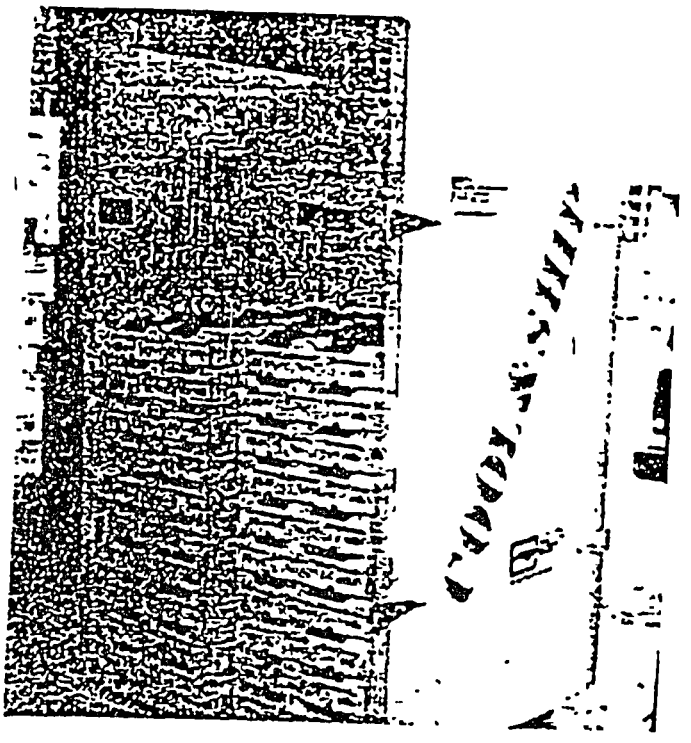

Figure 1–Cooling container.

These masters are in turn stacked six to a layer on a shipping pallet in lots of up to 144, 96, or 60 in the case of half-pint, pints, and quarts, (238 $cm^3$, 475 $cm^3$, and 950 $cm^3$), respectively Although desirable, it is not necessary that the cooling container be completely full Figure 2 shows an acceptable fill of 84 twelve pint masters.

Half-pint and pint masters have a width of approximately 34 cm (13-3/8 in ) and a length of approximately 51 cm (20 in ) such that when arranged in two rows of three each they form a square of approximately 102 cm (40 in ) on a side The maximum outside dimensions of the cooling container were limited to 122 cm (48 in.) to allow it to fit conveniently between the wheel wells of a full-size pickup truck Because of this limitation, the inlet and outlet plena were limited in depth to approximately 4 25 cm (1.67 in ), which seemed less than optimum but nevertheless proved satisfactory. Cold

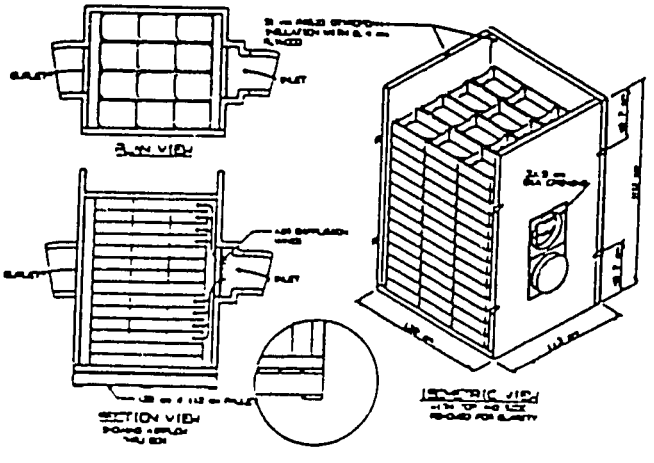

Figure 2–Drawing of cooling container with top and side removed for clarity

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air inlet and outlet holes, 30.5 cm (12 in.) in diameter, were cut in the center of opposing sides adjacent to the two plena, as shown in figure 2.

The height of a pint master is approximately 10.2 cm (4 in.). A pallet load of 96 masters, 6 to the layer, forms a stack approximately 162.5 cm (64 in.) high. The top of the cooling container, shown in figure 3, is designed to move vertically to accommodate various stack heights, allowing a tighter fit over the stack as shown and thus eliminating air short-circuits over the top of the stack of masters.

The sides of the cooling container are fastened by a pair of loose-pin strap hinges on each corner. Eyebolts are substituted for the hinge pins to facilitate assembly. An adhesive-backed foam strip approximately 2 cm (3/4 in.) wide × 1 cm (3/8 in.) thick is used as a gasket to seal all joints between the sides, top, and bottom. The outside plywood surface is painted with two coats of outside gloss enamel for protection. The cost of the materials to construct each container is approximately $115 (1992) and requires approximately two man-hours to construct.

### Refrigeration Unit

In many cases, even relatively low-capacity commercial refrigeration units are sold, not as a complete unit, but in component fashion. The selection of compressors, condenser coils, evaporator coils, and piping is customized for each application; therefore, the refrigeration engineer or contractor can select those components best suited for a particular application. The custom selection requires technical competence and contributes a significant amount to the overall cost of a system. The addition of forced-air capability to such a facility likewise requires custom engineering in the selection and application of fans and controls.

On the other hand, residential air-conditioning components are generally factory matched. As far as possible, major components are pre-assembled requiring much less labor at the jobsite. Residential window units and air-conditioning systems for mobile homes are even more unitized and standardized, thus requiring little or no jobsite assembly.

Grower attempts to utilize residential air-conditioning systems for produce refrigeration usually fail. Most residential air-conditioning systems are designed to cool air to 18 to 22° C (64.4 to 71.6° F) and, therefore, normally have evaporator coil temperatures at 6 to 10° C (42.8 to 50.0° F) which is too warm to effect much useful produce cooling. Fortunately, there are some residential air-conditioning units available with evaporator coil operating temperatures cold enough to provide excellent produce refrigeration. One such unit and the one selected for this investigation was a Comfort-Aire model MC37-1H manufactured by Heat Controller, Inc., of Jackson, Michigan. This model has a design cooling capacity (manufacturer's rating) of 10.366 kW. (2.95 t) at a 35° C (95° F) condenser coil ambient air temperature.

Cooling coils are quite often operated at temperatures below the dew point of the air passing through them. When this occurs, condensation collects on the coils and the air is dehydrated. The amount of water removed from the air is directly related to the size of the coils and the humidity of the air, and indirectly related to the temperature of the coils. That is, the larger and cooler the coils and the higher the humidity of the air, the more water will be removed. Fresh produce exposed to very dry air can suffer decline in weight and quality even if the air is properly cooled. Therefore, supplemental humidification is often recommended for commercial forced-air cooling facilities.

The minimum temperature to which a refrigeration system may cool is the operating evaporator coil temperature. Data supplied by the manufacturer of the unit selected indicated a minimum temperature of near −10° C (14° F). Subsequent tests conducted without a cooling load and with the insulated ducts configured into a closed loop revealed a minimum evaporator coil temperature of −13° C (8.6° F) and a minimum air temperature of −9° C (15.8° F). The power requirement is approximately 27 amps at 230 VAC, single phase. Integral to the unit is an air-handling fan with air flow data shown in table 1 below.

The complete cooling system weighs approximately 90 kg (200 lbs) and was supplied from the manufacturer with two lengths of 30.5 cm (12 in.) diameter insulated flexible duct. This flexible duct was used to connect the air-conditioning system to the cooling container. Initially, the only modification made to the air-conditioning system was to mount a bulb-type thermostat into the air intake of the unit as an automatic controller. Early field tests revealed that further modifications were necessary. These modifications are described in a subsequent section of this article. The cost of the unit plus the thermostatic controls was approximately $1,500 in 1989.

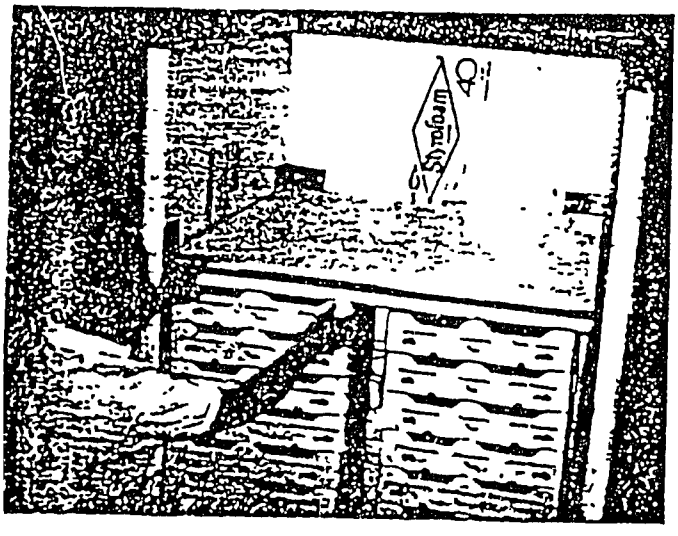

Figure 3–Fitting the top in place

## Procedures

Four of the five different on-farm cooling tests reported herein were performed at various locations in North

Table 1. Air flow data for Comfort-Aire model MC37-1H (Manufacturer's Data)

| Air Flow $m^3$ / min (cfm) | | Static Pressure kPa (in $H_2O$) | |
|---|---|---|---|
| 32.2 | (1140) | 0.100 | (0.40) |
| 31.0 | (1095) | 0.125 | (0.50) |
| 29.2 | (1030) | 0.150 | (0.60) |
| 25.5 | (900) | 0.175 | (0.70) |

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Carolina during the spring and summer of 1989. The fifth test was performed in the spring of 1992 after several modifications had been made to the unit to correct performance limitations discovered during the first four tests. Fruit selected for testing included strawberries, blueberries, vinifera grapes, and cherry tomatoes. All fruit cooled in the tests were in standard pint masters as described above except the strawberries which were in quart masters. All fruit tested were harvested on the day of the test. Although varying amounts of free water were present on the fruit from dew and rain, none of the fruit were intentionally wetted, precooled, or given other special preparations. Average pulp temperatures at the beginning of the tests were generally near or slightly below ambient dry bulb temperature.

### Cooling Tests

One type T thermocouple was positioned in the inlet and another in the outlet duct of the air-conditioning unit. Four additional type T thermocouples were positioned at preselected locations inside the cooling container. Thermocouples T1 and T2 were positioned to measure the temperature of the air entering and exiting the cooling container, respectively. Thermocouples T3, T4, T5, and T6 were all located inside individual fruit which were located at the interior of the containers. Thermocouples T3 and T4 were positioned directly adjacent to the cooling container inlet and outlet, respectively. Thermocouple T5 was positioned on the same horizontal plane as T3 and T4 but in a container to one side approximately 5 cm (2 in.) from the interior wall. Thermocouple T6 was positioned in the center of the first layer of masters from the bottom.

In addition, several custom-made, long-stem pulp thermometers were inserted near various thermocouples as checks. The digital temperature display modules for these thermometers were obtained from PSG Industries of Perkasie, Pennsylvania. The temperature is measured by a resistance temperature detector (RTD) attached to the module by a variable-length wire lead. The RTD and the wire lead were enclosed within a 0.51 m (20 in.) length of 0.32 cm (1/8 in.) diameter aluminum tubing filled with magnesium oxide paste to aid conductivity.

Measurements taken of pulp temperature just after filling the cooling container but prior to initiation of cooling often revealed differences between individual sensors of as much as 5° C (9° F). This difference resulted from the individual fruit's relative opportunity to dissipate field and respiration heat after harvest. If disparities of more than 3 or 4° C (37.4 or 39.2° F) were observed, the closed container was allowed to remain undisturbed for as long as 20 min in order to promote more temperature uniformity. The temperature at each thermocouple was recorded at the initiation of each test and in at least 10-min intervals as long as the system was operating. Additionally, a water-filled U-tube manometer was connected between the inlet and outlet ducts to measure pressure drop of the air flow through the cooling container. The measurement of air resistance through the load was necessary to confirm the fan was operating within specifications. Figure 4 shows a cooling test in progress.

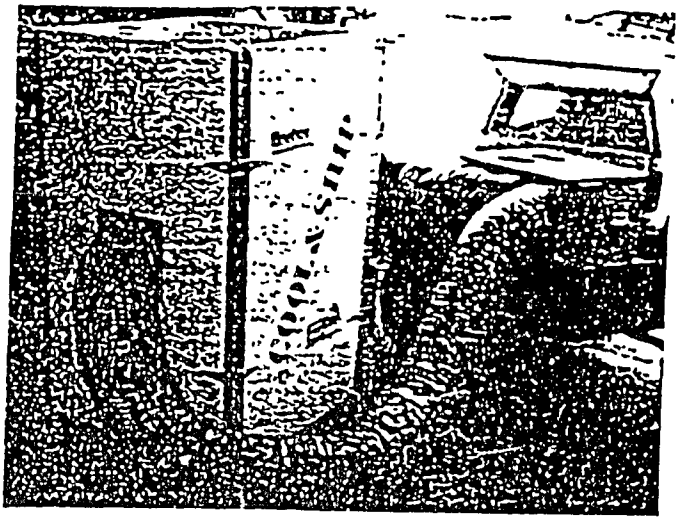

Figure 4—Cooling test in progress.

### Storage and Warm-up

In addition to the cooling tests described above, tests were conducted with grapes and strawberries to determine the ability of the cooling container to hold the precooled fruit at acceptable temperatures for short periods without active cooling. At the end of the cooling test, the air-conditioning system was shut down, the insulated ducts were disconnected, and the openings to the container were sealed as shown in figure 5. The temperature at each of the four thermocouples measuring fruit pulp temperature was periodically recorded over the next several hours.

## Results and Discussion

The ideal shipping temperature for strawberries, grapes, and blueberries is near 0° C (32° F), however, the actual freezing of some fruit in the process of cooling is undesirable and must be avoided. During the cooling process, the coolest fruit in the container was adjacent to

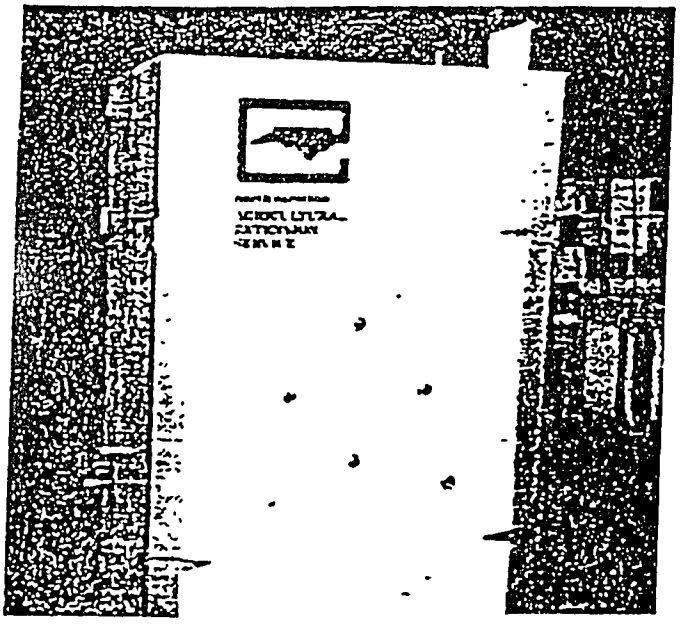

Figure 5—Sealed cooling container during warm-up test.

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the air inlet in the area of thermocouple T3. As the tests progressed, the temperature at T3 was closely monitored. Were it not for the premature termination of tests 1, 2, and 4 due to evaporator coil icing, testing would have continued until T3 approached freezing.

During some of the first tests (in 1989 and 1990), there was an attempt to obtain air-velocity data. Accurate measurements inside the container were found very difficult to obtain under field conditions and efforts were subsequently abandoned. We have, however, taken numerous air-velocity measurements of forced-air cooling of similarly packaged strawberries and blueberries inside a refrigerated room. In such situations, considerable variation in the air velocity was found from one place to another across the face of the stack. Air velocities from below 15 m (50 ft) to above 100 m (328 ft) per minute across the same pallet at the same time have been measured. Yet, even with these great difference in air velocity, the drop in temperature was reasonably uniform.

This suggests that above some velocity [possibly 20 to 30 m (65.6 to 98.4 ft) per minute, initially], the convective heat transfer from the packages is not the limiting factor. Apparently, the factor limiting heat transfer at higher air velocities is conduction inside the fruit and between adjacent fruit in a package. The best measure of heat transfer by all means, of course, is temperature change. Moreover, inside the cooling container, temperature is much easier to measure than air velocity.

Indirect measurements of air volume flow rate, however, were obtained by the use of inclined manometer readings across the container applied to the air-conditioner fan table. These measurements were obtained primarily to determine if the resistance through the cooling container was such to allow sufficient air flow for efficient heat transfer.

Before the commencement of the tests, it was assumed that the relatively narrow plena [4.25 cm (1.67 in.)] would constrict flow and lead to uneven distribution of air and widely varying cooling rates throughout the container. However, temperature data from thermocouple T6 located near the bottom of the cooling container indicated that the reduction was not significant. The temperatures recorded at T6 were normally no more than 3 to 4° C (5.4 to 7.2° F) warmer than those recorded at T3 located at the container inlet. The use of small air-diffusion vanes positioned in the inlet side of the container assisted in ameliorating the problem by aiding the lateral distribution of the air along the inlet plenum.

The relatively large capacity of the refrigeration system compared with the required cooling load resulted in rapid initial cooling of fruit. The temperature differential between the inlet and outlet at the beginning of the tests often exceeded 7° C (12.6° F). As the tests proceeded, however, the differential between the inlet and outlet air temperatures decreased. These conditions also contributed to the accumulation of condensation and eventually ice on the evaporator coils. Once disconnected from the container, the coil icing could be observed directly. The degree to which ice accumulated appeared to be related mainly to the amount of free water on the fruit and the duration of the test. Coil icing was indirectly observed to occur to varying degrees during all the first four tests. The evaporator coil remained clear of ice throughout the fifth test after modifications were made to eliminate the problem.

Although the accumulation of ice on the evaporator coils could not be observed directly while the system was in operation, its effects could be detected in two ways. First, the accumulation of ice increased the air resistance through the cooling coils and thus reduced the air flow through the system. This resulted in a gradual and noticeable reduction in pressure drop through the cooling container. Second, the accumulation of ice acted as insulation on the coils thereby greatly reducing heat exchange capacity. As a result, the air exiting the cooling container during the last portion of the test with the grapes experienced a slight rise in temperature rather than continuing to decline. To one degree or another, this condition prompted the premature termination of cooling Tests 1, 2, and 4.

There was no attempt to take weight data from any of the tests. The accumulation of ice on the cooling coils presumably came from water evaporated from the fruit and suggests that there was undoubtedly some weight loss by the end of the tests. The evaporation of liquid water from the surface of the fruit during cooling is beneficial in that wet fruit is more susceptible to disease. The evaporation of water from inside the fruit is not desirable. It would have been difficult, however, to determine how much of the loss was due to the loss of surface water and how much was lost from the interior of the fruit.

There was liquid water present on some of the fruit from dew or light rain. This was particularly true of the strawberries in Tests 4 and 5. Of the several types of small fruit tested, strawberries are the most susceptible to moisture loss, presumably because of their thin skins. Strawberries held for extended periods in refrigerated storage without supplemental humidification occasionally display skin darkening and shriveling indicative of dehydration. At the conclusion of all the tests there was no indication of dehydration. The strawberries, in particular, were examined for indications of darkening, no darkening was found.

Test 3, conducted with cherry tomatoes, had a target cooling temperature of 10° C (50° F) which was apparently too warm for significant ice accumulation. At the end of the 75-min test, the temperature of the air leaving the refrigeration system was still above freezing at 2° C (36° F). This suggests that the coil temperature was too warm to allow significant ice accumulation. There were no visible signs of fruit dehydration, although undoubtedly, some of the ice accumulated on the coil came from water evaporated from within the fruit. It was assumed that most of the ice came from free water evaporated from the surface of the fruit.

Test 5, with strawberries, was conducted two years after the first four tests and after modifications had been made to the refrigeration unit to eliminate evaporator coil icing. These modifications were essentially the addition of a pair of variable timer relays (W. W. Grainger part number 6X601C) to control the refrigeration compressor motor. A schematic drawing of this circuit modification is shown in figure 6.

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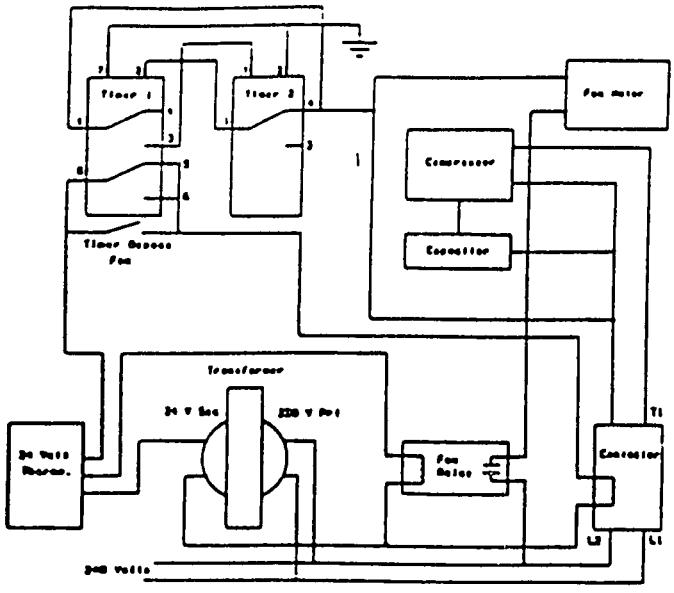

**Figure 6–Schematic drawing of modified electrical control system.**

The power control wiring arrangement allowed the compressor to cycle on and off at a predetermined rate, yet allowed the evaporator coil fan to operate continually Typical relay settings allowed the compressor to operate at a 75% duty cycle, on six minutes and off two minutes. Any evaporator coil icing that occurred during the time the compressor was operating was melted by the relative warm air from the cooling container during the compressor off time. No indications of evaporator coil icing was observed during the fifth test as had been observed in the first four tests. The cycling of the compressor in the fifth test apparently eliminated the evaporator coil icing problem

### Test 1 – Blueberries

Test 1 was conducted with 395 kg (870 lbs) of fresh highbush blueberries packaged in 72 twelve-pint masters arranged in 12 layers of 6 masters each. Each pint container was covered with a cellophane wrapper held in place with a rubberband. This cover undoubtedly reduced the cooling rate, however, no tests were done with uncovered containers for comparison The average ambient temperature during the test was 26 7° C (80° F).

The pressure drop at the beginning of the test was approximately 0.012 kPa (0.47 in. water) but had fallen to 0.009 kPa (0 38 in. water) by the time the test was terminated at 65 min. The test was terminated due to a very slow rate of cooling which rapidly developed approximately one-half hours into the test. Examination of the evaporator coil at the end of the test revealed large accumulations of ice restricting air movement.

### Test 2 – Grapes

Test 2 was conducted with approximately 350 kg (770 lbs) of rain wetted vinifera grapes packaged for the test in 66 twelve-pint masters without the pint containers The masters were arranged in 11 layers of 6 masters each There was no covering over individual masters The pressure drop across the container at the beginning of the cooling test was approximately 0 013 kPa (0 5 in. water). When the test was terminated after 110 minutes, the pressure drop was down to 0 007 kPa (0 27 in. water) Examination of the evaporator coil revealed severe ice accumulation. The average ambient temperature during the test was approximately 22.7° C (73° F).

At the end of cooling, the cooling container was sealed and allowed to warm. In 4 75 h, the average temperature of the fruit increased from 5.0° C to 11.1° C (41° F to 52° F) or an average of approximately 1.3° C (2.3° F)/h.

### Test 3 – Tomatoes

Test 3 was conducted with approximately 315 kg (693 lbs) of cherry tomatoes packaged in 60 twelve-pint masters without the use of pint containers. The masters were arranged in 10 layers of 6 each. No pressure drop measurements were made during the test. The test was successfully completed after 75 min of cooling when the target temperature of 10° C (50° F) was reached. Examination of the evaporator coil at the end of the test revealed only slight ice accumulation. The average ambient temperature during the test was 22.8° C (73° F).

### Test 4 – Strawberries

Test 4 was conducted with approximately 205 kg (450 lbs) of strawberries packaged in 36 eight-quart masters in open-top quart containers. The masters were arranged in six layers of six masters each. The pressure drop at the beginning of the test was approximately 0 010 kPa (0 38 in. water) decreasing to 0 0074 kPa (0 30 in water) at the end of the test The test continued for 70 min, but was terminated when the temperature at T1, the air inlet, approached freezing Examination of the evaporator coil at the end of the test revealed an accumulation of ice The average ambient temperature during the test was 31 1° C (88° F)

At the end of the cooling test, the air-conditioning unit was disconnected The cooling container was sealed and allowed to warm. In four hours, the average temperature of the fruit increased from 6.6° C to 12.8° C (44° F to 55° F)

### Test 5 – Strawberries

Test 5 was conducted with approximately 174 5 kg (384 lbs) of strawberries packaged in 24 eight-quart masters in open-top quart containers. The masters were arranged in six layers of four masters each. The pressure drop at the beginning of the test was approximately 0 010 kPa (0 38 in. water) which remained constant for the duration of the test. The cooling test continued for 109 min, but was terminated when the temperature at T1, the air inlet, approached freezing The average pulp temperature at the end of cooling was approximately 2.2° C (36° F). Examination of the evaporator coil at the end of the test revealed no accumulation of ice. The average ambient temperature during the test was 20° C (68° F)

At the end of the cooling test, the air-conditioning unit was disconnected from the cooling container. The cooling container was then sealed and placed on a small flatbed trailer for transport to market approximately 101 km (65 miles) away The total time from the end of cooling until the container was opened at the market was

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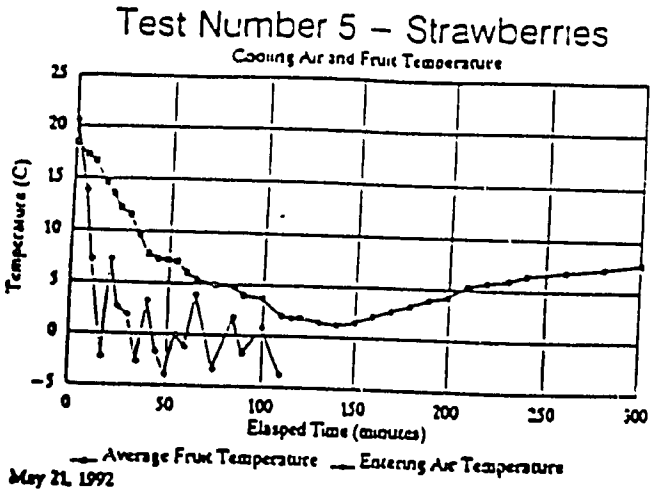


**Figure 7–Temperature of cooling air and average pulp temperature during cooling and warm-up.**

approximately 3 h, 10 min. The pulp temperature of the strawberries continued to be monitored during this time When the container was opened, the average pulp temperature was approximately 7 8° C (46° F). The average ambient temperature during transport and holding at market prior to opening was approximately 25.6° C (78° F). Fruit quality was judged to be excellent. The average pulp temperature over the test is shown in figure 7

## Tests Summary

The results of the cooling tests are reported in table 2 and the results of the storage and warm-up tests are reported in table 3. It should be pointed out that each of these tests is different, having different amounts of produce, different ambient temperatures, and different types of containers

The lumped parameter analysis of heat transfer is a useful method for comparing heat transfer rates of various systems where little internal temperature variation exists This type of analysis is most often applied to solids with high thermal diffusivity However, it may also be applied to specific examples of forced convection through porous media where small internal temperature variations may be shown to exist. From the first order differential equation of heat transfer, the temperature of the lumped parameter as a function of time is given as

$$Z = \mathrm{Ln}\left(\frac{T_t - T_e}{T_o - T_e}\right) = \frac{t}{\tau} \qquad (1)$$

$$\text{Then } \frac{dZ}{dt} = -\frac{1}{\tau}$$

Table 3 Summary of storage and warm-up tests

| Test No | Fruit | Initial Temp (°C) | Final Temp (°C) | Duration Minutes | Ambient Temp |
|---|---|---|---|---|---|
| 1 | grapes | 5 0 | 11 1 | 235 | 23 3 °C |
| 4 | strawberries | 6 6 | 12 8 | 240 | 31 6 °C |
| 5 | strawberries | 2 2 | 7 8 | 191 | 26 5 °C |

where

$t$ = time (min)
$T_t$ = pulp temperature at time, t (°C)
$T_e$ = ending pulp temperature (°C)
$T_o$ = pulp temperature at t = 0 (°C)
$\tau$ = time constant (min)

It may be shown that when $t = \tau$, the system has cooled 63.2% t of the difference between the beginning and ending values. The value of the time constant is a measure of the rate of heat transfer. A small time constant indicates a system with more rapid heat transfer. Any factor affecting the rate of heat transfer can influence the value of the time constant. Therefore, the heat transfer rates of various cooling configurations may be contrasted by comparing the values of their respective time constants

The initial cooling constitutes a step input of various combinations of thermal properties and temperature data from each of the above tests which were used to compute the time constants, $\tau$. As noted above, moderate-to-severe evaporator coil icing was experienced in the first four tests before modifications were made to eliminate the problem In several cases towards the end of cooling, the average temperature of the produce actually showed a slight increase This was likely due to a combination of heat conducted through the container and heat of respiration Although the test was allowed to continue for some time afterwards, we consider the data recorded, invalid and did not use it in our calculation of time constants The computed values for the time constant $\tau$ are shown in table 4

The time constants show considerable variation from test to test as would be expected Those with the smallest values indicate the most rapid cooling Notice that Test 3 and 5 have the largest time constants and, hence the least rapid heat transfer. In the case of Test 3, this may be partially explained by the fact that the tomatoes were larger than the other fruit and, therefore, had a smaller surface area to volume ratio Convective heat transfer depends significantly on surface area. Test 5 had the largest time constant value. The amount of fruit cooled in Test 5 was considerably less than in the other tests which should have reduced the load on the refrigeration system and decreased the value of the time constant. This effect was apparently offset, however, when the compressor was cycled on and off to prevent the accumulation of evaporator coil ice.

Table 2. Summary of cooling tests

| Test No. | Fruit | Net Weight | No. Masters | Initial Temp (°C) | Final Temp (°C) | Duration Minutes | Ambient Temp. |
|---|---|---|---|---|---|---|---|
| 1 | blueberries | 395 kg | 72 | 26 6 | 13 3 | 65 | 26 6 °C |
| 2 | grapes | 350 kg | 66 | 21 1 | 5 0 | 110 | 22 1 °C |
| 3 | tomatoes | 315 kg | 60 | 20.5 | 11 1 | 75 | 22 8 °C |
| 4 | strawberries | 205 kg | 36 | 27 2 | 6 6 | 70 | 31 1 °C |
| 5 | strawberries | 174 5 | 24 | 18 3 | 2 2 | 109 | 20 0 °C |



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Table 4. Computed time constants for various cooling tests

| Test No | Fruit | Time Constant τ (min) |
|---|---|---|
| 1 | blueberries | 28.44 |
| 2 | grapes | 26.42 |
| 3 | tomatoes | 34.27 |
| 4 | strawberries | 25.82 |
| 5 | strawberries | 36.67 |

Test 5 was the only test where cycling was employed. Possibly, the cycling had the effect of lengthening the time constant by approximately the off-time of the compressor.

## Conclusions and Recommendations

Based upon the data obtained from the tests described above, it appears that acceptable cooling rates may be obtained with the use a modified residential air conditioner coupled to an inexpensive pallet-load size container. The air flow resistance through the fully loaded cooling container tested low enough to be compatible with the fan supplied with the unit. Generally, the maximum allowable period for the timely removal of field heat is 2 h. Although several tests were foreshortened due to ice accumulations on the evaporator coil, it does appear that the heat transfer rates as reflected in cooling times for packaged berries were well within this acceptable limit. Undoubtedly, the cellophane covering on the blueberry packages hampered heat transfer; however, no comparative tests were made without the covering.

Initial problems with the accumulation of ice on the evaporator coil were eliminated by the simple modification of decoupling the operation of the fan from the refrigeration unit. By the use of a set of variable timer relays that cycle the refrigeration on and off while allowing the fan to operate continually, the heat transferred from the fruit was utilized to remove any ice accumulations. This resulted in an increase in cooling time as reflected in an increase in the cooling time constant for Test 5.

The insulated cooling container appears to be adequate in all respects including durability. After having been used, disassembled, and transported throughout North Carolina for more than a dozen demonstrations and tests, the container shows little wear. Warm-up tests with partial and full-pallet loads indicate an average temperature increase of between 1 and 3° C (1.8 and 3.2° F) per hour under varying ambient conditions. This is more than adequate to allow several hours for subsequent transport to market.

Although the cost of energy is an important consideration of any postharvest cooling operation, it was not the prime consideration of our study. The assumption was made that the energy requirements per pallet of cooled produce would be less for the test system than a more traditional forced-air cooling facility. With the same quantity of insulation, that part of the cooling load due to initial cool-down and conduction would be less for the container than a building. In addition, the service load is almost entirely eliminated. The service load is that refrigeration used to displace the heat from lights, air exchange, people and is normally 10 to 15% of the total load.

The major expense of the test system is the refrigeration system. The insulated cooling containers are relatively inexpensive and a grower may find it desirable to have several available for use. It is possible that several containers may be connected to the same refrigeration system for initial and subsequent maintenance cooling. Suggestions have also been made for semi-permanent truck- or trailer-mounted cooling containers that could be conveniently connected to a stationary refrigeration system. In any case, by utilizing the insulated cooling container as a shipping container, the need for a refrigerated truck is eliminated.

The labor requirements of the system versus the more conventional forced-air cooling system is similar. Both methods require the fruit be stacked onto pallets and either enclosed inside the container or positioned for the forced-air fans. Once this is done, the actual cooling is accomplished with little or no direct supervision. Once the fruit is palletized, it remains palletized until it is delivered to the buyers with either method. Once in the hands of the buyer, the container could be reconnected to a source of cool air for maintenance cooling or removed from the containers and placed into a conventional refrigerated room.

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# CENTRIFUGAL HUMIDIFIERS

add $265 to include automatic water controller

price: $968

The humidifiers may be mounted on columns or suspended from the ceiling in most cases Selection of the proper type of mounting depends on local conditions, ease of installation, etc. Occasionally it will be necessary to mount the humidifiers on a wall, and while this should not be done unless it is necessary, the machines will operate very satisfactorily Other types of mounting such as mounting on floor stands may be used in special applications.

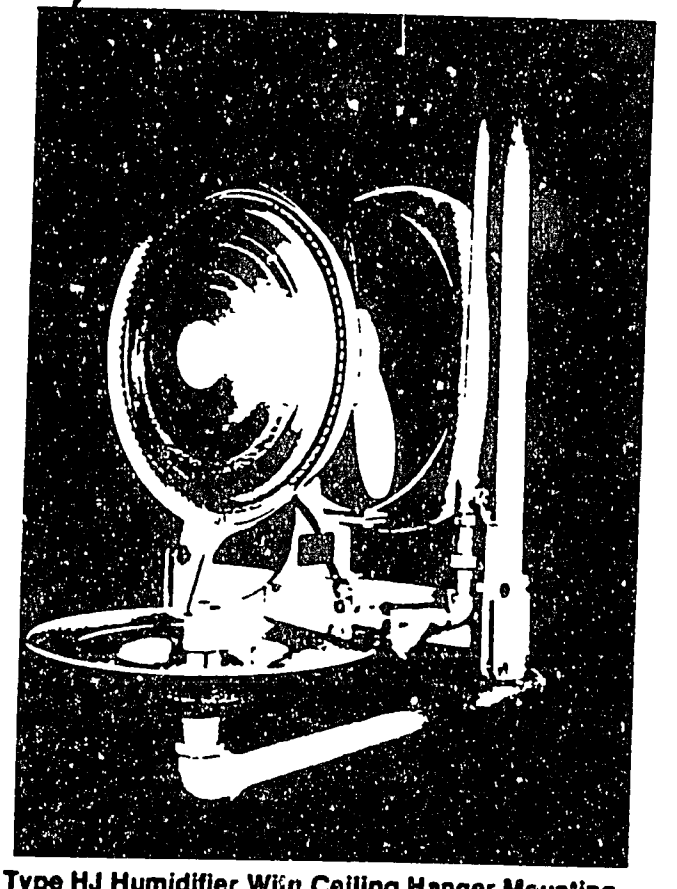
When humidifiers can be mounted on columns the amount of overhead piping is reduced to a minimum

When the humidifiers are suspended from the ceiling, they are normally located so that the axis of the motor shaft is parallel with and at east 5 feet from the wall.

When the humidifiers are mounted on a wall, he axis of the motor shaft should form an angle vith the wall of 45 degrees or less When Type J' ndividual controls are used the left or control ide of the humidifier should be away from the vall

The hangers should be positioned so that the rip pans will be at least 3 feet 6 inches below ie ceiling beams for the Type H (4 feet for the ype L) or any other overhead obstruction such s heating coils, sprinkler pipes, shafting, etc. his will prevent deposit of spray on these bstructions when they are directly in front of the imidifier.

Where the ceiling height is over 13 feet, the est results with the Type H will be obtained hen the humidifiers are located so that the drip n is 8½ or 9 feet above the floor With the pe L, where the ceiling height is over 15 feet, best results will be obtained when the midifiers are located so that the drip pan is r 10 feet above the floor



**Type HJ Humidifier With Ceiling Hanger Mounting**

## SETTING UP HUMIDIFIERS

After the crate has been opened, the hanger should be installed at the humidifier location, and the humidifier then assembled and mounted on the hanger

1 — When column or wall hangers are used, fasten the hanger to the support with ⅜" x 3" lag screws if the support is of wood, or with ⅜" x ¾" machine screws if the support is of metal In the case of concrete columns, a special strap is provided for clamping the hanger to the

BEST AVAILABLE DOCUMENT

# AHNSON®
# ENTRIFUGAL
# UMIDIFIERS

# DnB

## INSTRUCTIONS FOR OPERATING TYPES H, HJ, L AND LJ

The Types H and L Humidifiers are furnished complete with an orifice housing for water connection when used with Master B Controls. The Type HJ and LJ units are identical to the H and L except that they have a Type J Individual Automatic Humidity Control Assembly instead of the orifice housing.

### CONTENTS OF CRATE

Each Bahnson Humidifier is shipped complete, with all parts secured in a single crate. These parts are:

1 — The assembled humidifier

2 — The drip pan and drip cup, which are held the top of the crate by a brass cap screw. This cap screw and the large steel washer on e outside of the crate are to be saved and used described below.)

3 — The fan.

4 — The drip pan strainers.

5 — The hanger.

6 — The starter

7—Extra orifices and an adjusting key for pe J Control, which are in a small cloth bag d to the unit.

There are three types of hangers used with ntrifugal Humidifiers.

1 — The column hanger, which is formed to fit particular size of column on which the nidifier is to be mounted.

2 — The ceiling hanger, which is used when humidifier is to be suspended from the ling.

3 — The wall hanger, which is used when the nidifier is to be attached to a wall or flat tical surface

The hanger type is specified when the unit is ordered and only one type of hanger is provided with each unit.

### UNPACKING

Bahnson Humidifiers are shipped in wirebound slatted crates. To open a crate, proceed as follows:

1 — Place the crate so the solid panel, to which the fan guard, starter, hanger, and other parts are attached, is on the bottom.

2 — Open the wires and pry off the slatted panels of the crate.

3 — Remove the humidifier and all other parts from the crate, being certain that no parts are accidentally discarded since they will be used in assembly of the humidifier.

### LOCATION OF HUMIDIFIERS

Wherever possible, always locate a Bahnson Humidifier or group of humidifiers so as to establish a free and continuous circulation of air around the room. In a small room, the best location for one humidifier is near a corner, about 4 or 5 feet from each wall, with the axis of the motor shaft nearly parallel with the long side of the room. If two humidifiers are required, the other may be similarly located in the corner diagonally opposite the first humidifier and facing in the opposite direction.

In a large room requiring several humidifiers, locate them so that they will assist each other in establishing a horizontal circulation of air around the room. The humidifiers should never be located so the current of air set up by one machine blows directly toward that of another unless they are separated by at least 50 feet

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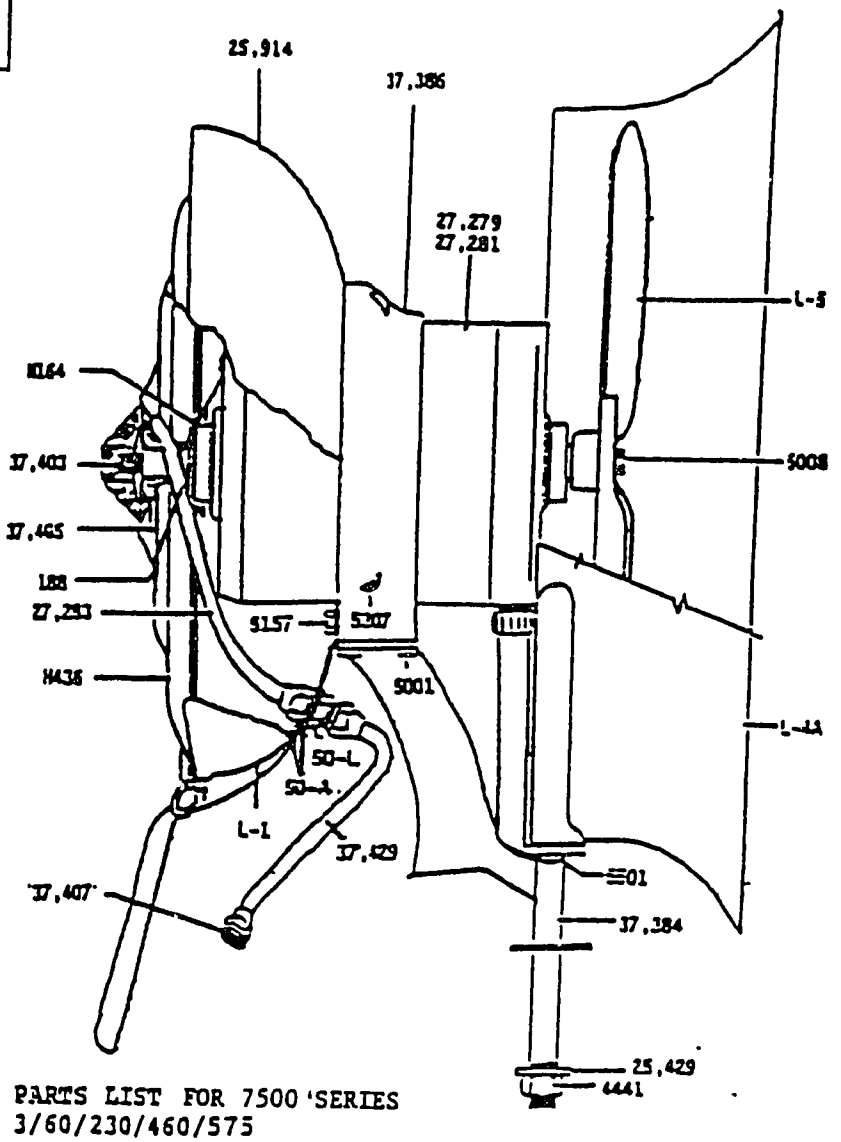
P.O. BOX 18290 BOISE ID. 83715

**Centrifugal Humidifiers**




PARTS LIST FOR 7500 SERIES
3/60/230/460/575

| | | | |
|---|---|---|---|
| 188 | Motor Shim Washer | 5307 | Set Screw |
| E164 | Sling Off Washer | 25,429 | Flat Washer |
| E436 | Disc | 27,279 | Motor Assy. 3/230/460 |
| L-1 | Grid Ring | 27,281 | Motor Assy. 3/575 |
| L-4A | Fan Guard | 27,283 | Inner Feed Pipe Assy. |
| L-5 | Fan | 37,384 | Stand |
| 50A | Double Union Washer | 25,914 | Case |
| 50L | Double Union Locknut | 37,403 | Front Head |
| 4441 | Hex Nut | 37,405 | Back Head |
| 5001 | Cap Screw | 37,429 | Outer Feed Pipe |
| 5008 | Cap Screw | 37,386 | Motor Mounting Collar includes (3) 5307 screws |
| 5157 | Cap Screw | 37,407 | Single Union |

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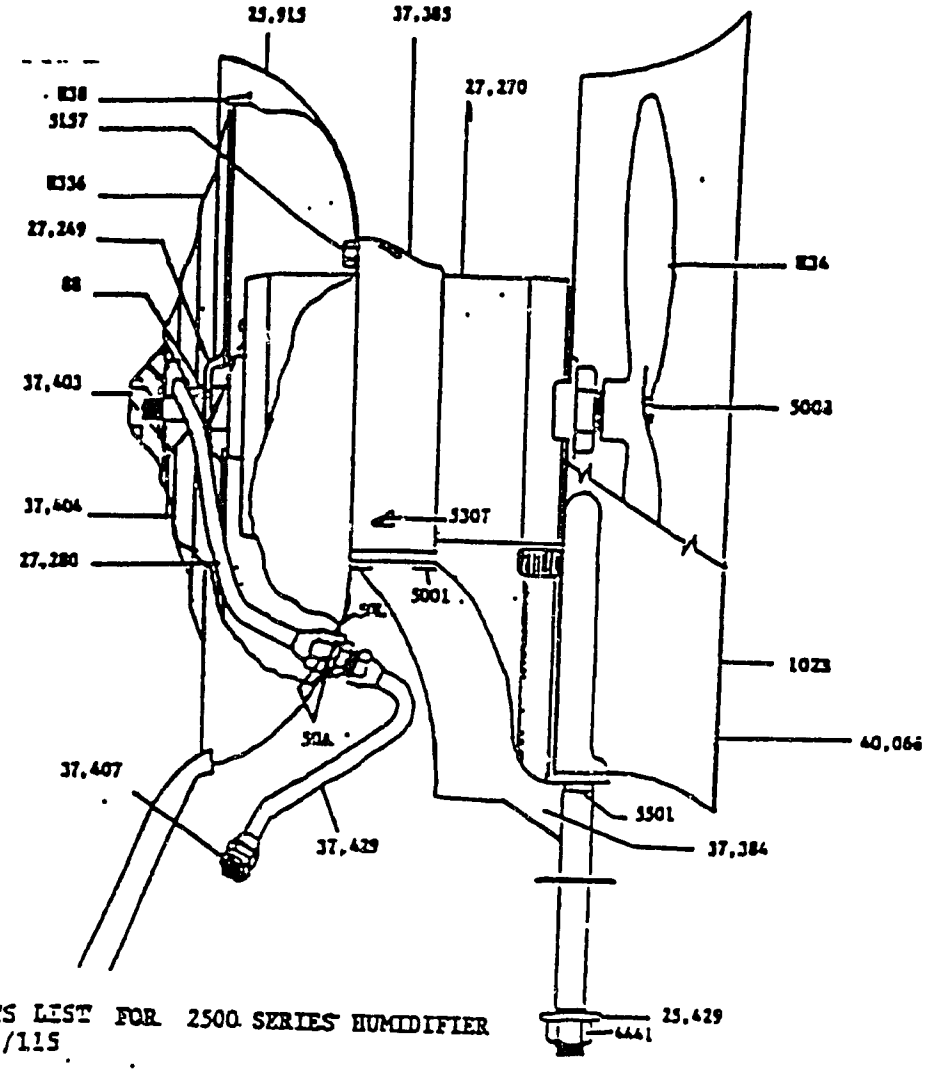
GELLERT
P.O. BOX 16290 BOISE ID. 83715
Centrifugal
Humidifiers




PARTS LIST FOR 2500 SERIES HUMIDIFIER
1/60/115

| | | | |
|---|---|---|---|
| 50A | Double Union Washer | 25,915 | Case |
| 50L | Double Union Locknut | 27,249 | Sling Off Washer |
| 88 | Motor Shim Washer | 27,270 | Motor Assy. 1/60/115 |
| E34 | Fan | 27,280 | Inner Feed Pipe Assy. |
| E336 | Disc | 37,403 | Front Bead |
| *102-B | Fan Guard | 37,404 | Back Bead |
| 4441 | Hex Screw | 37,407 | Single Union |
| 5001 | Cap Screw | 37,429 | Outer Feed Pipe |
| 5008 | Cap Screw | 37,384 | Stand |
| 5157 | Cap Screw | 37,385 | Motor Mounting Collar Includes (3) 5307 Screws |
| 5307 | Set Screw | *40,066 | OSHA Fan Guards (Front and Rear) |
| 25,429 | Flat Washer | | |

AVAILABLE DOCUMENT

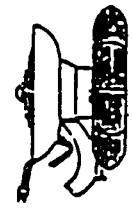
# EQUIPMENT MODEL NUMBERS

3/4 H.P., 3 PHASE

7500 SERIES

7500 HNV

$1178

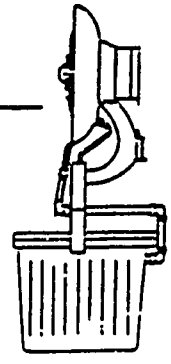


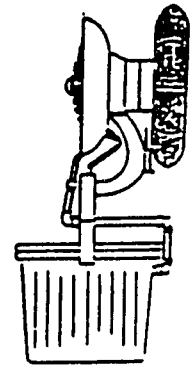
7500 HV

$1270

7500 CNV

$1497



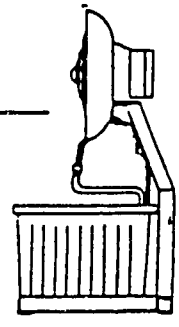


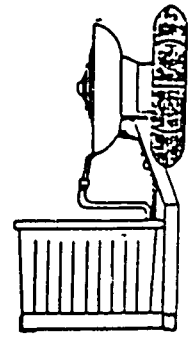
7500 CV

$1589

7500 FNV

$1630





7500 FV

$1722

LIST PRICE

ALL PRICES ARE F.O.B. BOISE ID. U.S.A.

CRAIG HORN

PHONE: (208) 343-7921

March 1994

GELLERT

P.O. BOX 16290 BOISE ID. 83715

Centrifugal Humidifiers

# EQUIPMENT MODEL NUMBERS

1/4 H.P., SINGLE PHASE

2500 SERIES

2500 HNV

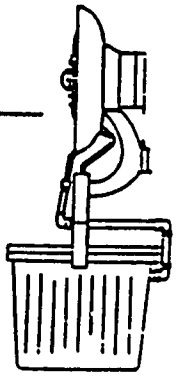
$1062

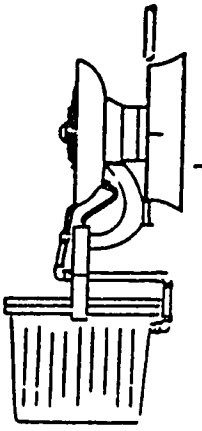
2500 HV

$1138

2500 CNV

$1381



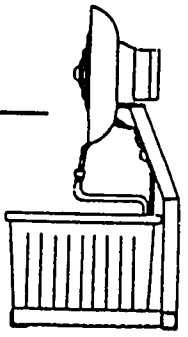


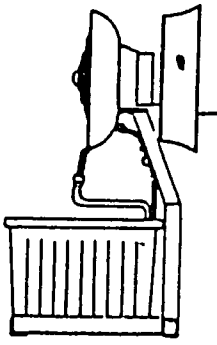
2500 CV

$1458

2500 FNV

$1499



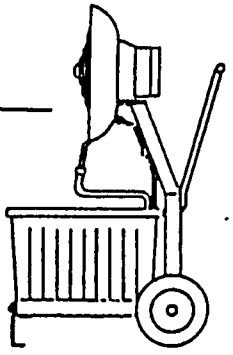


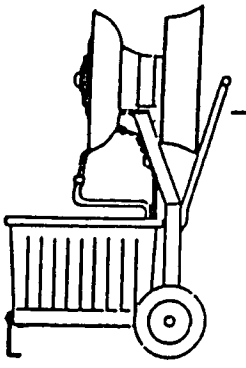
2500 FV

$1576

2500 PNV

$1581





2500 PV

$1658

LIST PRICE

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Centrifugal Humidifiers

American
# FruitGrower
cluding Eastern Fruit Grower

July 1993

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# Buyer's Guide 1993

- Orchard Pest Management
- Application Equipment
- Nursery Stock
- Irrigation
- Grafting & Pruning
- Planting & Tillage Equipment
- Harvesting Equipment
- Packing House Equipment
- Packages & Packaging
- Direct Marketing Supplies
- Storage Equipment
- Fruit Processing
- Orchard Management

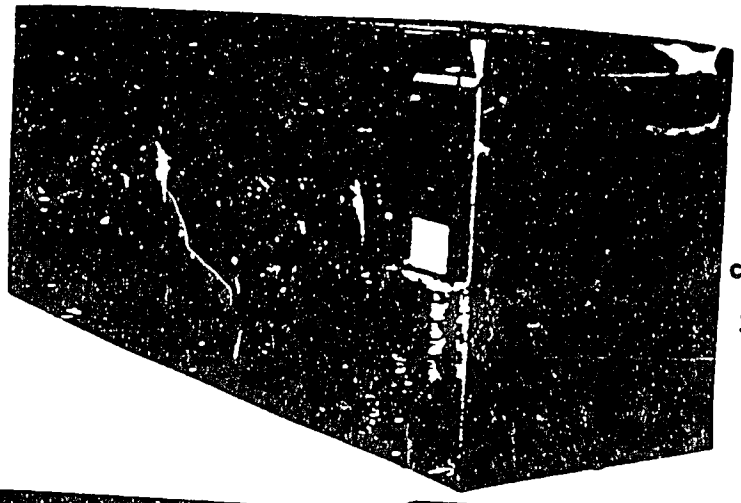
123

# Seabreeze

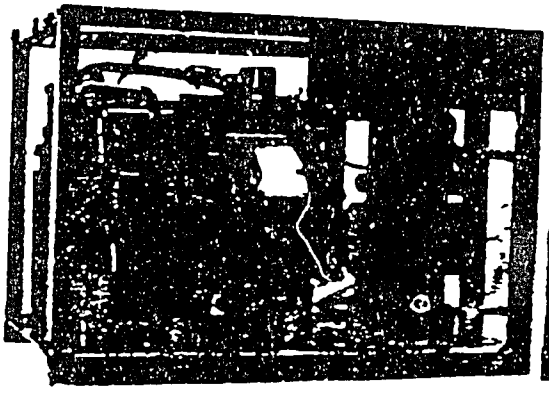
## HYDROCOOLERS

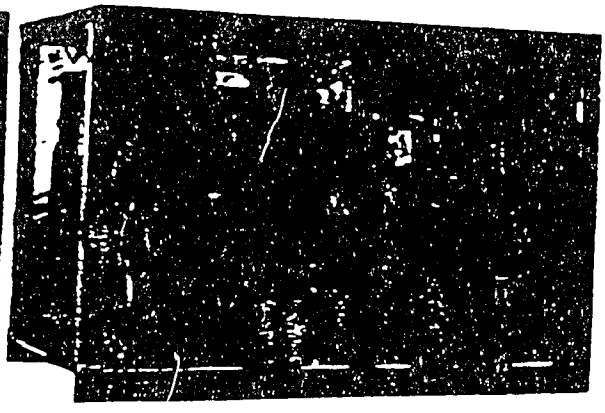
CONVEYOR BATCH IMMERSION

CONVEYORS
10ft.- 60ft.
stainless steel
polyethylene
belt
1ft. to 8ft width
skid mounted
variable speeds



ENCLOSURES
conveyor or batch
stainless steel
inner & outer walls
camlock construction
skid mounted
3½" - 5" urethane
panels





* 3 HORSEPOWER TO 500 HORSEPOWER COMPRESSOR SECTIONS
* 2.5 TON TO 500 TON PER HOUR AT 100 DEGREES F.
* MARINE GRADE ALUMINUM FRAME AND ENCLOSURE.
* UNCOMPLICATED REFRIGERATION CONTROLS AND OPERATION.
* OFF-THE-SHELF CONTROLS FOR EASY FIELD REPLACEMENT.
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* MAKE-UP TANK BAFFELED TO REDUCE FEED BACK CONTAMINATION.
* MARINE GRADE CHILLERS FOR LONG TROUBLE FREE SERVICE.

**1 800 220 0332**

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OMEGA
The OMEGA Technologies Company

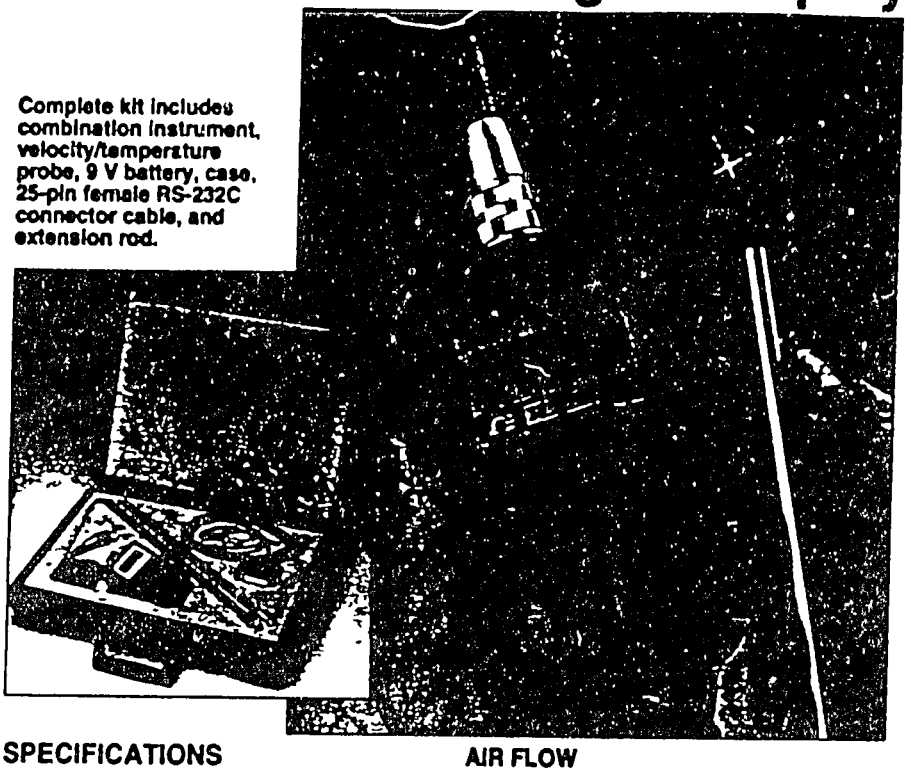
SPEC SHEET
HHF50

2 YEAR WARRANTY

Complete Kit with Velocity Probe
**$525**

- RS-232C Port Allows Field Replacement of Probe
- Fast Response Probe
- Resolution and Response Time Adjustable Through RS-232C Port

# Microprocessor-Based Thermal Anemometer with Digital Display



Complete kit includes combination instrument, velocity/temperature probe, 9 V battery, case, 25-pin female RS-232C connector cable, and extension rod.

The OMEGA Model HHF50 thermal anemometer combines air velocity and temperature measurement in one highly versatile instrument This precision instrument is ideal for air conditioning, cooling, heating, and ventilation applications. It features a fast response thermal probe, with one thermistor maintained at 120°C, and a second thermistor used to measure and compensate for changes in air temperature.

The HHF50 can also be supplied with a spare field-replaceable probe (HHF5P), which comes with its own calibration data. When replacing the probe, the calibration data must be downloaded from a computer via an RS-232C interface port. Additional features available through the RS-232C connector include: English or metric display, adjustable resolution for velocity and temperature, and adjustable response time.

## SPECIFICATIONS

### TEMPERATURE

**Instrument and Probe.** 0° to 40°C (32° to 104°F) Note. The HHF50 can be used to measure temperature ONLY up to 70°CF (158°) and down to -10°C (14°F)

**Accuracy:** ±1°C or 2°F

**Resolution:** 0 1°C or 0 1°F, adjustable from 0 01 °F or °C through RS-232C connector

**Temperature Response Time:** 0 5 sec using average of last eight data points (one data point every 60 milliseconds, adjustable from 0 5 sec up to 4 0 sec through RS-232C connector.

### AIR FLOW

**Range:** 10 to 6000 fpm, 0.1 to 30.0 mps

**Accuracy:** ±3% of rdg ±1% FS

**Resolution:** 0.1 m/sec or 10 ft/min, adjustable though the RS-232C connector for 0.1 or 0.01 m/sec, not adjustable for fpm

### GENERAL SPECIFICATIONS

**Display:** ½" LCD, 4½ digits

**Battery:** 9 V alkaline (included)

**Battery Check:** LOBAT display @ 6 V

**Battery Life:** 25 hr intermittent

**Dimensions:** Instrument: 130 H x 71 W x 36 D mm (5.1" x 2.8" x 1.4"); HHF5P probe 399 mm (15.7") long, 13 mm (½") tip diameter

**Shipping Weight:** 2.5 kg (5 5 lbs)

*For more information, see Page C-1 of the Volume 2 OMEGA Complete Flow & Level Handbook and Encyclopedia*

OMEGAfax
1-800-848-4271
Document # 4017

## To Order (Specify Model Number)

| Model No. | Price | Description |
|---|---|---|
| HHF51:G1 | $525 | Complete kit including combination instrument, velocity/temperature probe, 9 V battery, case, 25-pin female RS-232C connector cable, extension rod Displays in fpm and °F |
| HHF52:G1 | 525 | Same as HHF51, but displays in m/sec and °C |
| HHF5P:G1 | 200 | Field-replaceable velocity/temperature probe |
| MN1604:G1 | 3 | Replacement alkaline battery |

*Comes with complete operator's manual*

*Ordering Example: HHF52 thermal anemometer with m/sec and °C display, includes instrument probe, battery, case, 25-pin female RS-232C connector cable, and extension rod, $525.*

**OMEGA ENGINEERING, INC.**
One Omega Drive, Box 4047, Stamford, CT 06907
Telex 996404 Cable OMEGA EASYLINK 62968934

**1-800-82-66342**
**1-800-TC-OMEGA**

**International Customers Dial**
**(203) 359-1660**
**24-Hour FAX (203) 359-7700**

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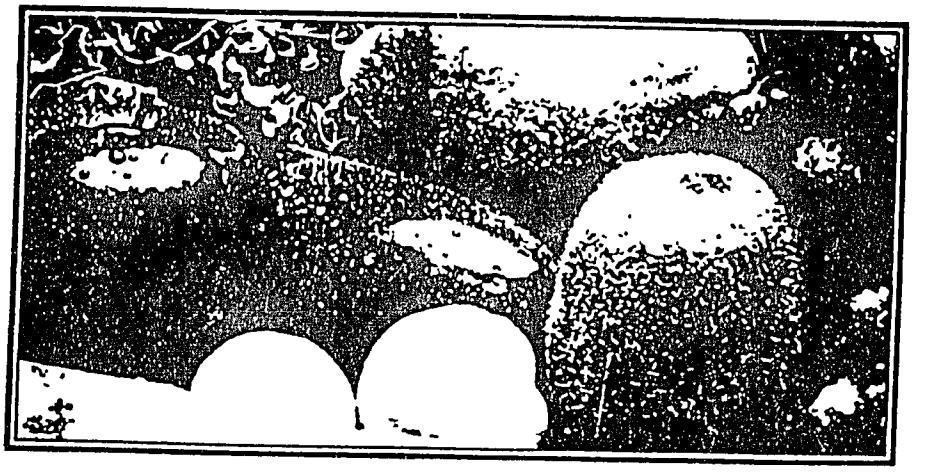
# THE PACKER

Vance



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# 1994 Produce Services Sourcebook

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phone: 913-451-6684
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Home office:
Melissa Bulgren, Scott Hanna;
Greg Snowman
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12 7

Jaybird Mfg. Inc.
Humidifan

| Humidifan Size | Cost | approximate room capacity |
|---|---|---|
| ¼ HP | $629 | 50′ x 50′ (2500 $ft^2$) |
| ½ HP | $659 | 65′ x 65′ (4200 $ft^2$) |
| 1 HP | $695 | 80′ x 80′ (6400 $ft^2$) |

Cost includes oscillator. Subtract $200 for unguarded fan models. Humidistat cost is extra (approximately $85 for a 50% - 95% RH unit ±3% RH accuracy) Solenoid, relay, timer costs also are extra.

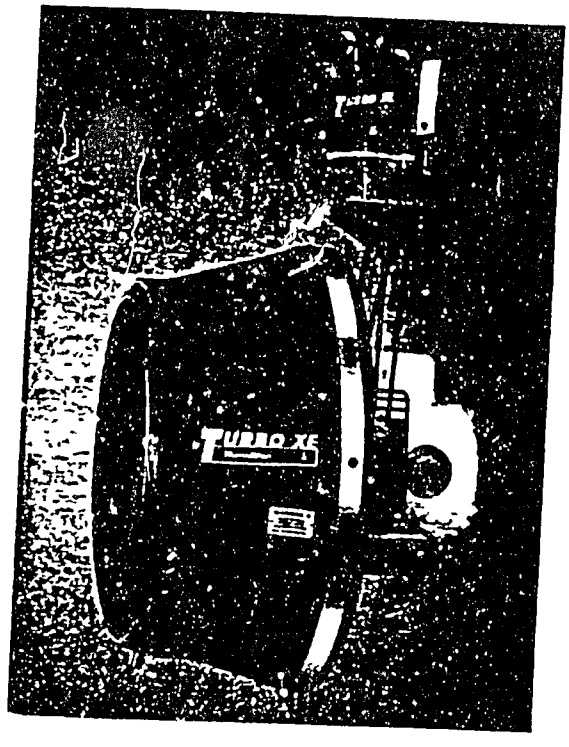
# NOZZLE-FREE FOGGERS TO HUMIDIFY

Humidifan is rapidly setting new standards for efficient, low cost fog production. Using no nozzles or high pressure pumps, the compact, self-contained units are incredibly productive.

***HUMIDIFAN® TURBO XE Series.***

*"The Horizontal Airflow Fan That Produces Fog."*

*A remarkable idea - the same blade that creates airflow, atomizes water into fog. Simple. Efficient. Effective.*




Humidifan

- HIGH CAPACITY. 0-50 GPH OUTPUT.
- POWERFUL, FORCED CIRCULATION.
- MICRON-SIZE ATOMIZATION.
- UNIFORM FOG DISPERSION.

A proven, dependable fogger, Humidifan has grown to 32 models in three HP sizes to meet the needs of every plant enthusiast, from large-scale commercial growers to smaller specialty growers.

*Premier Liquid Atomization Systems*

(814) 364-1810
FAX 364-1759

Jaybird Mfg., Inc.

RD 1 Box 489A • Centre Hall, PA 16828

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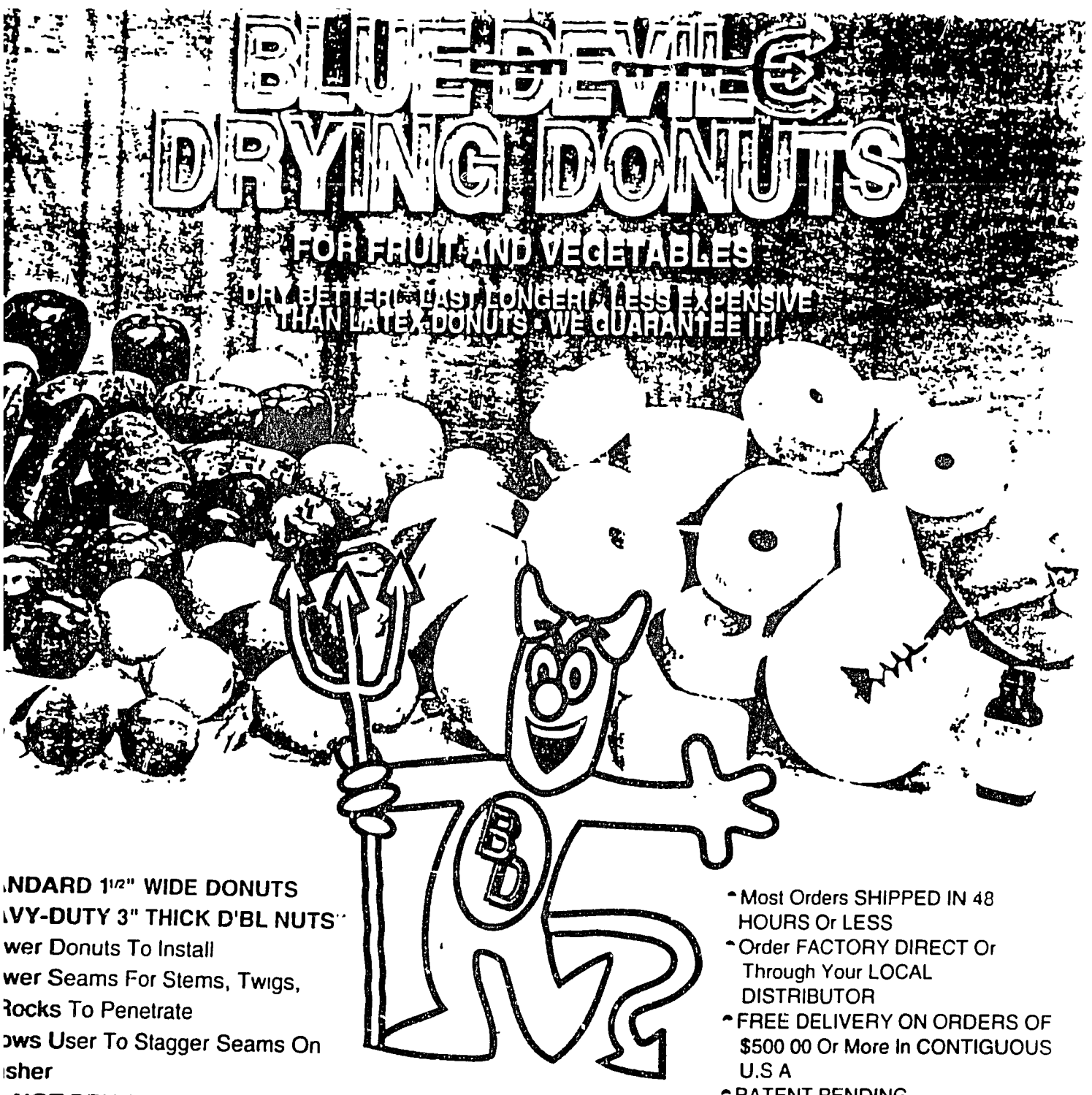
# BLUE DEVIL DRYING DONUTS

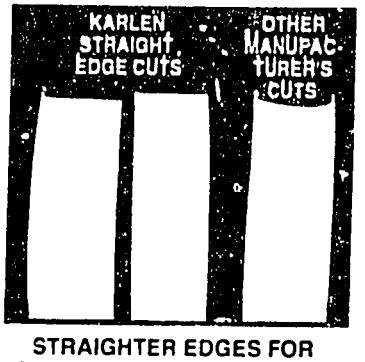
## FOR FRUIT AND VEGETABLES

DRY BETTER! LAST LONGER! LESS EXPENSIVE THAN LATEX DONUTS - WE GUARANTEE IT!



- NDARD 1½" WIDE DONUTS
- VY-DUTY 3" THICK D'BL NUTS
- wer Donuts To Install
- wer Seams For Stems, Twigs, Rocks To Penetrate
- ows User To Stagger Seams On isher
- . NOT DRY-ROT Like Latex Donuts
- Vork On ALL FRUIT AND ETABLES That Need To Be hed And Dried
- ' NUT™ REPAIR KITS AVAILABLE
- LESS DOWN TIME ON PACKING INCLUDES JIFFYJEL™.
- O.D. OR I.D., ROUND OR SQUARE
- T IN 1/8" INCREMENTS
- Y "NO RISK" GUARANTEE LY!)

- Most Orders SHIPPED IN 48 HOURS Or LESS
- Order FACTORY DIRECT Or Through Your LOCAL DISTRIBUTOR
- FREE DELIVERY ON ORDERS OF $500 00 Or More In CONTIGUOUS U.S A
- PATENT PENDING
- DON'T FORGET! Karlen Also Sells High Quality Latex Donuts Too!




STRAIGHTER EDGES FOR BETTER PERFORMANCE ON THE PACKING LINE

KARLEN MANUFACTURING, INC
5401 S Graham Rd
St Charles, Michigan 48655
ORDER FROM YOUR LOCAL DISTRIBUTOR OR CALL
1 (800) 262-8156
OUTSIDE U S A 01 (517) 865-8221

BEST AVAILABLE DOCUMENT

FAX ORDERS TOLL FREE! 1 (800) 262-8156 OUTSIDE U S A FAX 01 (517) 865-8156

Master Card or VISA Visa

1994 PACKER PRICE LIST / ORDER FORM

# BLUE DEVIL™ DONUTS

COMPARE AND SAVE MORE MONEY!

## High-Density Super Absorbent Sponge Donuts for Drying Produce

Blue Devil's Special Hydrophilic Polymer Foam Formulation Eliminates Water Quicker, and Lasts Longer than any other Water Eliminating Donut on the Market including Latex!

**No Crumbling! No Shredding! No Dry-Rot! No Mildew! Straight Edge Cuts! Chlorine Resistant!**

**NO RISK (REALLY!) GUARANTEE:** Order Blue Devil Sponges and if within 30 days you are not ABSOLUTELY PLEASED with their superior performance over latex, we will ship you Karlen Latex Donuts and credit you in full for the Blue Devils upon their return.

| 1-1/2" THICK | INSIDE DIAMETERS: ALL SIZES AVAILABLE INCLUDING SQUARE HOLES ■ | | |
|---|---|---|---|
| OUTSIDE DIAMETER (Any I.D.) | 20 – 99 | 100 – 499 | 500 & UP |
| 3" / 3-1/4" / 3-1/2" / 3-3/4" | .85 | .78 | .72 |
| 4" | .86 | .79 | .73 |
| 4-1/8" / 4-1/4" | .95 | .87 | .80 |
| 4-3/8" / 4-1/2" | .99 | .91 | .84 |
| 4-5/8" / 4-3/4" | 1.08 | 1.00 | .92 |
| 4-7/8" / 5" | 1.19 | 1.09 | 1.01 |
| 5-1/4" | 1.24 | 1.14 | 1.06 |
| 5-1/2" | 1.31 | 1.19 | 1.09 |
| 5-3/4" | 1.41 | 1.21 | 1.12 |
| 5-7/8" / 6" | 1.53 | 1.41 | 1.33 |
| 6-1/8" / 6-1/4" / 6-1/2" | 1.70 | 1.56 | 1.41 |
| 6-3/4" | 1.87 | 1.71 | 1.59 |

EN ACCOUNT TERMS: 1% 10, NET 30 on Credit Approval Others Credit Card or C O D
EIGHT: Prepaid in CONTIGUOUS UNITED STATES for orders of $500 00 or more Orders less than $500 00, shipped outside U S are F O B our nt in Michigan Or you may order through your LOCAL DISTRIBUTOR

## BLUE DEVIL ORDER FORM

| QUANTITY | OUTSIDE DIAMETER | INSIDE DIAMETER * | SHAFT SIZE | PRICE EACH | TOTAL |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | TOTAL ORDER | |

IDE DIAMETER (ID) ORDERED WILL BE ID SHIPPED PLEASE SPECIFY ID
LER THAN ACTUAL SHAFT DIAMETER TO ALLOW FOR TIGHT FIT ON SHAFT
IPLE: ORDER 5/8" ID FOR USE ON 1" DIAMETER SHAFT. WE CANNOT ACCEPT RETURNS DUE TO WRONG SIZE BEING ORDERED

MENT: Charge to my ☐ VISA ☐ M/C #_____ Exp. Date:____/____/____
lp COD ☐ Check or Money Order Enclosed ☐ Ship Open Account ☐ Bill Through My Local Distributor Below.

P TO: _____ BILL TO: _____

NE #: ( ) _____ PHONE #: ( ) _____

HONE TOLL FREE: 1 (800) 262-8221
OUTSIDE U.S.A. PHONE: 01 (517) 865- 8221

FAX TOLL FREE: 1 (800) 262-8156
OUTSIDE U.S.A. FAX: 01 (517) 865-8156

A. [illegible] MANUFACTURING INC • 5101 S. Graham Rd. • St. Charles, Michigan [illegible]

131

# How To Enhance Quality and Profits.

# STRATEGIC USES OF TEMPERATURE AND HUMIDITY MONITORS

152

# PROTECTING YOUR INTERESTS OVER THE ROAD, AT SEA, AND IN STORAGE.

Florida grapefruit in Japan Fresh Maine lobster in Los Angeles What was once thought impossible is now routine, thanks to advancements in shipping, packing and storage techniques However, as many have learned, these new methods are not foolproof. Every year millions of dollars in merchandise is damaged through human error or mechanical mishap in shipping or storage. Hard-won reputations are tarnished and revenue lost

These consequences aren't limited to the fresh and frozen food industries Many companies handle temperature/humidity sensitive items—pharmaceuticals, electronics, horticultural products So, from milk to micro-processors, companies serious about protecting brand image and market share have incorporated **Ryan temperature/humidity monitors** into their operations Regardless of product, the benefits are the same

**A QUALITY CONTROL STRATEGY.** With Ryan monitors, not only can you determine *if* damaging fluctuations occurred, but *when* they occurred—from processing through distribution—and take action For many companies, Ryan monitors are a critically important, yet inexpensive element in quality control

**A DISTRIBUTION STRATEGY.** Data recorded by our monitors gives you insig into the quality of your distribution syste Armed with this information, you can m informed decisions concerning storage, shipping and handling procedures

**A LEGAL PROTECTION STRATEGY.** When damage has occurred, Ryan monit provide you with the documentation and expert analysis which has proven effectiv time after time in claims resolution

## IF YOU INSIST ON QUALITY INSIST ON RYAN MONITOR

Chances are, your competition does And for good reason Since our first monitors replaced the men who rode banana trains t track temperature fluctuations, the Ryan name has become synonymous with relab instruments and excellent service

**RYAN TRIPMENTOR™**

Digital Temperature Monitor
**Temperature Range**
-40° to 110°F (-40° to 43°C)
**Monitoring Spans**
7 21, 42 or 84 days

- Electronic sensor cannot be affected by impact
- Digital data retrieval
- Chart return
- Automatic post use accuracy verification
- Pair with Ryan TripWriter™ for accurate dirt chains on-the spot

$25.00

**RYAN UTL™**

Analog Temperature Monitor
**Temperature Range**
-20° to 100°F ( 29° to 35°C)
**Monitoring Spans**
4 8 16 32 or 75 days

- Certified bi metal coil records temperature on pressure sensitive paper
- Automatic post use accuracy verification
- Chart return
- Extended span temperature ranges available

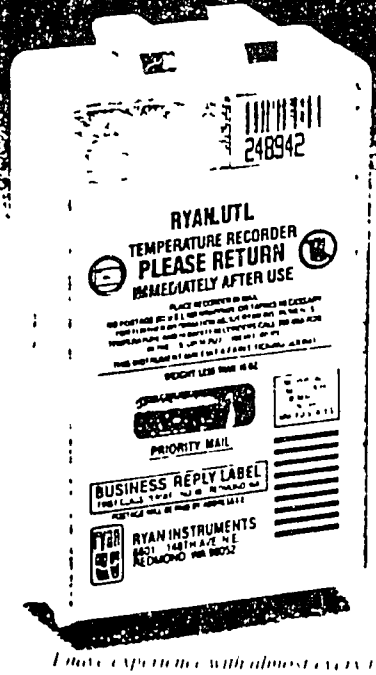
$23.50

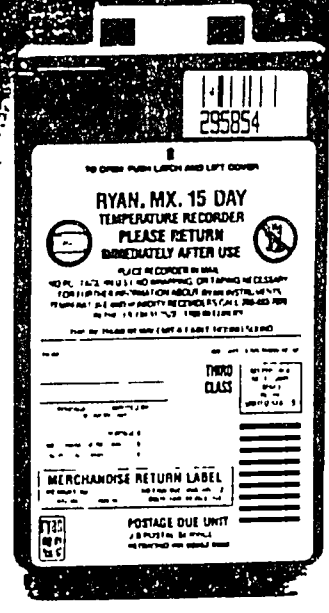
**RYAN MX**

Analog Temperature Monitor
**Temperature Range**
20° to 100°F (-29° to 38°C)
**Monitoring Spans**
15 and 60 days

- Ryan reliability in an inexpensive trip monitor
- Certified bi metal coil records temperature on pressure sensitive paper
- Post use accuracy verification
- No paperwork required

$18.00




*use Ryan monitors because of the quality of workmanship, and the curacy that I've had in the past*

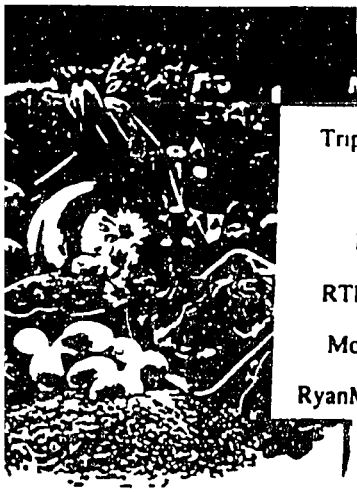
*nor Produce Distributor*

*I have experience with almost every type of temperature recording instrument in the industry. I have a confidence level in Ryan's accuracy. I don't get with any other. I've never had any easy disputes over a Ryan instrument in court*

Major Produce Receiver

# SELECT THE RIGHT MONITOR TO FIT YOUR NEEDS.

Below is a guide to help you choose the instrument best suited to your monitoring needs



| MODEL | DAY SPAN | SINGLE OR MULTIPLE CHARTS | ANALOG OR DIGITAL DATA | MONITOR PARAMETERS |
|---|---|---|---|---|
| TripMentor™ | 7, 21, 42, 84 | Multiple | Digital & Analog | Temperature |
| UTI™ | 4, 8, 16, 32, 75 | Single | Analog | Temperature |
| MX™ | 15, 60 | Single | Analog | Temperature |
| RTM2000™ | Programmable | Multiple | Digital | Temperature/RH |
| Model K™ | 10, 45, 90 | Single | Analog | Temperature |
| RyanMentor II™ | Programmable | Multiple | Digital | Temperature/RH |

# TECHNICAL SPECIFICATIONS

## TRIPMENTOR

| | |
|---|---|
| Range | -40° to 110°F (-40° to 43°C) |
| Time Accuracy | ± 01% |
| Temp Accuracy | ± 1°F (±.5°C) |
| Sensing Element | Fast response thermistor |
| Sample Rate | 5 minutes 7 days |
| | 15 minutes 21 days |
| | 30 minutes 42 days |
| | 60 minutes 84 days |
| Power | One 1.5 volt alkaline battery |
| Weight | <10 ounces |

## UTI

| | |
|---|---|
| Range | 20° to 100°F (-29° to 45°C) |
| Time Accuracy | ± 2% |
| Temp Accuracy | ± 2°F (±1°C) |
| Sensing Element | Certified bi-metal coil |
| Chart | Pressure sensitive paper |
| Chart Advance | 4 Day 6.0" per day |
| | 8 Day 3.0" per day |
| | 16 Day 1.5" per day |
| | 32 Day .750" per day |
| | 75 Day .750" per day |
| Paper Width | 2.6 inches |
| Scale Width | 2.1 inches |
| Power | Two 1.5 volt AA alkaline batteries |
| Weight | 15 ounces |

## RYAN MX

| | |
|---|---|
| Range | -20° to 100°F (-29° to 38°C) |
| Time Accuracy | ± 2% |
| Temp Accuracy | ±2°F (±1°C) |
| Sensing Element | Certified bi-metal coil |
| Chart. | Pressure sensitive paper |
| Chart Advance | 15 Day 1.94" per day |
| | 60 Day .485" per day |
| Paper Width | 2.6 inches |
| Scale Width | 1.9 inches |
| Power | One 1.5 volt AA alkaline battery |
| Weight | <15 ounces |

## RTM2000

| | |
|---|---|
| Range | Thermistor -72° to 163°F (-58° to 73°C) |
| | RTD -328° to 1112°F (-200° to 600°C) |
| | RH 5 to 100%, 14° to 122°F (-10° to 50°C) |
| Time Accuracy | ± 01% |
| Sensing Element | Fast response thermistor, RTD and humidity sensors |
| Sample Rate | 5 seconds to 9,999 days |
| Deployment Life | 2 years |
| Power | One 9 volt alkaline battery pack |
| Weight | <12 ounces |

## RYAN MODEL K

| | |
|---|---|
| Range | -15° to 95°F (-25° to 35°C) |
| Time Accuracy | ± 5% |
| Temp Accuracy | ± 2°F (±1°C) |
| Sensing Element | Certified bi-metal coil |
| Chart | Pressure sensitive paper |
| Chart Advance | 10 Day .12" per day |
| | 15 Day .8" per day |
| | 90 Day .1.5" per day |
| Power | One 1.5 volt AA battery |
| Weight | 12 ounces |

## RYANMENTOR II

| | |
|---|---|
| Range | -40° to 110°F (-40° to 43°C) |
| | RH 10 to 100% |
| Time Accuracy | ± 1% |
| Temp Accuracy | ± 1°F (±.5°C) |
| Sensing Element | Fast response thermistor |
| Sample Rate | 1 minute 1.4 days |
| | 5 minutes 7 days |
| | 15 minutes 21 days |
| | 30 minutes 42 days |
| | 60 minutes 84 days |
| Power | One 1.5 volt alkaline battery |
| Weight | 12 ounces |

# Ryan Instruments

8801 148th Avenue N.E., P.O. Box 599, Redmond, WA 98073-0599 USA (206) 883-7926 FAX (206) 883-3766
Ryan Europe Jagtlustkade 12C P.O. Box 169 2170 AD Sassenheim The Netherlands 31 2522-11108 FAX 31 2522 31032

With over 70 years' experience, we're a recognized leader in the field. Considering today's fierce competition, why trust your product or your reputation with anything else?

## WIDE RANGE OF MODELS AND SERVICES

From simple analog (strip chart) monitors to digital units with PC compatibility, Ryan has the right temperature/humidity monitor, whatever your application. What's more, we can provide you with the versatility and capability you need to manage the data you collect. Get your charts and graphics immediately, or have us prepare your report. Download data in the field using your portable computer, terminal or datalogger or transfer it to your IBM® PC or compatible in just minutes. We've got the software to make the most of your data analysis.

## BUILT FOR HARSH CONDITIONS

You can't afford to have a monitor quit when conditions get ugly. In fact, that's when their capability is needed most. At Ryan, we know what our instruments can be subjected to, day-in and day-out. So we build them to resist more than just broiling heat and freezing cold, rough handling is also taken into account.

## DOUBLE VERIFIED FOR ACCURACY

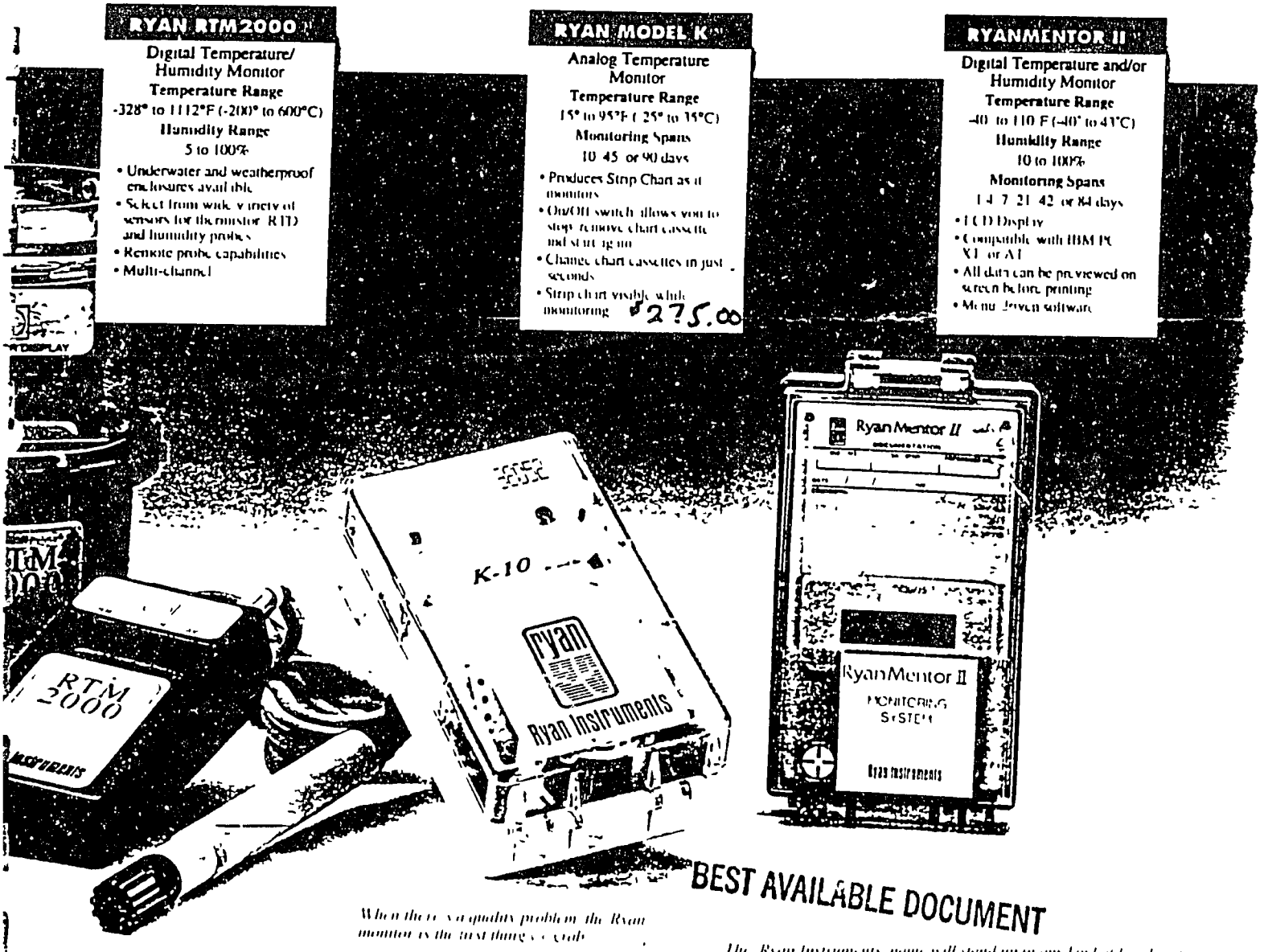
Accuracy is vital in any kind of monitor. No monitor passes through our doors without first being calibrated at *two* or more temperature extremes. Proof of this calibration is available and all Ryan monitors come with tamper-proof seals. So, whether your product goes over the road, under water or in storage, count on Ryan monitors with chart accuracy that has held up in court.

## SALES AND SERVICE WORLDWIDE

With distribution points worldwide, we guarantee quick response, fast shipments and outstanding service. Many customers insist on Ryan Instruments for this reason alone. Shouldn't you?

For a demonstration or more information, call Ryan Instruments at **1-800-999-7926** (U.S. & Canada only) or **206/883-7926**. FAX us at **206/883-3766**. Or simply write us: Ryan Instruments, P.O. Box 599, Redmond, WA 98073-0599.

**Ryan Instruments**




BEST AVAILABLE DOCUMENT

*make our distributors more confident in the they feel it gives them an edge*

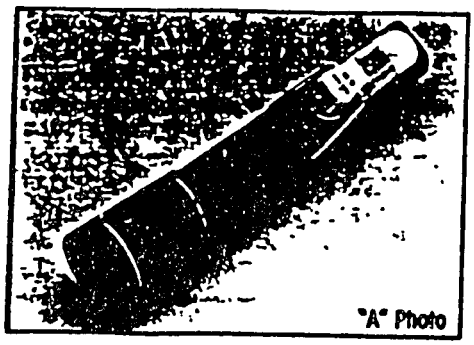
*When there is a quality problem, the Ryan monitor is the first thing we check*

Major Produce Distributor

*The Ryan Instruments name will stand up in any kind of legal suit if we have to go back and collect for damages*

Major Beverage Producer

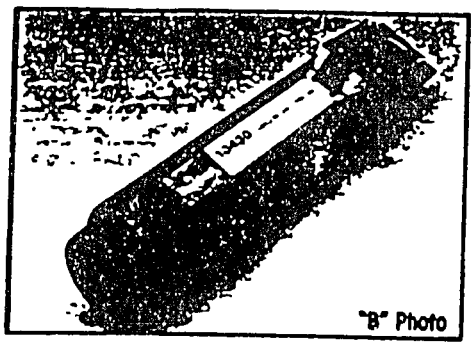
# Optical refractometers for sugar measure the % solids (Brix) in foods.


"A" Photo

For % solids (sugar, Brix) measurements, just place a small drop or small piece on the prism. Using any convenient light source, look through the eyepiece and read the scale at the border between light and dark regions.

Works on these foods and more·

| | | |
|---|---|---|
| corn syrup | tomatoes | wine |
| invert sugar | beer | strawberries |
| honey | fruit juice | grapes |
| jams-jellies | maple sap | candies |
| soft drinks | melons | citrus fruit |


"B" Photo

Temperature compensation accuracy
±0 05 for 0.10 scale division model,
±0 25 for all others
Calibration liquid
Distilled water for 0-30, 0-50 Brix models,
50% wt/wt sucrose for 44-77 Brix model

AMERICAN MADE

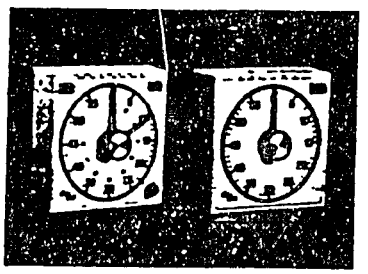
For More Info·
FAXED answer #730
(800)888-1335

**Optical Refractometer for Brix Measurements, automatically temperature compensated:**

| | |
|---|---|
| 0 - 30 Brix, 0.2 scale division. ("B" Photo) Model #AQA1078... | $219 |
| 0 - 30 Brix, 0.1 scale division. ("A" Photo) Model #AQA1080... | $830 |
| 0 - 50 Brix, 0.25 scale division. ("B" Photo) Model #AQA1079... | $265 |
| 44 - 77 Brix, 0.25 scale division. ("B" Photo) Model #AQA1077... | $265 |

## Three Countdown Timers For Safer Food Holding, Frying, Rising/Baking, Incubating, Broiling, Service-Timing, ...

### Two easy to read "moving hand" electro-mechanical timers.



With zero to 60 minutes time intervals Black numerals 1/2" high on 6-1/2" white dial Loud built-in buzzer signals end of cooking or other cycle Plastic cover protects power switch from build up of grease, flour, etc. The 7.5" x 7.5" x 2.5" easy to clean case has wall-mounting keyholes, and recessed hand grip for portability.
120V, 50/60 Hz, UL and CSA listed. American Made.

**1 to 60 minutes countdown moving-hand timer Model #AQA1064... $ 80.ea.**
**1 to 60 seconds and minutes up/down counting moving-hand timer, larger numerals show time remaining, inner scale shows elapsed time. This model has a 600 watt power outlet to control small appliances and buzzer adjustable volume control. Model #AQA1065... $93.ea.**

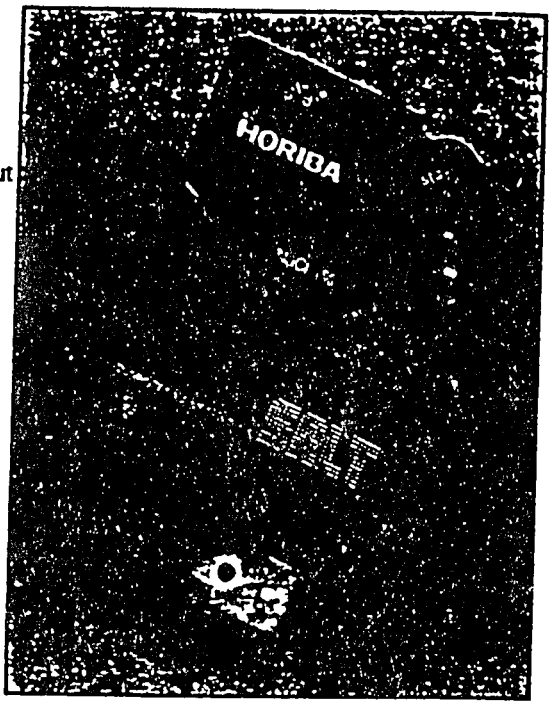
For More Info:
FAXED answer #731
(800)888-1335

### Battery-powered digital countdown timer with beeper

Low cost, versatile and compact, this timer counts down with large 0 3"H. digits to a beeper signal One button sets timer 0 to 99 minutes. A second button sets timer at 0 to 59 seconds Large start-stop button. Moderate-volume beeper is suitably audible, but the above line-powered buzzers are louder. Timer memory repeats last setting unless reset Battery shelf life one year Neck lanyard for mobile users such as dieticians, area supervisors

# Measure salt, sodium, potassium, and nitrates with these economical ion-specific digital meters.

These ion-specific meters do not have cables or separate probes. You place the samples directly on the flat sensor electrode beneath the lift-cover at the bottom of the display panel. The recess serves as a container, and cleans easily, but also snaps out for replacement. Liquids require just a 0.15 ml drop sample. Solids and powders are to be ground finely and diluted 10:1 with pure water (extraction method).




Housing Size: 3.7" x 2.2" x 0.35" wt 1.4 oz

All have automatic temp comp. of sample 41° to 95°F (5° to 35°C)

All have 2-digit display and use two ea Lithium batteries #CR-2025 for 500 hours continuous operation

Accessories for all standard solutions, deionized water sampling sheet (soak in liquid to sample), tweezers, instructions

All use 2-point calibration by Std/Slope controls with standard calibration solutions, Std 2000ppm, Slope, 150 ppm.

*For More Info:*

**FAXED answer #733**
**(800)888-1335**

>OPTIONAL CARRYING CASE for any of the following four meters and accessories... Model AQA1113..... $30. ea.

SALT METER (SODIUM ION) operates independently of other ions or pH of sample; range 0.1-10% NaCl(w/w). Resolution 0.01% to 0.99%, 0.1% to 9.9%, then 1% up to 25%. Model #AQA1092..... $215. ea.

SODIUM ION METER, range 23 - 2300 ppm ($10^{-3}$ to $10^{-1}$ mol/l, but usable beyond). Repeatability ± 20%. Includes pipet. Model AQA#1114.... $215. ea.

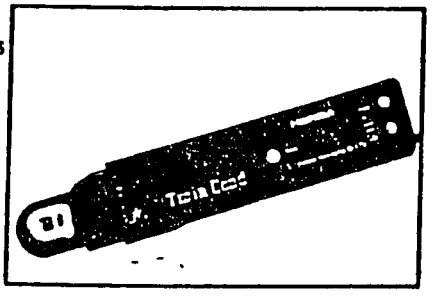
POTASSIUM ION METER, range 39 - 3900 ppm ($10^{-3}$ to $10^{-1}$ mol/l, usable beyond). Repeatability ±20%. Includes pipet. Model #AQA1115... $215 ea.

NITRATE ION METER, range 62 to 6200 ppm ( $10^{-3}$ to $10^{-1}$ mol/l, but usable beyond). Repeatability ± 20%. Includes pipet. Model #AQA1116.... $225 ea.

# Measure Conductivity or pH with no cable! In-the-pocket size measurement instruments.

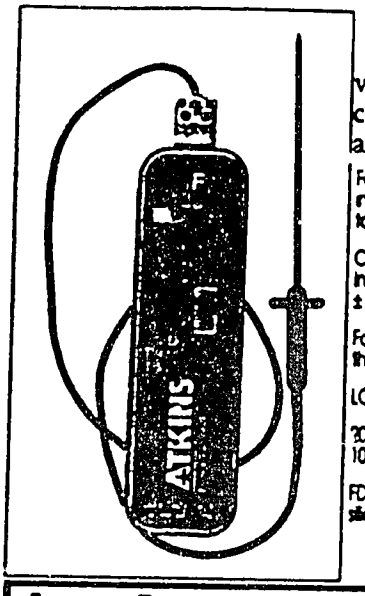
Waterproof "flat sensor" can be immersed in sample, but is easily replaced if necessary. "Hold" button to retain reading for recording. Two lithium batteries #CR-2032; low-batt signal. Auto shut-off. Compact size: 6"L x 1" W x 0.6". Accessories: two standardizing solutions, deionized water, carrying pouch, instructions.

**FAXED answer #734**
**(800)888-1335**



CONDUCTIVITY/SODIUM CHLORIDE SALINITY CONVERSION METER, covers 0 - 19.9 mS/cm in 3 ranges. Repeatability ± 1% full scale. Auto Temp Compensation from 5° to 35°C. One touch auto calibration (1 point). Accessories include pipet...Model #AQA1117.....$245 ea.

# Economical thermocouple thermometer – Made in USA.




This affordable thermometer is manufactured in high volume with engineered economies. It uses integrated circuit chips, surface mount technology, component nest housing, and insert-molding parts capture.

Fahrenheit model measures -100 to +1000°F in 1° increments. Accuracy within 0.25% of reading, ±2 F°: 68° to 86°F ambient

Celsius (Centigrade) model measures -120 to +550°C in 1° increments. Accuracy within ± 0.25% of reading, ±1C°: 20° to 30°C ambient

For use with any Type K (Chromel-Alumel) thermocouple probe with miniature connector

LCD Digits full 4/10-inches high.

2000 hour 9V replaceable battery with 10 hour "Lo Batt" alert

FDA approved materials: nylon handle, silicone cable

AMERICAN MADE

FAXED answer #708 (800)888-1335

Economy Thermometer.
Atkins #AQA31303-KF... $69
Atkins #AQA31308-KC... $69

Probes:

(Note Use any Type K thermocouple probe with miniature connectors. The following economically priced probes are suitable for use in 400°F continuous, 500° intermittent heat.)

Economy Needle K-Thermocouple Probe, 4" needle tip, handle, 30" cable.
Atkins Model #AQA31901-K... $25

Economy Surface Fixed Bell Probe, K-Thermocouple 0.125" dia. x 4" L. stem with 3/8" dia. tip, handle, 30" cable.
Atkins Model #AQA31907-K... $28

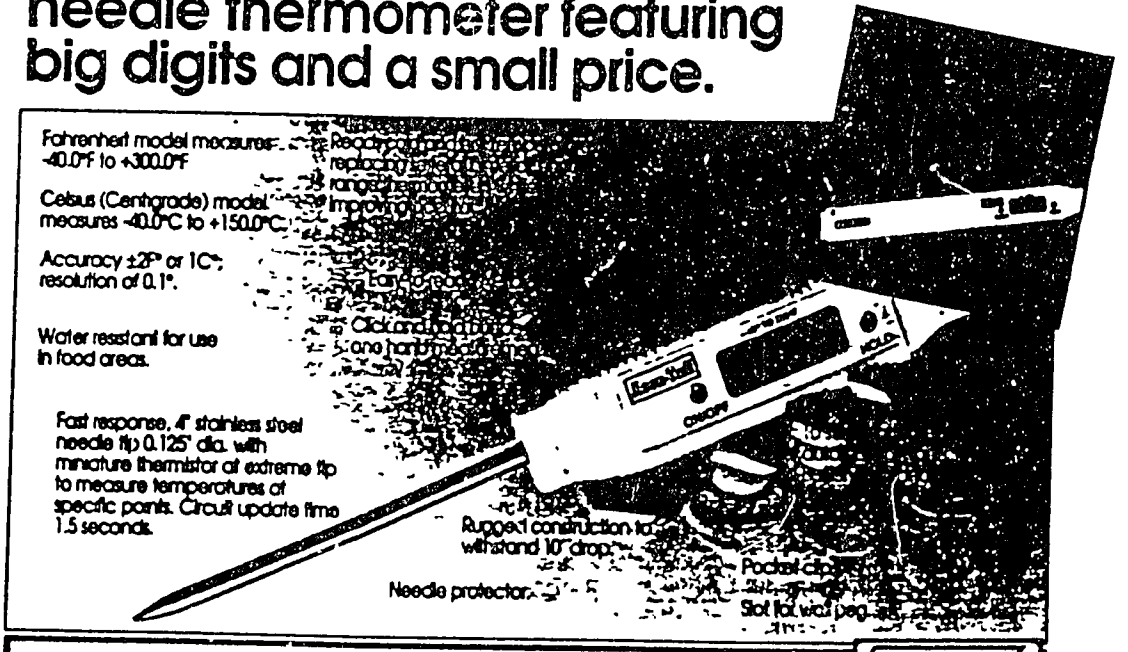
Economy Air K-Thermocouple Probe; 4" L, fast response radiation shield, 30" cable.
Atkins Model #AQA31903-K... $28

Economy Bare Tip Probe, 30" cable.
Atkins Model #AQA31905-K... $15

Accessories:

Economy carrying case, vinyl with zipper.
Atkins Model #AQA14230... $8

# Speed read temperatures with this handy needle thermometer featuring big digits and a small price.



Fahrenheit model measures -40.0°F to +300.0°F

Celsius (Centigrade) model measures -40.0°C to +150.0°C

Accuracy ±2F° or 1C°; resolution of 0.1°.

Water resistant for use in food areas.

Fast response, 4" stainless steel needle tip 0.125" dia. with miniature thermistor at extreme tip to measure temperatures at specific points. Circuit update time 1.5 seconds.

Rugged construction to withstand 10" drop.

Pocket clip

Needle protector

Slot for wall peg

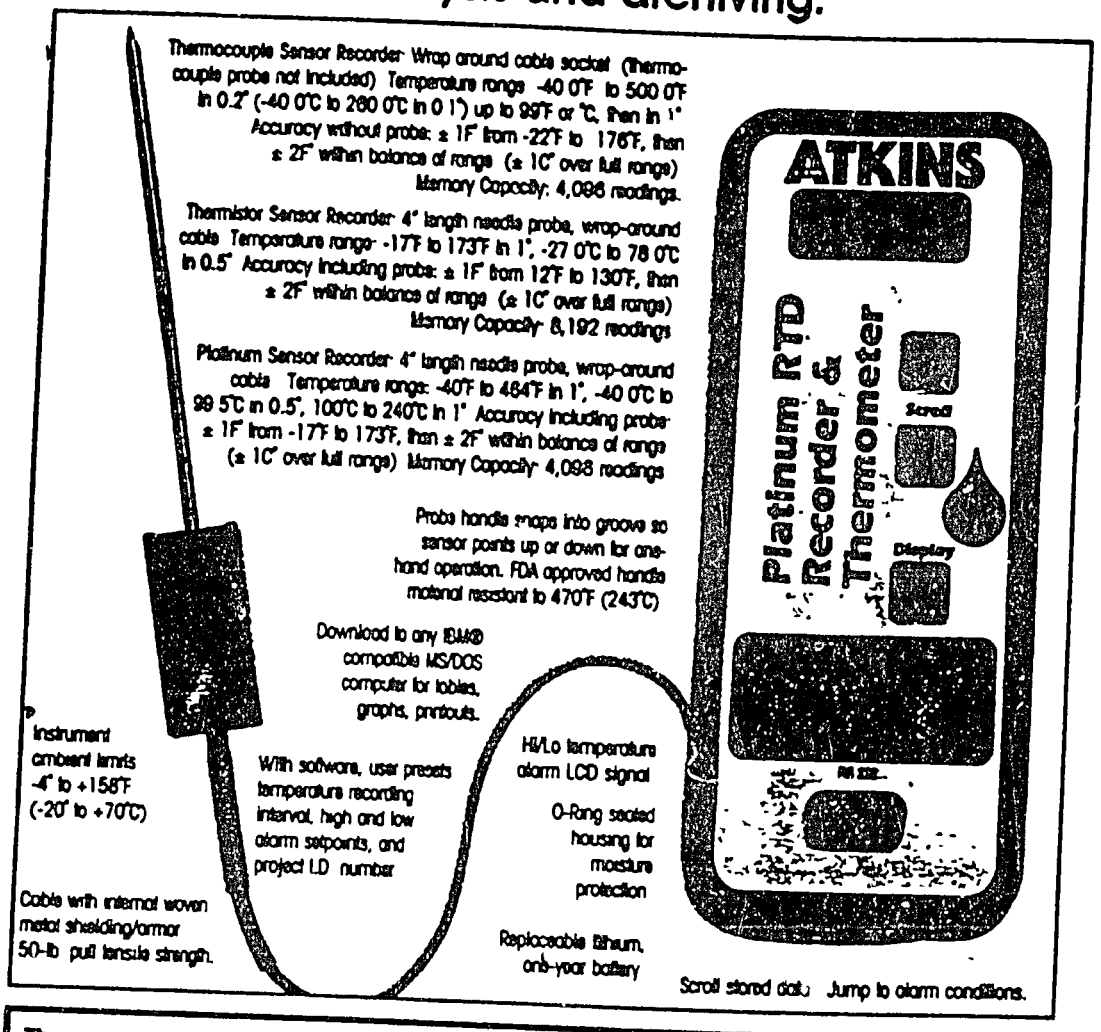
Fahrenheit Pocket Needle Thermometer.
Model #AQA11012-F... $26.95 (Four for $89)
Celsius (Centigrade) Pocket Needle Thermometer.
Model #AQA11012-C... $26.95 (Four for $89)

FAXED answer #709

138

# These thermometers keep a record of the temperature.

## Scroll the display to read stored data, alarm conditions. You can even send the data to your computer for analysis and archiving.




**Thermocouple Thermometer-Alarm-Recorder Kit:** Thermometer, cable mounted socket for probe (not supplied), software, RS232 cable, hinged carrying case. Atkins Model #AQA1054-(specify K or T thermocouple type desired)... $425./kit.

**Thermocouple Recorder Thermometer only.** Atkins Model #AQA37313-(specify K or T thermocouple type desired)... $395. ea. For AQA thermocouple probes, see listings for other thermocouple meters, plus specialized probes on pages 16 & 17.

**Thermistor Thermometer-Alarm-Recorder Kit:** Thermometer, 4" needle probe tip, software, RS232 cable, hinged carrying case. Atkins Model #AQA1051... $325./kit.

**Thermistor Recorder Thermometer only.** Atkins Model #AQA37112 $295 ea

*For More Info:*

**FAXED answer #713**
**(800)888-1335**

Time and temperature graph

**Platinum Thermometer-Alarm-Recorder Kit:** Thermometer, 4" needle probe tip, software, RS232 cable, hinged carrying case. Atkins Model #AQA1052... $375./kit.

**Platinum Recorder Thermometer only.** Atkins Model #AQA37262... $345. ea.

**Meter holder, wall mounted.** May be padlocked. Allows probe and cable to be inside or outside holder.
Atkins Model #AQA14016 $39 ea

# Temperature recorder-indicator, with hi/lo alarms also shows DEGREE-MINUTES, DEGREE-HOURS, DEGREE-DAYS, uses interchangeable thermocouple probes, K or T.

For More Info
FAXED answer #743
(800)888-13[illegible]

This recorder-indicator is similar to those shown on page at left, and records 4,096 time and temp readings. Use any IBM-compatible PC for setup and eventual downloading for graphing and archiving The recorder-indicator on this page has detachable thermocouple probes, can record at intervals of once a second up to once per 12 hours, and it has an optional-use new degree-time calculation feature.

If degree-time calculation is desired, in the PC setup menu you will make several selections including start time, °F or °C, and then "Multiplier" or "Comparator" degree-time calculation, whether "over" or "under" a baseline is desired and the baseline temperature, then a calculation time unit of days, hours, or minutes.

Later, when using the recorder-thermometer in the field, if you selected °F, "multiplier calculation", "hours", and "over", then properly activating the display will give you a reading of the °F degree-hours over the baseline since your startup.

If in the setup you previously selected "comparator calculation, °F, hours, and over", then the display properly activated will give you a reading of the total number of hours (Not degree hours!) the temperature has been over the °F baseline since your startup.

These instruments have display scrolling, and can be jumped to read the time and temp. at the alarm conditions. Range for both K and T is: -40.0° to 500.0°F in 0.2° (-40.0° to 260.0°C in 0.1°) but over 99°F or °C the display is in 1° while internal calculations are in 0.1C° resolution. Instrument accuracy ± 1F° from -22°F to 176°F, range balance is ± 2F° (± 1C° over full range). Display only auto-off after 5 min. Battery one 3V Lithium, lasts one year

**Thermocouple Recorder-Indicator-Alarm Kit, with instrument and cable-mounted miniature socket for K or T thermocouple (but without the probe), RS232 cable for setup by PC, software, hinged carrying case.**
**Model #AQA1054-(specify K or T thermocouple type desired)... $425. /kit.**
**Thermocouple recorder-indicator-alarm only. Model #AQA37313-(specify K or T thermocouple type desired)...$395. ea.**
**K or T Thermocouple probes used must match the above K or T instrument selection.**

*For AQA thermocouple probes, see listings for other thermocouple meters, plus specialized probes on pages 16 & 17.*

# Time and temperature chart recorder.

Select chart speed so one roll covers 4, 8, 16, or 32 days Choose °F or °C and View through clear top

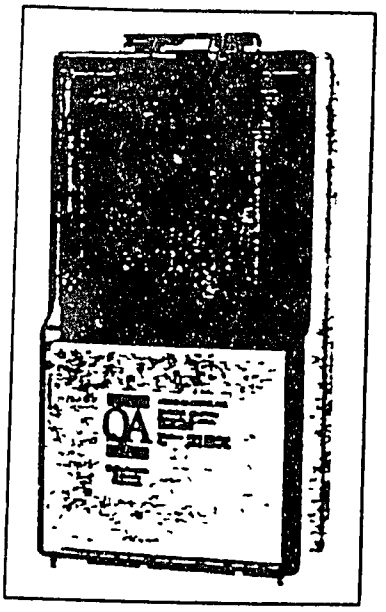
On/Off switch

Temperature range -20° to + 100°F or -25° to 35°C

Temperature sensor bimetallic coil driving stylus

Accuracy ± 1F°, ± ½C°

Recorder size 7" X 3.75" X 2.25" (188mm X 94mm X 57MM) Weight, 15-oz (420 grams)



$98.50 complete and ready for use in deliveries, coolers, refrigerators, freezers, shipments, storage, produce.

Pressure-sensitive paper is treated for humidity resistance

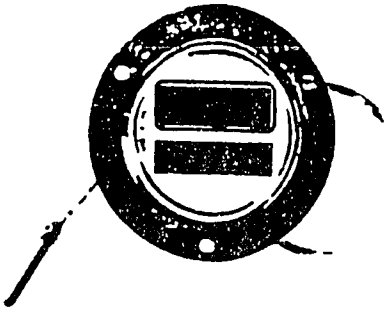
Housing locks for security.

For More Info:
FAXED answer #714
(800)888-1335

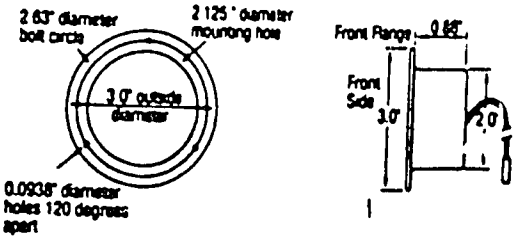
**Temperature Chart Recorder. 9V alkaline battery. 4 charts. 12 adhesive mounting pads, 12 metal tamper-proof seals.**
**#AQA1007-F... $98.50**
**#AQA1007-C $98.50**

**Replacement packet, battery plus 4 charts.**
**#AQA1008-F... $9.50**
**#AQA1008-C... $9.50**

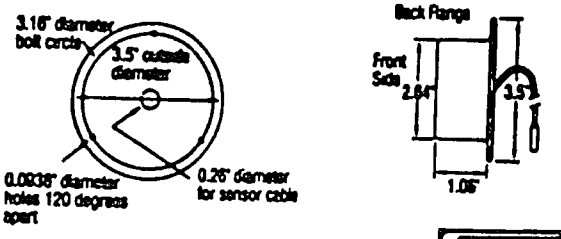
# Built-in solar powered thermometer and probe, NSF certified for food zone areas.



## Front Flange, Into-Panel Mounting, #AQA1045



## Back Flange, On-Wall Mounting, #AQA1046




Easy to install. No line power needed. Ideal for refrigerators, coolers, portable containers.

Solar powered with only 100 LUX light level required. Lithium battery backup

NSF certified cable for use in food zone areas.

Calibrated traceable to NIST

Switch between °F and °C.

Measures -50.0° to 158.0°F (-45.0° to 70.0°C) in 0.1°F or °C.

Resolution 0.1°F or °C.

Ten-second updates.

Accuracy ±2F° or ± 1C°

Digits 0.4" tall black on silver

Easily replaces standard 2" diameter dial thermometers.

Powerful thermistor sensor with 48" extra length cable

Stainless steel housing.

**FAXED answer #715 (800)888-1335**

Solar Powered Thermometer panel mount with front flange. Model #AQA1045... $47

Solar Powered Thermometer wall mount with back flange Model #AQA1046... $55

# Two-Probes: Temperature, time, date, one high/low alarm, plus daily highs and lows in memory

AMERICAN MADE

Measures -65° to +215°F (-54° to +101°C)

Accuracy ± 2F° or 1C°

Keeps time 12 or 24 hour format

Both high and low alarms are settable, and operate on either main or auxiliary probe but not both.

Stores high and low time-stamped temperatures since midnight (main probe only)

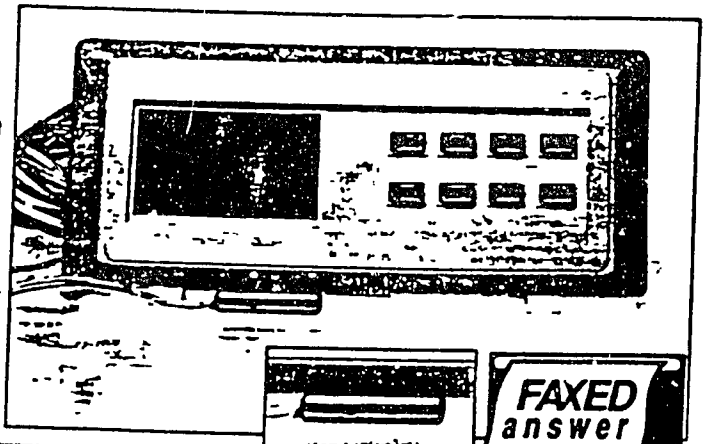
LCD black digits 0.6" high.

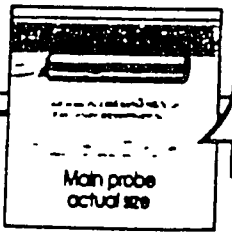
Two probes, each on separate 14-foot cables.

High or low temperature alarm.

9V alkaline battery lasts one year. Low battery signal.

For countertop or wall.





Main probe actual size

**FAXED answer #716 (800)888-1335**

Thermometer and clock/calendar with two remote probes plus alarms. Model #AQA1014... $79

# Order Form

Complete, then phone, fax, or mail to All QA Products, Inc , 3443 S W 42nd Way, Gainesville, FL 32608-2375, U S A See page 3 for additional ordering instructions. Add pages as needed

| Page # | Model # | Qty | Unit Price | Total Price |
|---|---|---|---|---|
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| 3 | Viking Model Swiss Army Knife | 1 | | FREE* |

*Genuine Swiss Army Knife. FREE through 3/1/94 with your order of $250 or more. See page 3

| | |
|---|---|
| Total Merchandise $ | |
| Sales Tax: Florida recipients add 6% $ | |
| U.S. Shipping & handling (Ground) $10.00 $ | |
| U.S. Shipping & handling (Two-day) $20.00 $ | |
| U.S. Shipping & handling (Overnight) $30.00 $ | |
| International Shipping (Fax request for shipping cost) $ | |
| Total $ | |

Payment (Circle one) VISA MasterCard American Express

Check Money Order

Credit Card # _____
Expiration ___/___/___
Signature _____

SATISFACTION GUARANTEED

Satisfaction Guaranteed Check your order when it arrives. In case of loss or damage, tell the carrier right away If you are not completely satisfied with your purchase notify us within 30 days. Call to get a return authorization number We'll refund the purchase price.

Warranty. All QA Products, Inc warrants these products to be free of defects in materials or workmanship for one year from the date of shipment No other warranties or representations, implied or expressed, are intended. All QA Products, Inc. will not be liable for consequential, incidental, or special damages.

## Help us find new QA products

All QA Products, Inc. is looking for new products to offer. They may be based on new technology, or introduce new and clever applications of old technology.

Our criteria are. usefulness, reliability, and ease-of-use. If you know of such products we'd like to know about them. Just call 1-800-845-8818.

| Ordered by | Ship to |
|---|---|
| Name _____ | Name _____ |
| Company _____ | Company _____ |
| Street or P.O. Box _____ | Street address _____ |
| City _____ | City _____ |
| State, Zip, Country _____ | State, Zip, Country _____ |

Would you like us to send our catalog to somebody else? Yes ☐ No ☐
Name _____
Address _____

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Bally

# The Industry Standard for Quality.

Bally

## Walk-In Coolers/Freezers

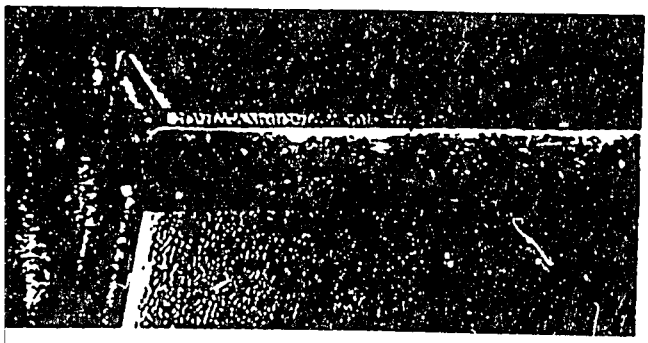
A recognized leader in the refrigeration industry, Bally provides walk-in coolers and freezers uniquely designed to save you time and money when you build...and to keep operating costs down for years to come.

Bally's insulated, pre-engineered panels are constructed of the finest quality materials and are virtually maintenance free. Simplicity of design assures ease of assembly — or disassembly — for future expansion or relocation. And a quality product is only part of what Bally offers

Our experienced customer service organization is backed by the full support of the Bally engineering and design team — a large in-house staff using computer-aided technology to respond quickly to your every need. Your investment in a Bally structure is also protected by a ten-year warranty on the insulated panels. It all adds up to your assurance that Bally is proven dependable... and your project will be up and running — on time and within budget.

# Pre-Engineered Panels

**Competitor***
Inferior ceiling design weakened and damaged the panel It had to be fixed on-site which destroyed the structural integrity of the panel



Bally

**Urethane Insulation**
In all panels consists of urethane foamed-in-place (not frothed) for peak insulating efficiency. The foam — **using a formula that relies on HCFCs with just one-tenth the ozone depleting characteristics of CFCs formerly used** — enters the mold in a liquid state, and rises uniformly, filling all voids. Lightweight panels are available in 4", 5" and 6". (Beware of competitors offering polystyrene or laminated components.)

**Speed-Lok® Joining Mechanism**
Forms a tight, secure panel joint, holding warm air out, cold air in. Promotes easy assembly or disassembly for expansion or relocation. Speed-Lok joins all panels — wall to wall, ceiling to wall and wall to floor — for a complete vapor barrier system. A minimum of three Speed-Loks is used along each vertical joint

**Tongues and Grooves**
on all panel edges are molded to extremely close tolerances for a tight fit between panels. Prevents condensation from forming on the foam and minimizes heat transfer.

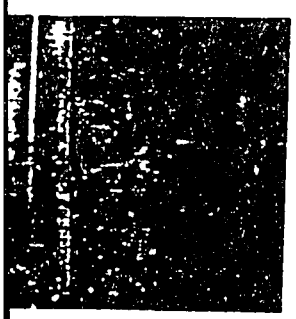
**Right Angle Corners**
ensure that the walk-in is aligned at installation, guaranteeing a perfectly square box and a tighter fit.

**Heavy-Gauge Steel Connector Straps**
connect the locks to form continuous steel bands through panels. Eliminates any possible separation between panels. Allows for easy disassembly and reassembly for expanding or moving the walk-in.

**Outside Metal Skins**
are available in a variety of finished metals and custom colors.

**Gasketing**
made of soft compression plastic guarantees a tighter panel joint.

**Wash Primer**
yields tenacious adhesion between metal skin and urethane foam.



**Competitor***
Tongue and groove do not seal properly, and do not form a compression joint This allows warm air to seep into the cooler/freezer which reduces insulation effectiveness

Bally

* Competitor photos were taken during an actual field installation

BEST AVAILABLE DOCUMENT

# Ceiling Panels

**One-Piece Ceilings**
are available for outdoor use.

**Clear-Span Design**
allows for more usable space Column-free construction saves time and money.

**Variety of Widths and Lengths**
are available to suit every requirement. Reinforced types now available up to 17'4" without internal steel support.

**Competitor**
The large void at corner of the foam is due either to the foaming process or mechanical damage The only way to repair was to load up with caulk It is a less clean and less effective installation

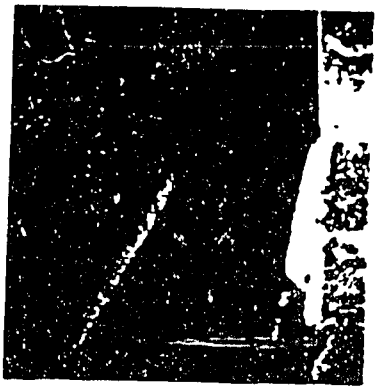
Bally

# Floor Panels

**Variety of Widths and Lengths**
suit varying applications.

**Durable Construction**
withstands uniformly distributed stationary floor loads up to 600 psf.

**Customized Fit**
of 4" floor panels with 4" or 5" wall panels will maximize efficiency and ease of installation.



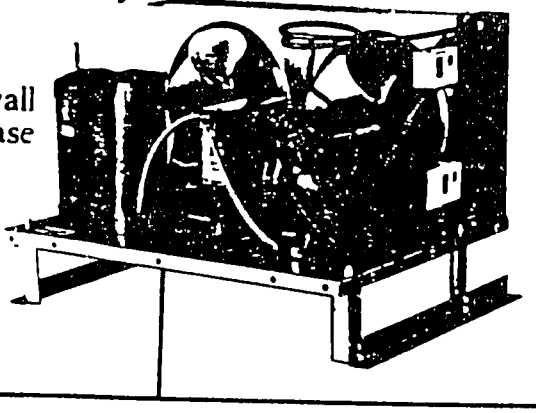
**Competitor**
This shows a failure of tongue and groove to mate, creating a void which permits the passage of warm air through the space It is likely to cause condensation on outside of box (Beware of panel systems without full tongues and grooves on all panel edges.)

Bally

# Refrigeration Systems

**Many Types Available**
including self-contained, preassembled remote varieties with semihermetic or hermetically sealed compressors.

**Simple, Efficient Design**
results in ease of installation, minimal repairs and reliable operation with low energy consumption.



**Factory-Assembled**
systems result in precise quality control.

**Leak-Tested and Test-Run**
before delivery to ensure maximum performance.

BEST AVAILABLE DOCUMENT

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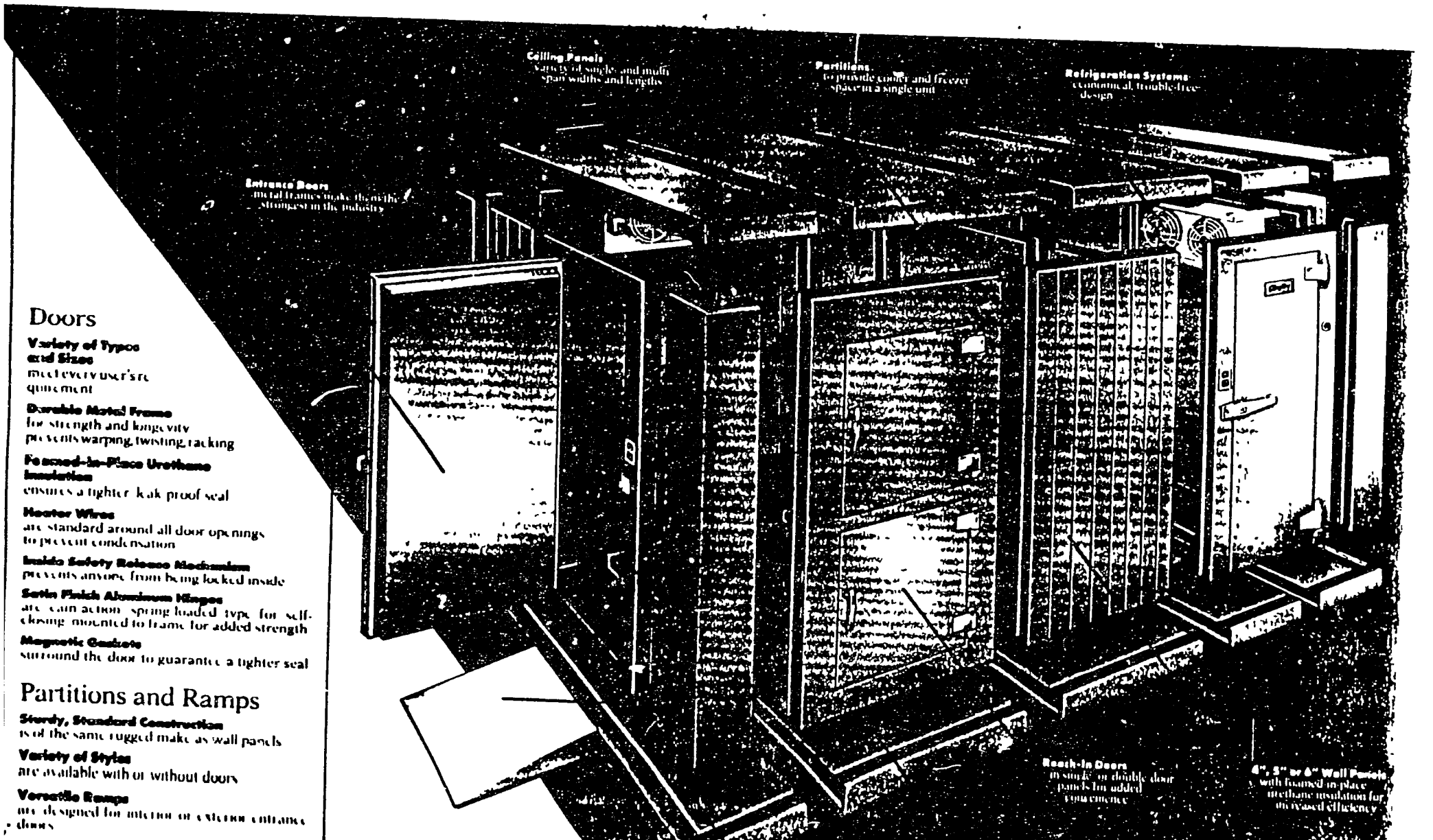


## Doors

**Variety of Types and Sizes**
meet every user's requirement

**Durable Metal Frame**
for strength and longevity
prevents warping, twisting, racking

**Foamed-In-Place Urethane Insulation**
ensures a tighter, leak proof seal

**Heater Wires**
are standard around all door openings
to prevent condensation

**Inside Safety Release Mechanism**
prevents anyone from being locked inside

**Satin Finish Aluminum Hinges**
are cam action, spring loaded type, for self-closing, mounted to frame for added strength

**Magnetic Gaskets**
surround the door to guarantee a tighter seal

## Partitions and Ramps

**Sturdy, Standard Construction**
is of the same rugged make as wall panels

**Variety of Styles**
are available with or without doors

**Versatile Ramps**
are designed for interior or exterior entrance doors

## Optional Accessories

The Bally walk-in is designed for the utmost in versatility and dependability. The following accessories are also available for increased storage capacity, added accessibility and maximum protection.

Partitions • Sectional Roofs for Outdoor Walk-Ins • Pressure Relief Ports • Modular Shelving • Temperature Alarms • 4" Floor Screeds • Wall Protectors • Meat Rails • Door Ramps • Floor Racks • Floor and Ceiling Edge Caps

## Prompt Delivery

Indoors or out, large or small, freezer or cooler ... when you want it your way, and you want it now ... Bally delivers. We ship any of 10,000 walk-in varieties, in your choice of sizes, shapes, finishes and equipment, in just 10 working days after you place your order.

## 10-Year Warranty

Bally stands behind the quality of our products. Our panel construction is warranted for ten years. Extended plans covering the complete refrigeration system are also available.

## CFC Compliance

Bally continues to be committed to maintaining our safe environment. We endorse the Montreal Protocol and the Clean Air Act. By using HCFCs in our products, we will continue to provide our customers with the highest quality, state-of-the-art, and environmentally safe insulation panel and refrigeration systems.

Bally panels carry these important listings

For more information call us at
**1-800-24-BALLY** or 215-845-2311
FAX: 215-845-6110
(After 1/1/94, use area code 610.)

Catalog No 93 252 Printed in U S A
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*Proven dependable.*

Bally
WALK-IN COOLERS/FREEZERS

Bally Engineered Structures, Inc
Walk In Coolers/Freezers Division
20 N Front St P O Box 98
Bally PA 19503-0098

1475 Linda Way
Sparks NV 89431-6126

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## Chloride Cont'd.

sources of salt are the ocean and various salt deposits above and below ground

Chloride is very corrosive to most metals in systems with elevated pressures and temperatures such as boilers and oil drilling equipment In coastal areas higher than normal chloride concentrations in drinking water can indicate seepage of seawater into the water supply or the presence of industrial effluents

**The Titrimetric Method.** CHEMetrics employs mercuric nitrate titrant in acid solution with diphenylcarbazone as the end point indicator Bromide and iodide will titrate as chloride Results are express as ppm (mg/L) Cl

**Shelf-life.** Although the reagent itself is stable, the diphenylcarbazone, used as the end point indicator, has a limited shelf-life We recommend stocking chloride test kits in quantities that will be used within 4 months Replacement diphenylcarbazone Titret tips have a 6-month shelf-life, the activator solution has a 4-month shelf-life

**BEST AVAILABLE DOCUMENT**

**CHLORIDE, 50-500 ppm**
*Type of test* Titret cell
*Analysis time* 2 min
*Method for quantifying results* Direct reading
*Scale units* 50, 55, 60 65 70 75, 80 90, 100, 125, 150, 175, 200, 250 350 500 ppm

| | CAT NO | PRICE |
|---|---|---|
| Ampoule kit | K-2050 | $22 50 |
| Ampoule refill | R-2050 | 22 00 |
| Activator solution | A-2000 | 1 00 |

**CHLORIDE, 250-2500 ppm**
*Type of test* Titret cell
*Analysis time* 2 min
*Method for quantifying results* Direct reading
*Scale units* 250 275, 300, 325, 350, 375 400, 450, 500, 625, 750, 875, 1000, 1250, 1750, 2500 ppm

| | CAT. NO | PRICE |
|---|---|---|
| Ampoule kit | K-2051 | $22 50 |
| Ampoule refill | R-2051 | 22 00 |
| Activator solution | A-2000 | 1 00 |

**CHLORIDE, 1000-10,000 ppm**
*Type of test* Titret cell
*Analysis time* 2 min
*Method for quantifying results* Direct reading
*Scale units* 1000, 1100, 1200 1300, 1400, 1500, 1600, 1800, 2000, 2500, 3000, 3500, 4000, 5000, 7000, 10,000 ppm

| | CAT. NO. | PRICE |
|---|---|---|
| Ampoule kit | K-2055 | $22 50 |
| Ampoule refill | R-2055 | 22 00 |
| Activator solution | A-2000 | 1 00 |

**CHLORIDE, 10,000-100,000 ppm**
*Type of test* Titret cell
*Analysis time* 2 min
*Method for quantifying results* Direct reading
*Scale units* 10,000, 11,000, 12 000 13,000, 14,000, 15,000, 16,000, 18 000, 20 000 25,000 30 000, 35,000, 40,000, 50,000, 70 000 100 000 ppm

| | CAT. NO | PRICE |
|---|---|---|
| Ampoule kit | K-2070 | $22 50 |
| Ampoule refill | R-2070 | 22 00 |
| Activator solution | A 2000 | 1 00 |

**Test kits and refills each contain 30 tests**

## Chlorine (free & total)

**References:** DPD method–EPA Methods for Chemical Analysis of Water and Wastes, method 330 5 (1983)
PHA Standard Methods, 18th ed , p 4-45, method 4500-Cl G (1992)
DPD method–Developed by CHEMetrics, Inc

ecause of its strong oxidizing properties, chlorine in aqueous solution is excellent biocide used to treat potable waters, municipal wastes and imming pools When used to treat potable water chlorine not only acts a biocide but also helps alleviate the adverse effects of iron, manga-se, ammonia and sulfide

**e Colorimetric Methods.** CHEMetrics offers two methods for the termination of free and total chlorine The DPD methodology is used in t kit K-2500 Free chlorine reacts with DPD to form a red product The ensity of the color formed is directly proportional to the concentration chlorine in the sample When ammonia or amines are present, some of chlorine may exist as "combined chlorine" Combined chlorine will t interfere with the free chlorine results, provided the readings are taken minute To determine total chlorine (the sum of free and combined), the A-2500 activator solution (potassium iodide) supplied in the kit sults are expressed as ppm (mg/L) $Cl_2$

**The DDPD method is a derivative of the DPD method. The DDPD mpound is more sensitive, more stable, and free from low-level erference from chromate.** The DDPD methodology is employed in test K-2503, K-2505, K-2505A through D, and K-2511 These kits are well ed for use in situations where biocides and chromate corrosion ibitors are used simultaneously The DDPD compound reacts with orine to form a purple product The intensity of the color formed is ctly proportional to the concentration of chlorine present in the ple When ammonia or amines are present in the sample, some of the orine may exist as "combined chlorine" Combined chlorine will not rfere with the free chlorine result, provided the reading is taken at 1 ute To determine total chlorine (the sum of free and combined), use A-2500 activator solution (potassium iodide) which is supplied in the Results are expressed as ppm (mg/L) $Cl_2$

Cont'd

**CHLORINE (free & total, DPD method), 0.1-2.0 ppm**
*Type of test* CHEMet ampoule
*Analysis time* 1 min
*Method for quantifying results* Visual color comparison
*Comparator standards* 0 1 0.2 0 4 0 6, 0 8, 1 0, 1 5, 2 0 ppm

| | CAT NO | PRICE |
|---|---|---|
| Ampoule kit | K-2500 | $32 00 |
| Ampoule refill | R 2500 | 19 00 |
| Activator solution | A-2500 | 6 00 |

**CHLORINE (O-Tol ), 0 1-2 0 ppm**
*Type of test* CHEMet ampoule
*Analysis time* 2 min
*Method for quantifying results* Visual color comparison
*Comparator standards* 0 1 0.2 0 4, 0 6, 0 8, 1 0, 1 5, 2 0 ppm

| | CAT NO | PRICE |
|---|---|---|
| Ampoule kit | K-2502 | $32 00 |
| Ampoule refill | R-2502 | 19 00 |

**CHLORINE (free & total, DDPD method), 0-0.20 ppm**
*Type of test* ULR CHEMet
*Analysis time* 2 min
*Method for quantifying results* Visual color comparison
*Comparator standards* 0 0, 0 04, 0 06, 0 08, 10, 12 16, .20 ppm

| | CAT. NO | PRICE |
|---|---|---|
| Ampoule kit | K-2511 | $51 00 |
| Ampoule refill | R-2511 | 32 50 |
| Activator solution | A-2500 | 6 00 |
| Neutralizer solution | A-2501 | 6 00 |

**CHLORINE (free & total, DDPD method), 0-4 ppm**
*Type of test:* Vacu-vial ampoule
*Analysis time* 2 min
*Method for quantifying results* Photometer (13 mm cell)
See page 8 for more information

| PHOTOMETRIC | CAT NO | PRICE |
|---|---|---|
| Ampoule kit (refill access ) | K 2503 | $ 22 50 |
| Ampoule refill | R-2503 | 19 00 |
| Activator solution | A-2500 | 6 00 |
| Neutralizer solution | A-2501 | 6 00 |
| Complete System 1000 kit (ampoule kit, photometer filter and case) | T-2503 | 495 00 |

**CHLORINE (free & total, DDPD method), 0-1 0 and 1 0-5 0 ppm**
*Type of test* CHEMet ampoule
*Analysis time* 1 min
*Method for quantifying results* Visual color comparison
*Comparator standards* 0, 0 1, 0.2, 0 3, 0 4, 0 6, 0 8 1 0 ppm 1 0 1 5 2 0, 2 5 3 0 3 5 4 0 4 5 5 0 ppm

| | CAT NO | PRICE |
|---|---|---|
| Ampoule kit | K-2505 | $44 50 |
| Ampoule refill | R-2505 | 19 00 |
| Activator solution | A-2500 | 6 00 |
| Neutralizer solution | A-2501 | 6 00 |

**Call 1-800-356-3072 to place your order.**

To determine total chlorine the o-tolidine-based methodology employed in test kit K-2502 is recommended Chlorine reacts with o-tolidine to form a yellow product The intensity of the color formed is directly proportional to the concentration of chlorine in the sample The manner in which this potentially carcinogenic reagent is packaged and handled virtually eliminates the possibility of skin contact and consequently any danger to the analyst

**CHLORINE (free & total, DDPD method), 0-600 ppb**
*Type of test* CHEMet ampoule
*Analysis time* 2 min
Also see page 7

| DCR PHOTOMETER | CAT. NO. | PRICE |
|---|---|---|
| CHLOR 1 DCR kit | I-3002 | $435 00 |
| Ampoule refill | R-2505 | 19 00 |
| Activator solution | A-2500 | 6 00 |
| Neutralizer solution | A-2501 | 6 00 |
| Cal Check ampoule | A-0117 | 2 50 |
| Set Zero ampoule | A-0100 | 2 50 |

**CHLORINE (free & total, DDPD method), 0-25 and 25-125 ppm**
*Type of test* VACUette ampoule
*Analysis time* 2 min
*Method for quantifying results*
Visual color comparison
*Comparator standards* 0, 2 5 5 7 5, 10, 15, 20, 25 ppm
25 37 5 50, 62 5 75 87 5 100 112 5, 125 ppm

| | CAT. NO. | PRICE |
|---|---|---|
| Ampoule kit | K-2505D | $47 50 |
| Ampoule refill | R-2505D | 22 00 |
| Activator solution | A-2500 | 6 00 |

**CHLORINE (free & total, DDPD method), 0-50 and 50-250 ppm**
*Type of test* VACUette ampoule
*Analysis time* 2 min
*Method for quantifying results*
Visual color comparison
*Comparator standards* 0 5, 10 15 20 30 40 50 ppm
50 75, 100 125, 150, 175 200 225 250 ppm

| | CAT NO | PRICE |
|---|---|---|
| Ampoule kit | K-2505A | $47 50 |
| Ampoule refill | R-2505A | 22 00 |
| Activator solution | A-2500 | 6 00 |

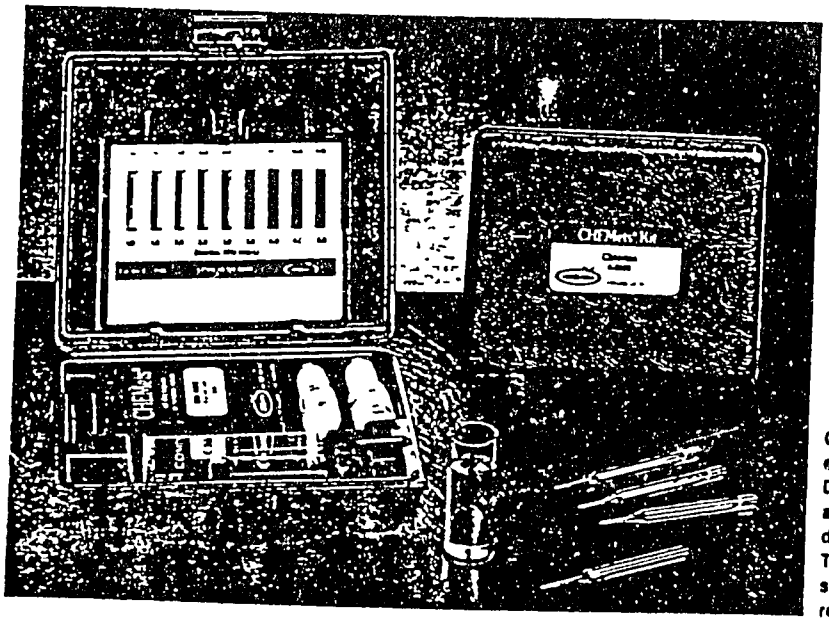
**CHLORINE (free & total, DDPD method), 0-100 and 100-500 ppm**
*Type of test* VACUette ampoule
*Analysis time* 2 min
*Method for quantifying results*
Visual color comparison
*Comparator standards* 0, 10, 20, 30, 40 60, 80, 100 ppm
100, 150, 200, 250, 300, 350, 400, 450 500 ppm

| | CAT NO | PRICE |
|---|---|---|
| Ampoule kit | K-2505B | $47 50 |
| Ampoule refill | R-2505B | 22 00 |
| Activator solution | A-2500 | 6 00 |

**CHLORINE (free & total, DDPD method), 0-1000 and 1000-5000 ppm**
*Type of test* VACUette ampoule
*Analysis time* 2 min
*Method for quantifying results*
Visual color comparison
*Comparator standards* 0, 100 200 300 400 600 800 1000 ppm
1000, 1500 2000 2500, 3000, 3500, 4000 4500 5000 ppm

| | CAT. NO. | PRICE |
|---|---|---|
| Ampoule kit | K-2505C | $47 50 |
| Ampoule refill | R-2505C | 22 00 |
| Activator solution | A-2500 | 6 00 |

**Test kits and refills each contain 30 tests**



CHEMets ampoules employing the DDPD or DPD reagent provide an accurate chlorine determination to 0 1 ppm The DDPD reagent is more sensitive, stable, and resistant to interferences

## hlorine (hypochlorite)

**rence: DDPD method–Developed by CHEMetrics, Inc**

introduction for "Chlorine, free & total "

**Colorimetric Method.** CHEMetrics' method is applicable to the ct determination of hypochlorite concentrations in various cleaning parations and disinfectants prior to their dilution The DDPD hodology is a derivative of DPD The DDPD compound reacts with ochlorite ions to form a blue color The intensity of the color is ctly proportional to the concentration of hypochlorite present ults are expressed as percent NaOCl

**CHLORINE (hypochlorite), 0 3-1 6%**
*Type of test:* VACUette ampoule
*Analysis time* 2 min
*Method for quantifying results*
Visual color comparison
*Comparator standards* 0 30, 0 45 0 60, 0 75, 0 95, 1 15, 1 30 1 45, 1 60%

| | CAT. NO | PRICE |
|---|---|---|
| Ampoule kit | K-5805 | $41 00 |
| Ampoule refill | R-5805 | 22 00 |

**CHLORINE (hypochlorite), 2.5-12%**
*Type of test.* VACUette ampoule
*Analysis time* 2 min
*Method for quantifying results*
Visual color comparison
*Comparator standards* 2 5, 3 5, 4 5 6 0 7 0 8 5 9 5 10 5, 12 0%

| | CAT. NO | PRICE |
|---|---|---|
| Ampoule kit | K-5812 | $41 00 |
| Ampoule refill | R-5812 | 22 00 |

**Test kits and refills each contain 30 tests**

BEST AVAILABLE DOCUMENT

# Terms and Ordering Information.

## o place an order

Write CHEMetrics, Inc., Route 28 Calverton VA 22016

Call **1-800-356-3072** or 1 703-788-9026

Fax: 1-703-788-1856

## ours

8:00 AM to 4 30 PM Eastern Time Monday through Friday, except holidays

## rms

Net 30 days from date of shipment with approved credit. FOB Calverton, VA.
VISA and MasterCard accepted

## scount policy

Quantity discounts off list price are as follows for identical items

| Quantity | Discount |
|---|---|
| 50-99 | 10% |
| 100-199 | 15% |
| 200 or more | 20% |

Substantially higher discounts are available for large quantity orders Contact the Marketing department for details

## pping

In the absence of instructions from the customer merchandise will be shipped via UPS whenever possible Freight cost plus $3 00 handling will be added to the invoice Claims for transportation damage must be submitted to the common carrier

## urned Merchandise

CHEMetrics generally accepts returns of resellable restockable merchandise for credit However a 20 percent fee will be imposed unless the problem resulted from CHEMetrics error We also accept instruments in new condition returned within thirty days of purchase Merchandise requiring relabeling repackaging, or other remedial expense will be subject to reduced credit The customer should contact CHEMetrics in advance to obtain a return authorization number

## ranty

CHEMetrics warrants its products to be free of defects in materials and workmanship for two years from date of manufacture, except as follows Those reagent products which we identify as having shelf-lives shorter than two years are warranted through the expiration dates printed on the merchandise Instrument products, other than their expendable components, are warranted for one year from receipt by the customer This warranty does not apply to merchandise improperly stored or handled by a party other than CHEMetrics

THIS WARRANTY SHALL BE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

## ity

Liability of CHEMetrics Inc for defective merchandise is limited to the cost of repair or replacement of that merchandise whichever is lower In no event shall CHEMetrics be liable for any injury loss or damage resulting from the handling or use of its products CHEMetrics does not authorize any person or agent to accept liability on its behalf

Call 1-800-356-3072 for a free demo kit and introductory video.

Trademark Acknowledgments
CHEMetrics, CHEMets, Titrets, Vacu-vials, VACUettes, Quanti-Chlor and the sea gull logo are registered trademarks of CHEMetrics, Inc.

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Patents
CHEMets, Titrets, ULR CHEMets, Vacu-vials, and VACUettes are covered by U.S. patents 3,634,038, 4,332,769, 4,537,747, 4,596,780, 5,013,155, and Des 327,027.



BEST AVAILABLE DOCUMENT

Hydrocooler Costs

Clarksville Machine Works (Arkansas)

| Item | Cost |
|---|---|
| Batch Hydrocooler (will cool 2,000 lbs. at one time)<br>includes: 10 tons of refrigeration<br>2 horsepower pump | -$22,500 |
| (without refrigeration<br>(i.e. use ice) | -$11,500 |
| Shower Hydrocooler<br>includes: 18 ft. 8 in. cypress slat<br>7½ HP pump (8")<br>½ HP conveyor drive<br>refrigeration not included | -$24,400 |
| Spare parts for Batch Hydrocooler" | |
| pump lower bearing | $50 |
| pump upper bearing | $50 |
| pump shaft | $200 |
| pump impeller | $100 |
| Spare parts for Shower Hydrocooler | |
| pump - same as Batch | |
| conveyor chain | $7.50 - $17.50 per foot |
| sprockets | $25 - $200 each |

Fruit & vegetable "Market Maker"®

Tew manufacturing corp.

**1993**

OUR 41st YEAR
SERVING THE INDUSTRY

# PACKAGING MACHINERY

**And Replacement Parts**

KING LINES FOR:
pples
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g Plant
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atoes
ars
rus Fruit
i Pumpkins
d Others

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**TEW MANUFACTURING CORPORATION** PHONE. AC 716-586-6120

MAILING ADDRESS P.O BOX 87
PENFIELD, NY
14526

FACTORY ADDRESS: 470 WHITNEY RD WEST
PENFIELD, NY
14526


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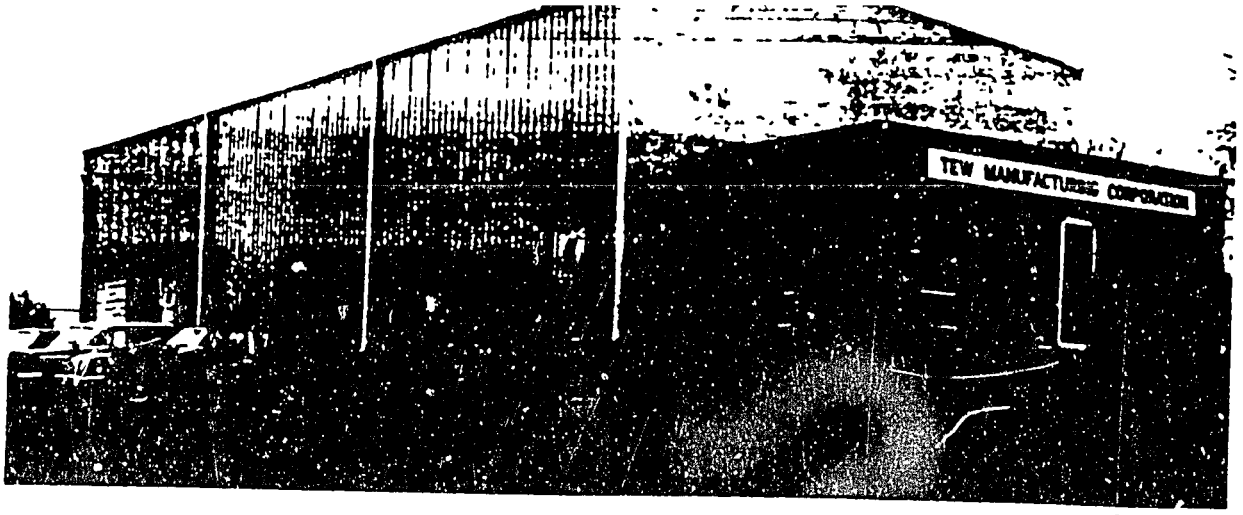
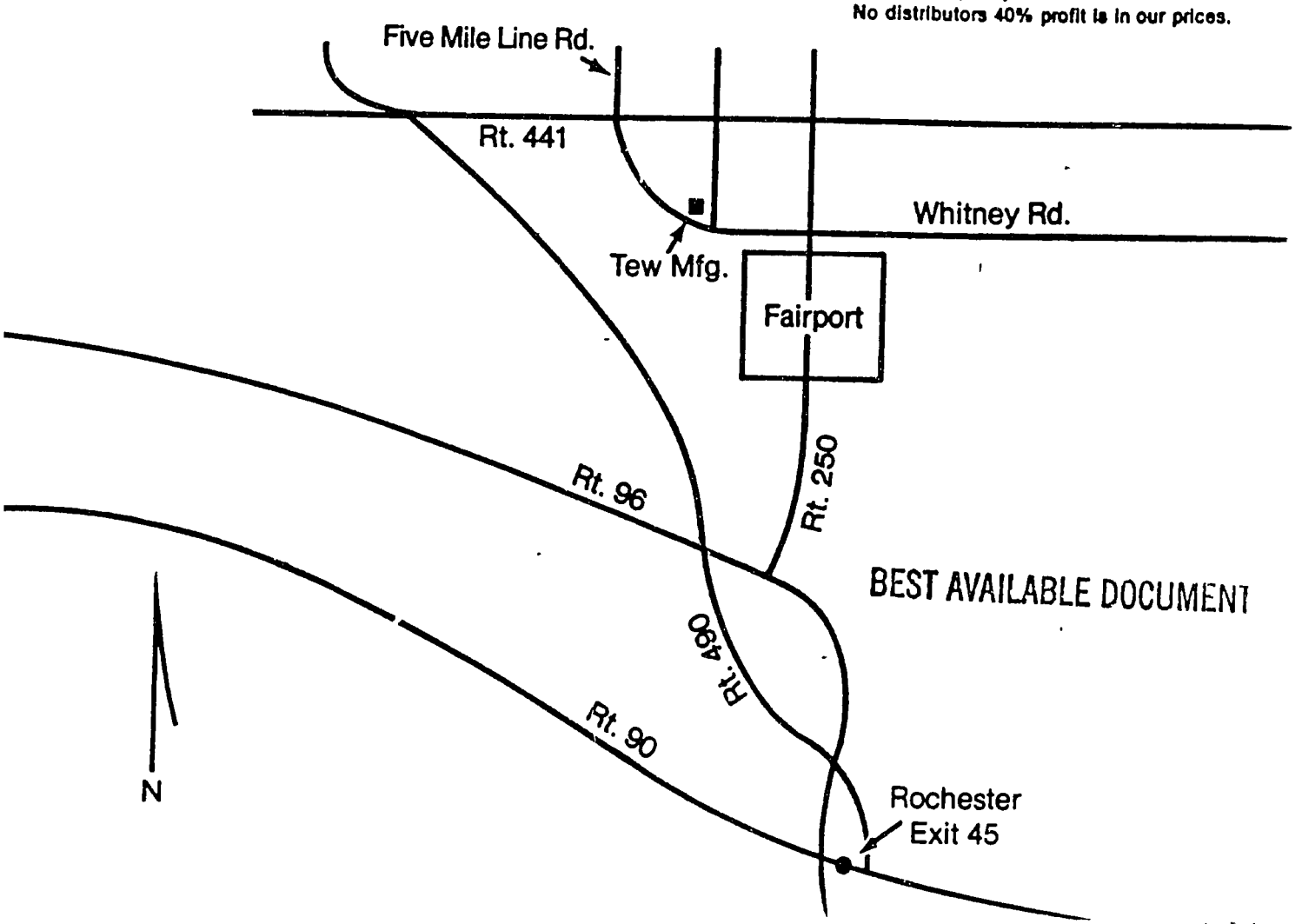



**COMPANY BACKGROUND** Tew Manufacturing Corporation was formed and began business in October 1952 at Fairport, New York for the express purpose of manufacturing Friend brand fruit packing house equipment. In 1954 it purchased the grader division of the Trescott Company and continued manufacturing both Friend and Trescott machines until 1960 when both lines were discontinued in favor of an improved Tew line of packing house equipment. Since that date, continuing efforts have been made in engineering and manufacturing, permitting us to now offer our finest machinery for cleaning and packing fruits and vegetables

**POLICY & GUARANTEE** Tew Manufacturing Corporation sells its products direct to the consumer and not through any distributor or dealer organization This allows us to price superior equipment lower than our competitors' machinery to the benefit of our customers. We guarantee our products against defects in material and workmanship for a period of one year after shipment If any item or machine is defective, we will (1) repair it, if brought back to our factory, (2) pay a local serviceman to make the repair at your place, or (3) replace the part or machine free of charge and prepaid Customer to install replaced part or machine

**TERMS OF SALE & ORDERING INFORMATION** Due to processing costs, our minimum order is $10.00. If the part you need is less, we suggest you order two or add some other part that will be useful in the future Please enclose your check for parts order with order. Add $5 00 to cover shipping for orders valued to $25 00; $8 00 for orders $25 00 to $100 00. Machine orders require a 20% deposit with order, balance due before machine leaves our factory If you want immediate machine shipment, please enclose full amount. Machines are prices f.o.b. our factory Crating is extra if we ship, it does not apply if you pick up at our factory. Our low prices result from our policy of DIRECT SALES ONLY No distributors 40% profit is in our prices.

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"Service was very quick and helpful. They were happy to answer all my questions and lead me in the right direction when we needed to purchase new equipment."

Trent M Colford
Burger King Franchisee
Cranston, RI

"Atkins has provided us with excellent service in the past and even now. You have, I feel, the best temperature meters on the market."

David Delay
Commercial Food Equipment
Davenport, IA

A high quality, easy-to-use product!"

Thomas Weber
Weber Heating & Air
Rossville, GA

# ATKINS THERMOMETERS SHORT-FORM CATALOG

"Service was excellent and product was reasonably priced, easy-to-use and well made We like the idea that we may get other probes for other applications."

Chuck Paulosky
Northern Expediting
Union, NJ

"Good ideas for use in printing & heat transfer machines — really pinpoints exact cool spots & precise temperatures. A must for older transfer machines when using hot peel transfers."

Terry Supple
1st Street Graphics
St Joseph, MO

"Very useful in my research lab, also on jobsites."

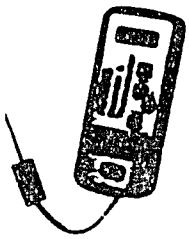
Thomas Jakubik
Tufco International Flooring Co.
Gentry, AR

Made In Florida, USA, By ATKINS

# ATKINS THE

## Recording & Indicating Thermometers

**(Probes Attached)** Read & Record Temperatures; Scroll Display to Check Recorded Data Or To Jump To Any Alarm Conditions. Later, Analyze Or Graph Data On Any IBM Compatible Computer. Simple, User-Friendly Software And O-Ring Sealed Housing Included.



### MEDIUM RANGE, THERMISTOR SENSOR

°F/°C Switchable Reads in 1° from 12°F to 130°F, in 2° from –17°F to 173°F Switch to °C to read in 0.5° from –11°C to 54°C, then in 1° from –27°C to 78°C Needle tip probe attached by 29" cable. Memory Capacity of over 8,000 date-time-temperature readings

**Recorder Indicator with Software #37112 . . . $295**
**RS 232 Cable #14031 . . . $14**

### WIDE RANGE, PLATINUM SENSOR

°F/°C Switchable Reads in 1° from –17°F to 173°F, in 2° from –40°F to 410°F Switch to °C to read in 0 5° from –11°C to 54°C, then in 1° from –40°C to 210°C

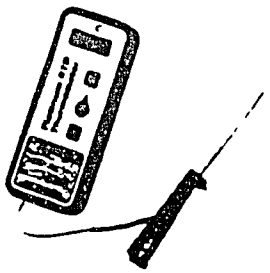
**Recorder Indicator with Software #37262 . . . $395**
**RS 232 Cable #14031 . . . $14**

## ndicating Thermometers (Probes Attached)

### EXTRA-HIGH ACCURACY PLATINUM SYSTEM

Combined instrument and probe accuracy ±0 5F° (±0 3C°) over range of 76 0°F to 199 9°F (–60 0°C to 199 9°C), reading in 0 1° resolution Accuracy 1° up to 500°F (260°C) with 1° resolution Needle tip probe permanently attached by 29" cable

**36036-F or C . . . $159**



### HIGH-ACCURACY THERMOCOUPLE/PROBE SYSTEMS

Total probe & instrument accuracy ±0.6°C over range –115°F to 440°F (usable to 500°F) in 1° resolution °C reads in 0 1° over range of –55°C to 199 9°C Probes attached by 29" high-temperature armored cable

**Choice of 4 Probe Styles:**
**Small-Handled Needle Probe**
**#33033-F or C . . . $115**
**Large-Handled Needle Probe**
**#33032-F or C . . . $129**
**Small-Handled Surface/Universal Probe**
**#33034-F or C . . . $119**
**Large-Handled Surface Probe**
**#33035-F or C . . . $149**

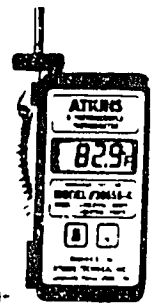
## ndicating Thermometers (Use Interchangeable Thermocouples As Shown At Right)

### LCD LED DIGITS, MICROPROCESSOR, RS-232 to Computer, °F/°C

Accuracy ±0 1% of reading ±0 4C° over range of –148°F to 2502°F, °C equivalent times complete with IBM PC compatible software and RS-232 cable for computer hookup. **#49600-K . . . $396**

### BIG LCD DIGITS, MEMBRANE SWITCHING, °F/°C AND AUTO-RANGING 0.1°/1°, SMALL PROBE HOLDER

Accuracy ±1% of reading ±1° over range of –112 0°F to 1999°F. Auto-ranging unit housed in rugged ABS plastic
**#39658-K . . . $99**
Multi-Probe Switchbox when used with #39658-K thermometer can accommodate up to four probes simultaneously Select probe to be read with rotary switch **#39667-K . . . $119**



### LCD DIGITS, MICROPROCESSOR, °F/°C, 1 PROBE

Accuracy ±0 5% of reading ±1° over range of –60 0°F to 1999°F Instrument capable of output to recorder
**#49200-K . . . $185**

### STAINLESS STEEL HOUSING, SHIRT-POCKET SIZE, SMALL PROBE HOLDER, °F/°C

Accuracy ±0 7% of reading ±1° over range of –40°F to 1832°F Shirt pocket sized unit housed in stainless steel
**#38653-K . . . $129**

*All Above Units Are Available In Thermocouple Types J, K & T*

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# RMOMETERS

International Accuracy Standards Traceable to U.S. National Institute of Standards & Technology

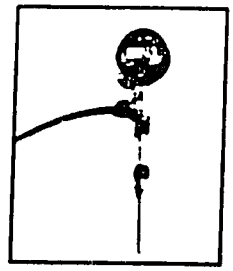
## Built-In Digital Thermometer

**leplace Bimetals or Bulb and Capillaries With hermocouples and Digital Display**

istrument with 2" digital dial has accuracy of ±2F° 0.25% of reading from –100°F to 1000°F and is vailable in °C equivalent. Can use any type K ermocouple.

**wer Supply #14018 . . . $13**

**Panel Mount Design #61810 . . . $89**



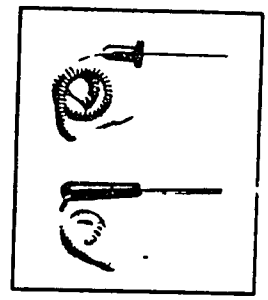
**"Stem" or Pipeline Mount Design,** housing connecting external threads 1/4" NPT **#61820 . . . $89**

**Mounts on surface of wall #61820 . . . $89**

## and-Held Thermocouple Probes

### or Use With Atkins Thermometers

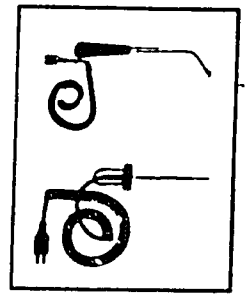
*er 150 probe designs available in thermocouple types J, K or T. (Some popular models shown.)*



**EEDLE TEMPERATURE PROBES** for foods (meat, produce, fish, chicken, salad bars, milk-shake/ las), plastic melt temperatures, solder pots **#50335-J, K or T . . . $41**

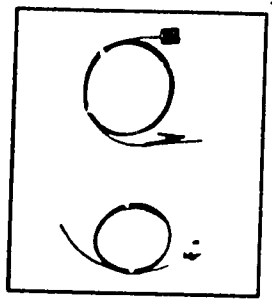
**URFACE TEMPERATURE PROBES** for over-heating motors, transformers, cooking griddle librations of thermostats, heat sealers, plastic molding dies, maintenance. **0318-J, K or T . . . $64 #50012-J, K or T . . . $59**

**R & GASES TEMPERATURE PROBES** for HVAC contractors, air balancing, refrigeration, oven temperatures, dryers, shwashers. **#50332-J, K or T . . . $44 #50338-J, K or T . . . $28**

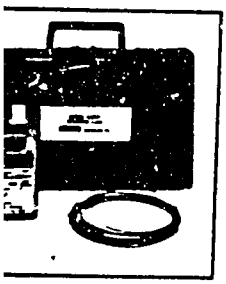


**OD EQUIPMENT MULTI-USE PROBES** for calibrating cooking thermostats, oven calibrations for product temperatures or e temperatures, refrigerators, dishwashers. See Needle, rface & Air Probes shown above.

**MPOSTING PORTABLE PROBES** garbage disposal sites. **135-K . . . $250**



**REEN PRINTING DRYER PROBE,** on garment with measurement t in drying ink to track proper ration. **#50008-K . . . $105**



**Soft Carrying Case, zipper closure, #14057 . . . $9**

**Hinged Standard Carrying Case #14235 . . . $16**

**Deluxe Attache' Carrying Case #14237 . . . $75**

Many standard assemblies for auto diagnostics, food service, repairmen, plastics, HVACR, screen printing, racing, field servicing, laboratory, industrial maintenance, etc

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# The Control of Quality at Atkins

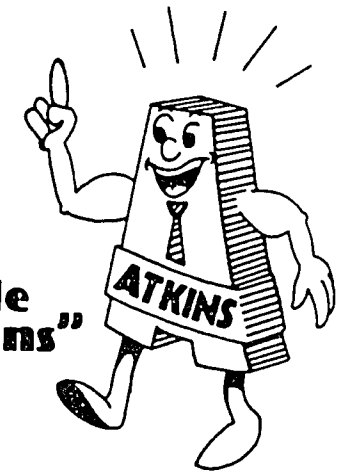
Atkins Technical Incorporated maintains master calibration standards traceable to the National Institute of Standards and Technology and against which all plant working standards are regularly checked. Independent Quality Control personnel are responsible for standards, calibration equipment, and incoming and outgoing inspections in conformance with written procedures.

# General Product Guarantee

All Atkins' products, standard and custom, are guaranteed to perform within our specifications for a period of one year when subjected to normal usage. This guarantee covers both parts and labor, but does not cover any consequential damages. Products to be returned must be approved by Atkins in advance based on the user's reported difficulty. State how much error, whether high or low, at what point, under what conditions, and compared to what standard.

# See Our Products Advertised In:

- Prepared Foods
- Food Processing
- Food Products & Equipment
- Foodservice Equipment & Supplies Specialist
- Restaurant Business Magazine
- Food Equipment Distributors Association
- Journal of Food Protection
- Dairy, Food and Environmental Sanitation Magazine
- Modern Plastics
- The Thomas Register
- Printwear Magazine
- ScreenPlay Magazine
- Impressions
- Screenprinting Network




"Reliable Atkins"

**To order, to request a specific catalog, or for nearest distributor,**

## CALL ATKINS ORDER DESK

## 1-800-284-2842

**Atkins Technical Inc., 3401 SW 40th Blvd., Gainesville, FL 32608-2399**
**Customer Service/Engineering Assistance: (904) 378-5555**
**FAX: (904) 335-6736**

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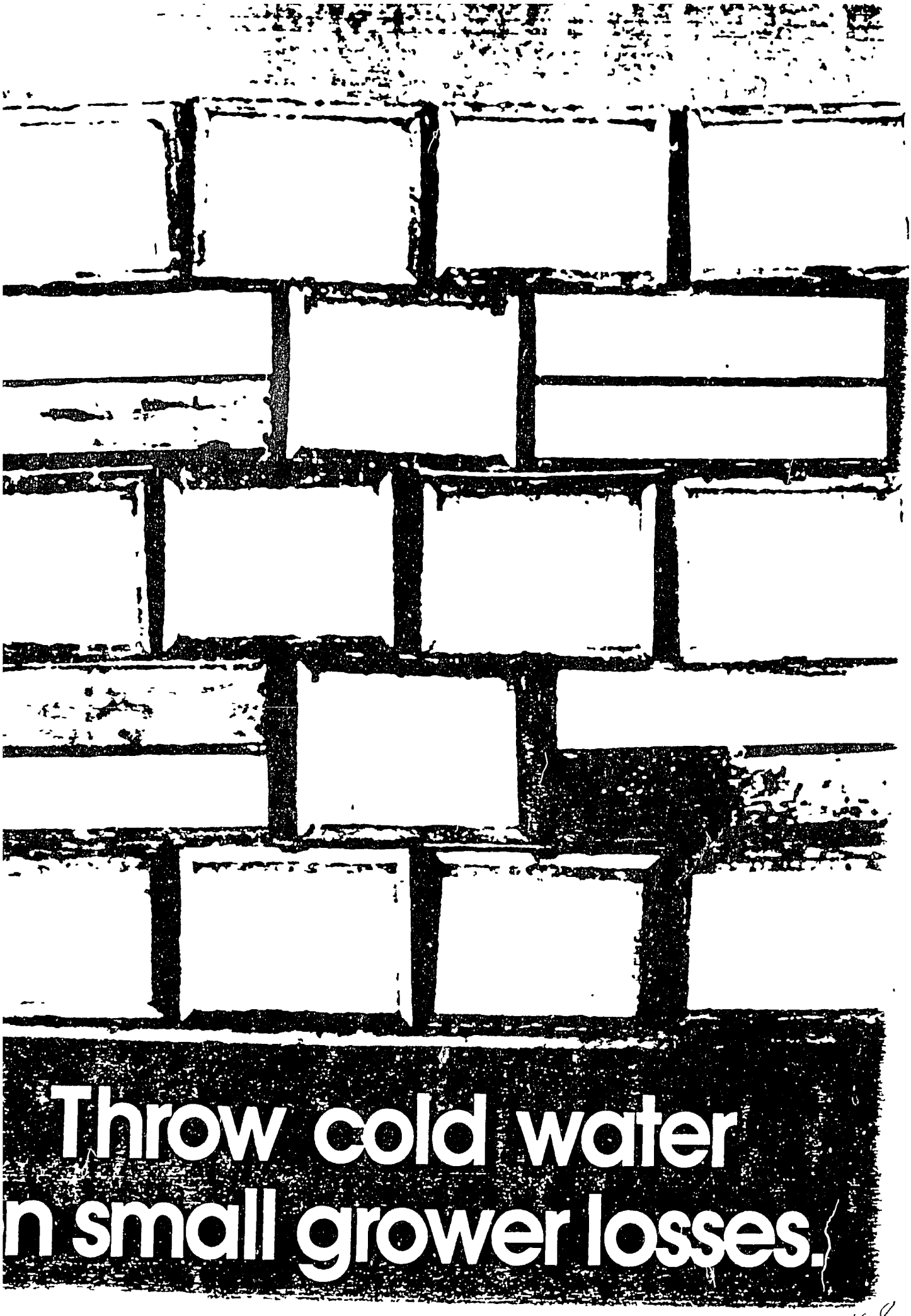


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# Introducing the Batch Hydro-Cooler from Clarksville Machine Works.

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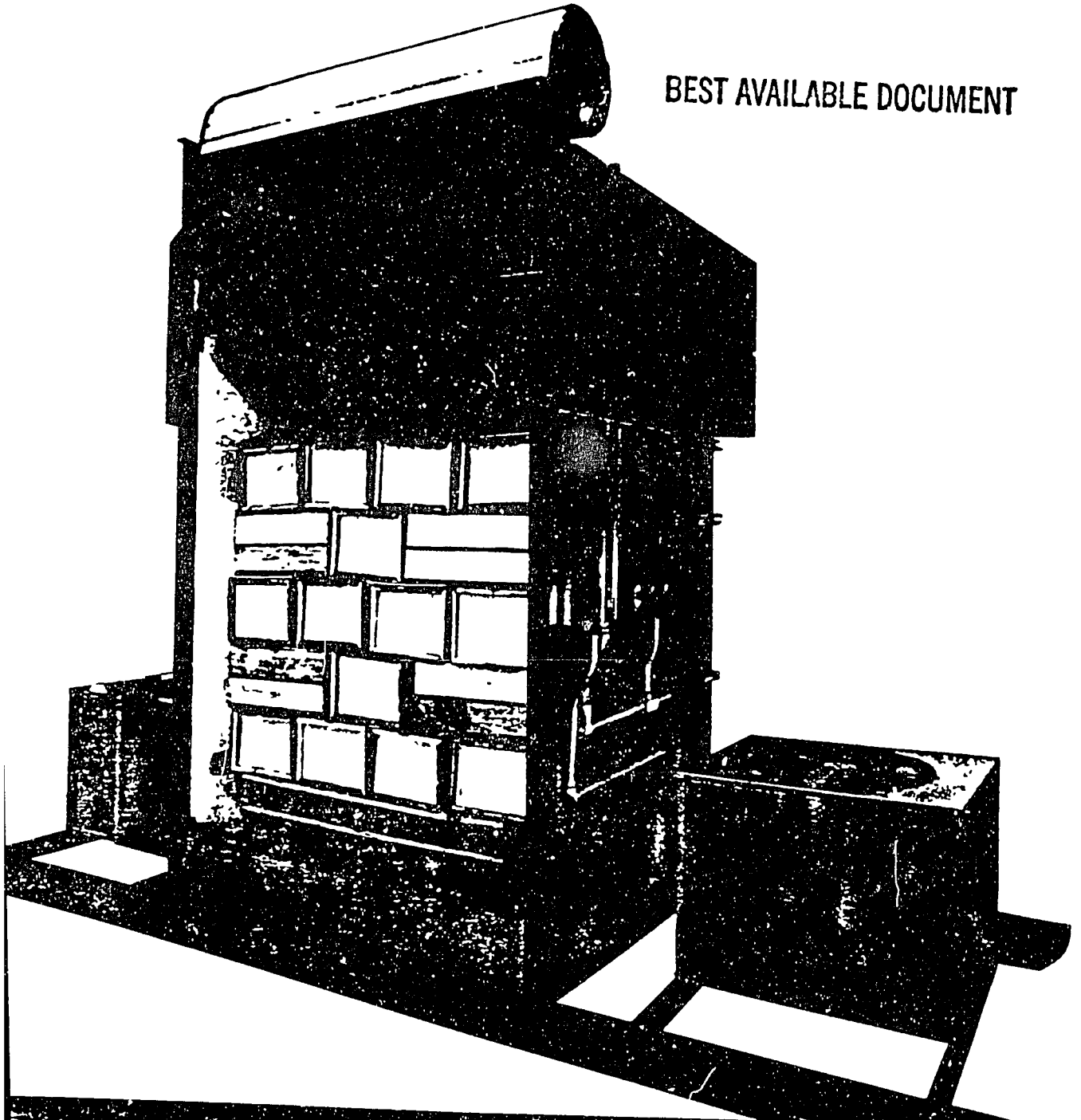


The self-contained, affordable way to throw cold water on farm-to-market spoilage, decrease shipping losses, lengthen shelf life and raise grower returns.

# Batch cooling brings a low-cost cold wave to small growers.

Now the proven benefits of hydro-cooling are available to small growers and producers with the economical Batch Hydro-Cooler from Clarksville Machine Works.

The fastest, surest way of removing field heat from most fresh vegetables and fruit, Hydro-Cooling thoroughly drenches produce with icy chilled water, "shock-cooling" it to put the brakes on the natural ripening process.

Completely self-contained, the space-saving Batch Hydro-Cooler cools a ton of produce at a time, thoroughly drenching it with a high volume of icy, filled water.

Produce is cooled several degrees in a matter of minutes Length of time is determined by the beginning produce temperature and the amount of reduction desired.

High efficiency water flow system provides high volume with low power requirement Here, a 2-hp motor provides 280-gpm flow Maintenance-free water cooled pump never needs oiling

## Built to last. With quality materials and our famous workmanship.

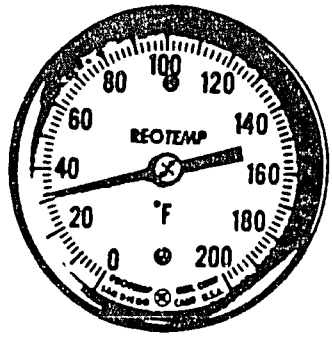
Clarksville Hydro-Coolers are built of steel, fiberglass and rugged marine grade plywood to be remarkably dependable and efficient Fiberglass lining cannot rust or corrode is unaffected by oxidation, water, cold or heat. It doesn't expand or contract from the constant wetting of normal operation Our craftsmanship and attention to control mean long life and trouble-free service

## Big job. Small space.

In a remarkably small space (about 7 feet deep, 12 feet long and 10 feet high) the Batch Hydro-Cooler performs an amazingly big job.

Its 59" wide by 59" deep and 72" high opening can be loaded by forklift or hand with a full pallet (about 2,000 pounds) of produce per batch.

Its space-saving curtain door is then closed, and with the flick of an automatic timer-switch, the Batch Hydro-Cooler goes to work Within minutes, produce temperatures are drastically reduced, putting the brakes on the ripening process and adding days or weeks to shelf life




Batch Hydro-Cooler can reduce produce temperatures nearly to the freezing mark. Temperature gauge tells the story

## Variety of options available.

The Clarksville Batch Hydro-Cooler can be ordered with a variety of refrigeration and convenience options. These include

- Increased refrigeration tonnage (10 tons or more) for decreased chilling time with large loads
- Automatic door opening/closing
- Pendant or radio controls for remote or forklift operation.
- Trailer mounting for portability
- No refrigeration (where pre-cooled water is available or ice-loading is practical)

Batch Hydro-Cooler standard features include

- Space-saving overhead door
- Two individually controllable refrigeration units
- Single- or three-phase power
- Low-profile high-volume circulation pump, water lubricated and maintenance-free, 2-hp electric motor, 280 gpm output.
- Compact modular self-contained design, with all components permanently mounted to heavy angle-iron skids.
- Fiberglass lining for long life, easy cleaning and low maintenance.
- Automatic single-control timer switch.

## Backed by our famous warranty.

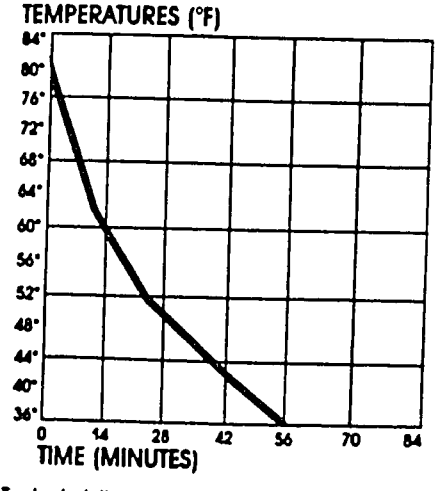
The Clarksville Hydro-Cooler has built an outstanding record of maintenance-free service in hundreds of installations in the U.S and abroad over the past 35 years

We're so sure of our products, we back the Batch Hydro-Cooler with our outstanding limited warranty a full 10 years against defects in the tank and structure

## Purchase or lease.

We offer flexible financing plans for the Batch Hydro-Cooler from Clarksville Machine Works And we'll tailor a purchase or lease plan to your requirements

We'll make it easy to own or use the best An authentic Clarksville Hydro-Cooler




Typical chilling cycle shows duration for heat loss at different temperatures. For instance, time required to reduce temperature from 80 to 45 degrees is less than time needed to chill produce from 60 to 35 degrees Time varies with heat conditions, refrigeration capacity, other factors

BEST AVAILABLE DOCUMENT

# Cold facts about the Clarksville Hydro-Cooler from Clarksville Machine Works.

:ver since we designed the first :ksville Hydro-Cooler over 35 years , growers, sellers and consumers e been benefiting from the h-picked quality of hydro-cooled s and vegetables Our ory-making equipment set the dard for high volume continuous luction. And it still does. ur original "shock-chilling" process ches produce with a high volume y, chilled water. It is still the st, surest way to remove field Even so-called "modern" n-ice methods can't compare for ency, even coverage and increased -life. And advances in refrigeration iology have made our process more efficient

## oilage protection ans more profit.

e benefits of hydro-cooling are For example, the U S Dept riculture has shown that at 86°F . corn loses 50 percent of its content within 24 hours after harvest The Clarksville Hydro-Cooler dramatically reduces this loss of quality and flavor in these and other vegetables and fruits

## Here's how you benefit:

- Produce can be tree- or vine-ripened longer for better color and sales appeal
- Hydro-Cooling prevents spoilage and waste, giving growers and packers more flexibility.
- Hydro-Cooling removes residue, dust and dirt so produce looks fresher and tastier
- The chilled water may be treated to destroy harmful bacteria or spores on produce
- Lets you expand your market. Produce stays fresher longer, requires far less refrigeration before and during storage and shipping
- Hydro-Cooling lengthens the shelf-life of perishable produce.

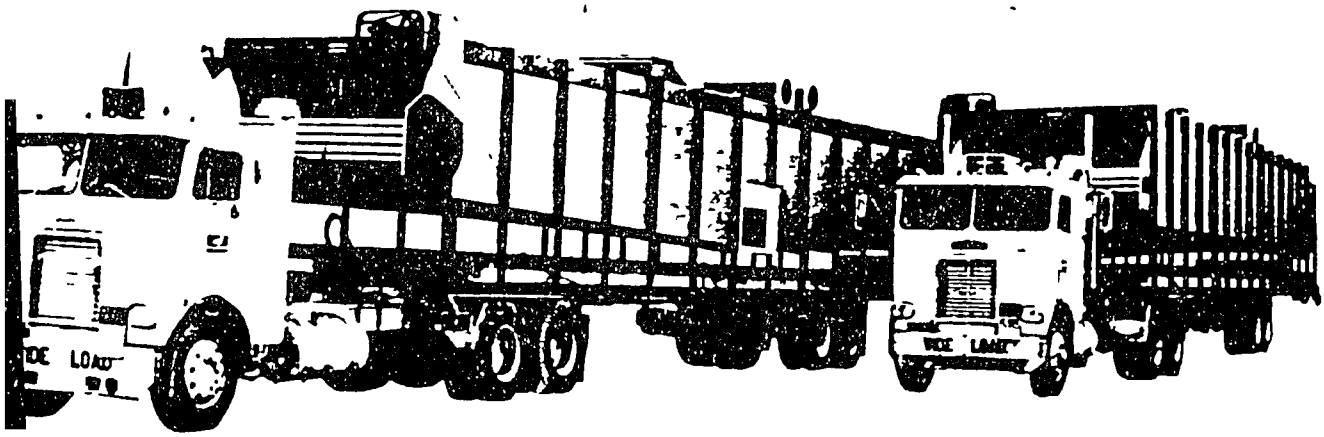
An authentic Clarksville Hydro-Cooler is an outstanding investment for the production of high quality produce demanded by today's wholesalers, retailers and consumers. One that will save you money and make you money every day it's in operation.

Clarksville Hydro-Coolers are built with steel, fiberglass and rugged marine grade plywood to be remarkably strong, dependable and efficient.

We custom-build our high-volume pumps in our plant Their low profiles save space, while water lubrication means oiling is never needed. Our record for long pump life and freedom from maintenance is outstanding.

We have a complete line of standard and custom-made Hydro-Coolers, with capacities to meet any production requirement. Models are available for both packaged and bulk produce, and a wide variety of options lets us meet your individual needs.

No matter what your produce, your volume needs and space requirements, there's a Clarksville Hydro-Cooler to do the job



**CLARKSVILLE MACHINE WORKS**

P.O. Box 378, Clarksville, AR 72830 Phone (501) 754-7161

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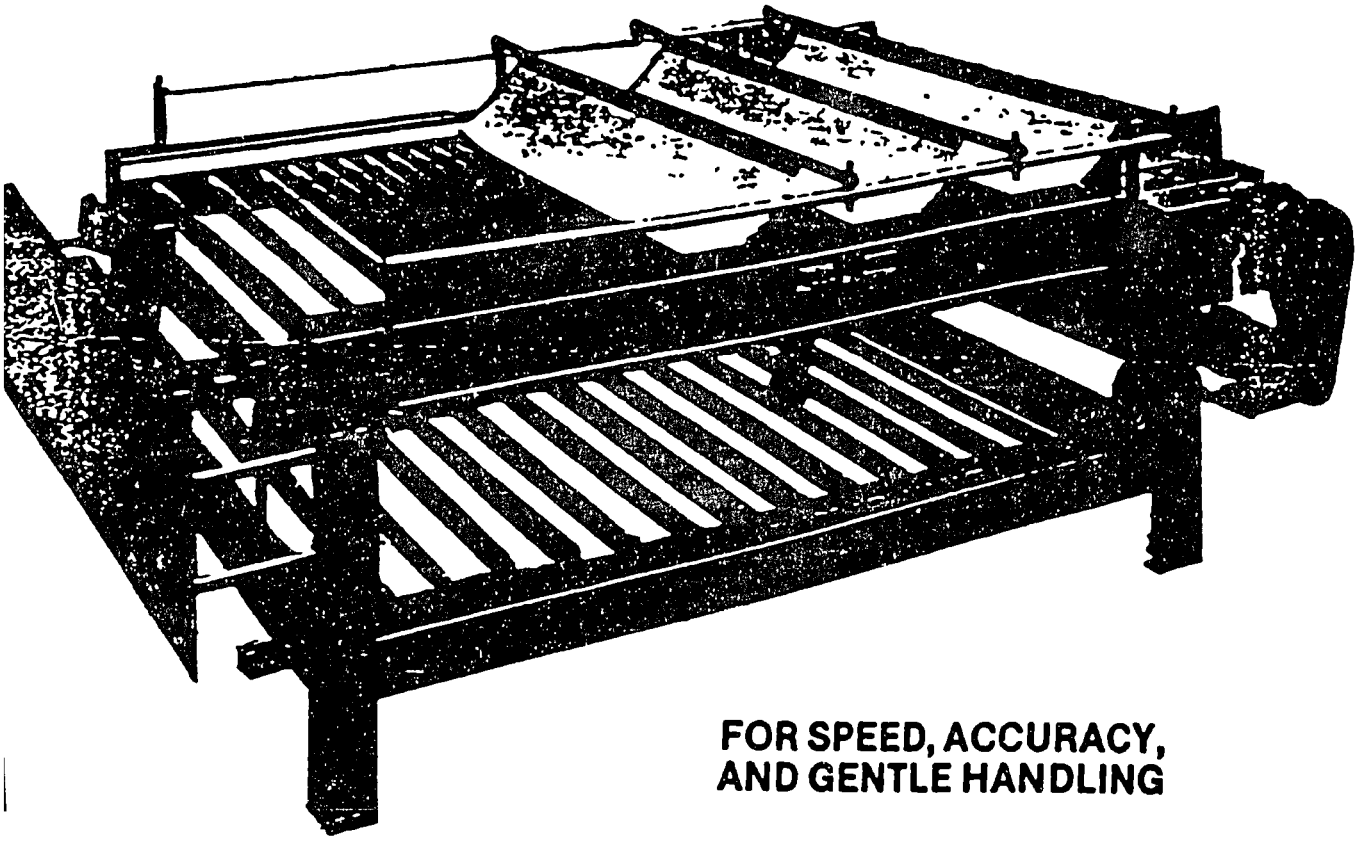
Fruit And Vegetable

# KERIAN SPEED SIZER



**FOR SPEED, ACCURACY, AND GENTLE HANDLING**

**SIMPLE DESIGN**—Easy to maintain, easy to adjust, with a unique patented method of roller expansion.

**COMPACT AND EFFICIENT**—A large capacity in a small floor space, yet rugged enough for field use.

**UNEQUALLED ACCURACY**—No other diameter grader comes close, because of continuous product rotation and individually-driven heavy-duty rollers which maintain precise separation.

**PROVEN ABILITY**—Customized features and gentle handling are part of the package in hundreds of applications for apples, beets, carrots, citrus, cucumbers, fish, garlic, melons, nuts, olives, onions, peppers, potatoes, radishes, stone fruit, squash, sweet potatoes, tomatoes, and others.


## KERIAN MACHINES, INC.

Hwy. 81 S., P.O. Box 311 • Grafton, N.D. USA 58237

PHONE 701/352-0480 • Telex 4932886 • Fax 701/352-3776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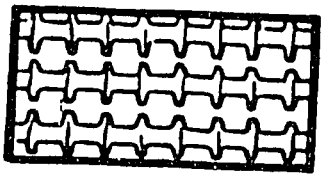
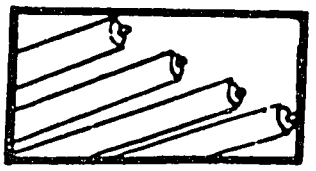
# STANDARD FEATURES

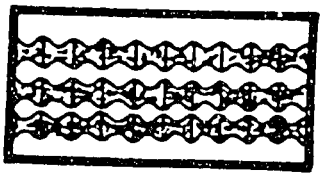
**Rollers designed for your product**—The expanding rollers ride on V-pulleys, rotating and orienting the produce. Overroller turning flaps furnished for long produce also align the product. Roller types include spaced rubber spools, three diameters of PVC-covered steel, and urethane rounded spools. Stainless steel rollers are also available.



Rubber spools for: round potatoes, onions, oranges, etc.



Plastic-covered rollers for most products: long potatoes, cucumbers, bell peppers, etc.



Urethane rounded spools for: easily bruised apples, tomatoes, etc.

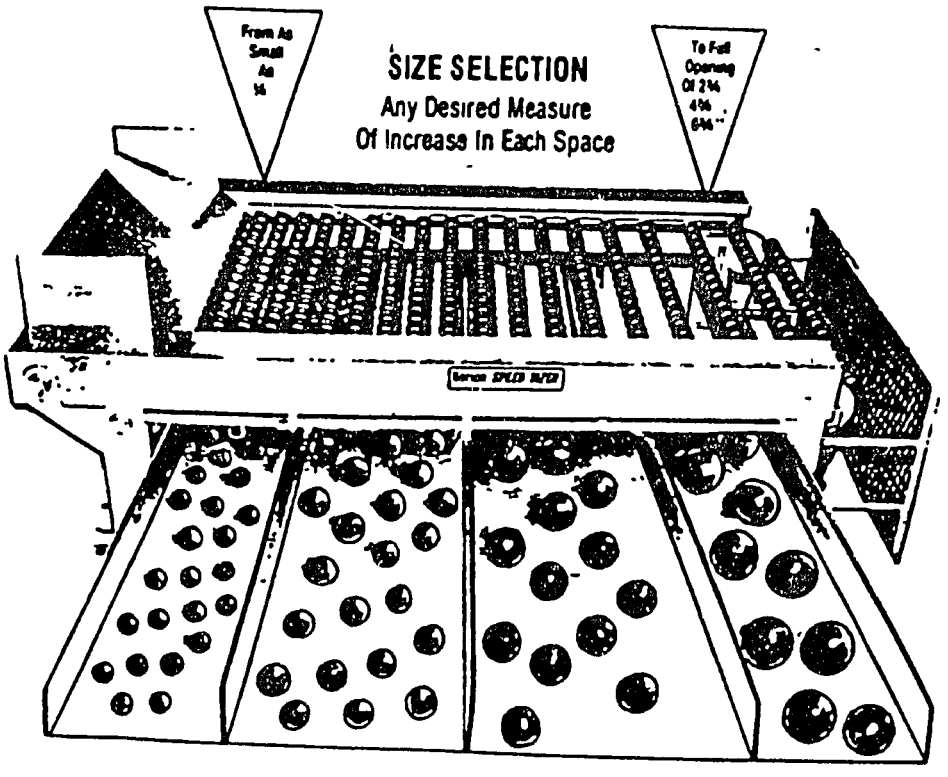
**Accuracy in sizing** — The Kerian Sizer is equipped with an exclusive patented roller drive that is selected for your particular sizing needs. Whether a standard or special application, the choice is from over 300 drive patterns presently in use. A custom design is also available for a small additional charge.

**No bruising or skinning** — Your product is gently rotated on moving rollers with direct separation onto a conveyor or delivery pan.

**Easy adjustment features** — Easily-movable dividers for precise size selection and full adjustment. Dividers can be easily added or subtracted to change the number of sizes. The legs are adjustable over one foot of height. The foot pads accept standard 6-inch casters.

**Low power consumption** — Standard single or 3-phase TEFC motors range from 1 to 2 HP.

**Built in durability** — The frame is rigid 2x5 steel tubing and all parts are made with precision to last for many years. We pre-test every machine before it is shipped.



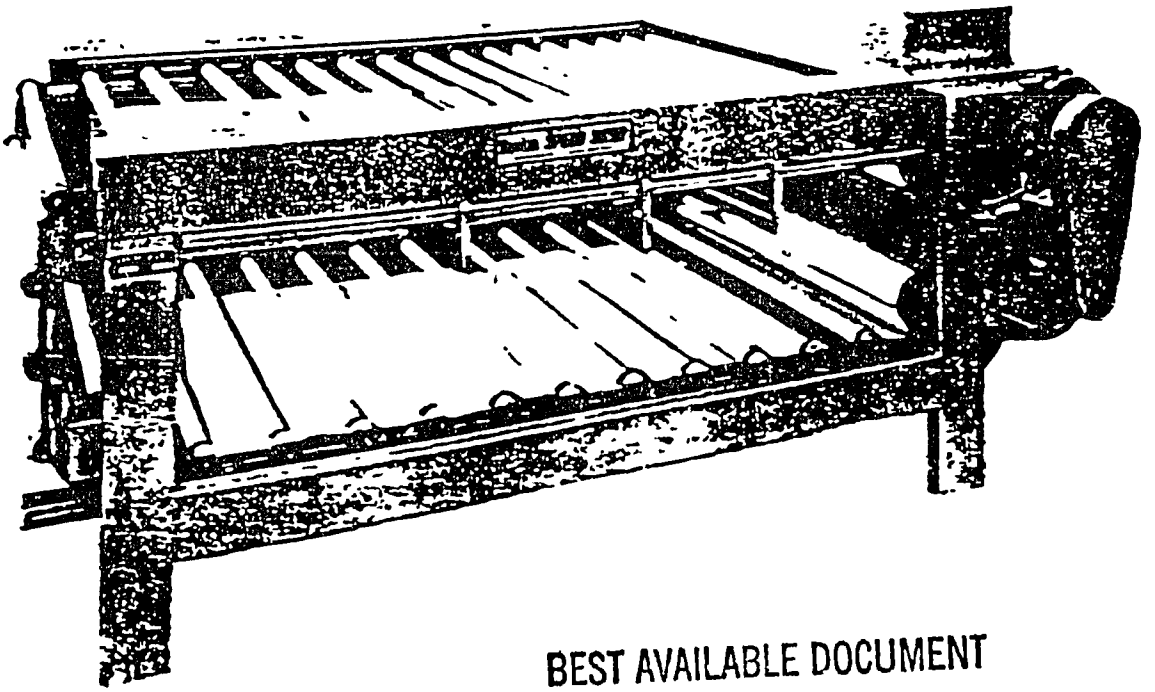
# KERIAN *SPEED SIZER*

## THREE LENGTHS AND FIVE WIDTHS

| | | M SERIES | L SERIES | X SERIES |
|---|---|---|---|---|
| Sizing Width | Capacity* Lb./Hr. | 60" Sizing Length 2 To 4 Sizes | 80" Sizing Length 3 To 6 Sizes | 120" Sizing Length 5 To 9 Sizes |
| 30 In. | 25,000 | M-30 | L-30 | |
| 40 In. | 32,000 | M-40 | L-40 | X-40 |
| 50 In. | 40,000 | M-50 | L-50 | X-50 |
| 60 In. | 50,000 | M-60 | L-60 | X-60 |
| 72 In. | 60,000 | | L-72 | X-72 |

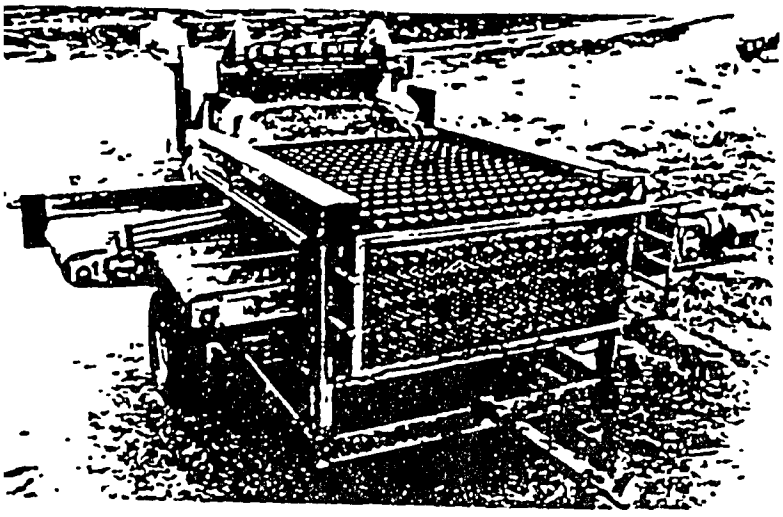
*Approximate capacity of combined sizes per hour depends on the size, shape and weight density of the product, as well as product flow and product distribution on the sizing rollers. Listed capacities are those normally experienced for a product such as round potatoes, onions, or oranges, at a roller speed of 100 rollers per minute.

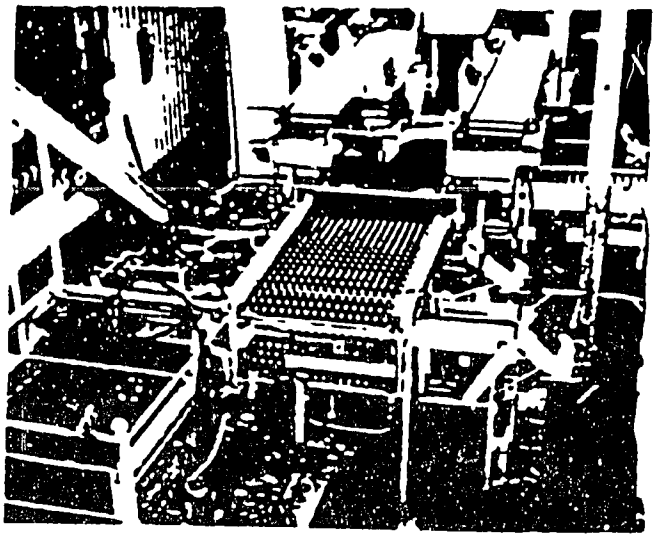
**CALL US TODAY FOR A QUOTE TO FIT YOUR REQUIREMENTS**



BEST AVAILABLE DOCUMENT

**KERIAN MACHINES, INC.**





The versatile KERIAN SIZER adapts to almost any packing system. At the left is the KERIAN SIZER Model M-50 complete with cart, elevator, and reversible takeaway belts. At the right, the Model L-60 is installed after the grading tables and in front of a conveyor system which consists of six independently reversible belts.

---

## OPTIONS

**Custom Separation**—If none of the standard patterns fit your unique application, we can design a separation to your exact specifications. Accurate within 1/64 inch.

**Corrosion Protection**--Imron Polyurethane paint provides extra protection for high acid or salt conditions. Recommended for some food processing applications are stainless steel rollers, stainless contact points, or an all stainless Sizer.

**Portability**—Heavy-duty casters with a swivel-locking feature bolt onto the legs for easy movability. Also available is a cart and hitch to take the KERIAN SIZER right into the field

**Takeaway Tables**—Single, double, or triple belt tables carry your product to either side of the Sizer. Included are channeling for separate lanes and side delivery as needed. Side conveyors are also available.

**Elevators**—Peg apron or finger flighted belt elevators, either stand-alone or Sizer-mounted, are designed to "fit" with the Sizer.

**Lubrication Systems**—Centralized lubrication panels and automatic roller lubrication simplify maintenance procedures.

**Other Options**—An over-end roller assembly allows delivery of large product off the end of the Sizer. The vertical takeaway clearance can be increased as needed for chutes or flumes with the assistance of an over-end damping assembly. The Sizer can also be provided with triple-seal ball bearings throughout to provide long-life service in harsh environments. Rigid platforms raise the Sizer to any desired height. Variable-speed operation can be achieved either by mechanical or electrical adjustment.

BEST AVAILABLE DOCUM

# KERIAN *SPEED SIZER*

January 1, 1988

U.S. Prices

| SIZING WIDTH | M SERIES 60" SIZING LGTH 2 TO 4 SIZES | | L SERIES 80" SIZING LGTH 3 TO 6 SIZES | | X SERIES 120" SIZING LGTH 5 TO 9 SIZES | |
|---|---|---|---|---|---|---|
| 30 IN. | M-30, | $7200. | L-30, | $9330. | | |
| 40 IN. | M-40, | $7840. | L-40, | $9950. | X-40, | $13100. |
| 50 IN. | M-50, | $8510. | L-50, | $10600. | X-50, | $13730. |
| 60 IN. | M-60, | $9350. | L-60, | $11300. | X-60, | $14460. |
| 72 IN. | | | L-72, | $12300. | X-72, | $15290. |

Prices are FOB Factory. All Models Include: Adjustable dividers and legs; Choice of rollers; Standard Spiral Drives, and Single or 3-phase motor. Takeaway Tables Additional. Capacities depend on size, shape, and weight of product being sized.

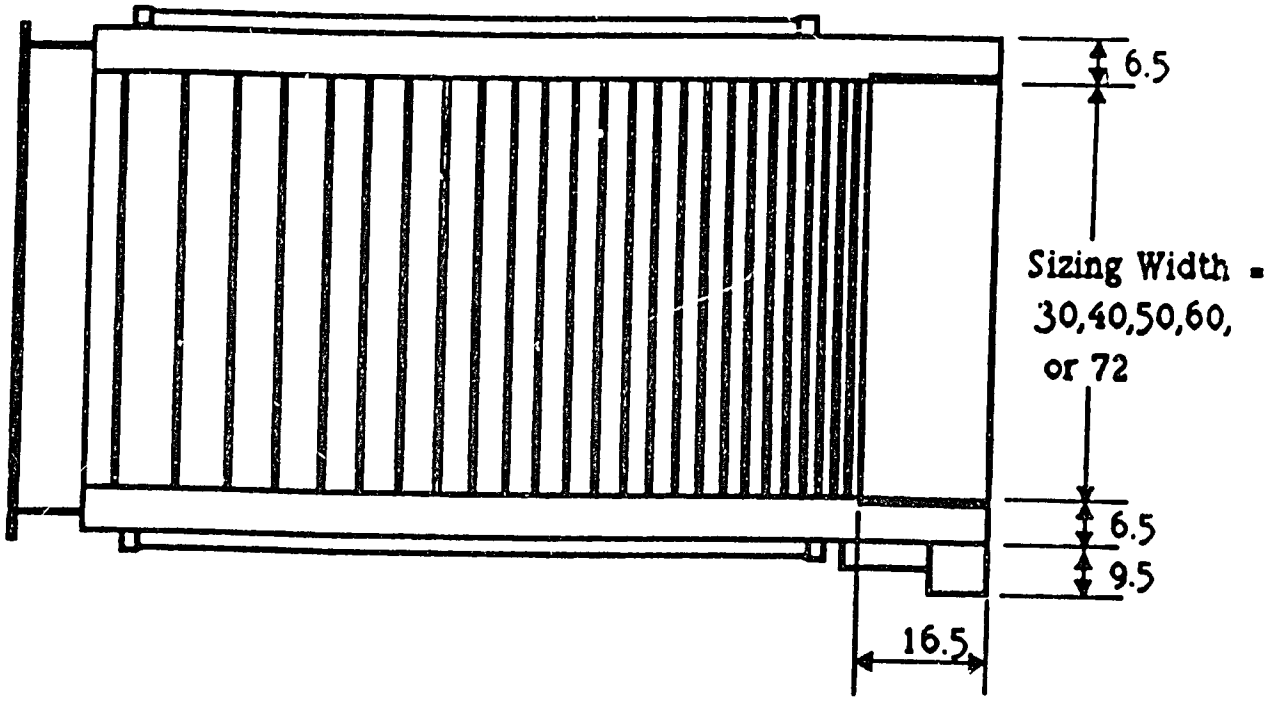
## OPTIONS

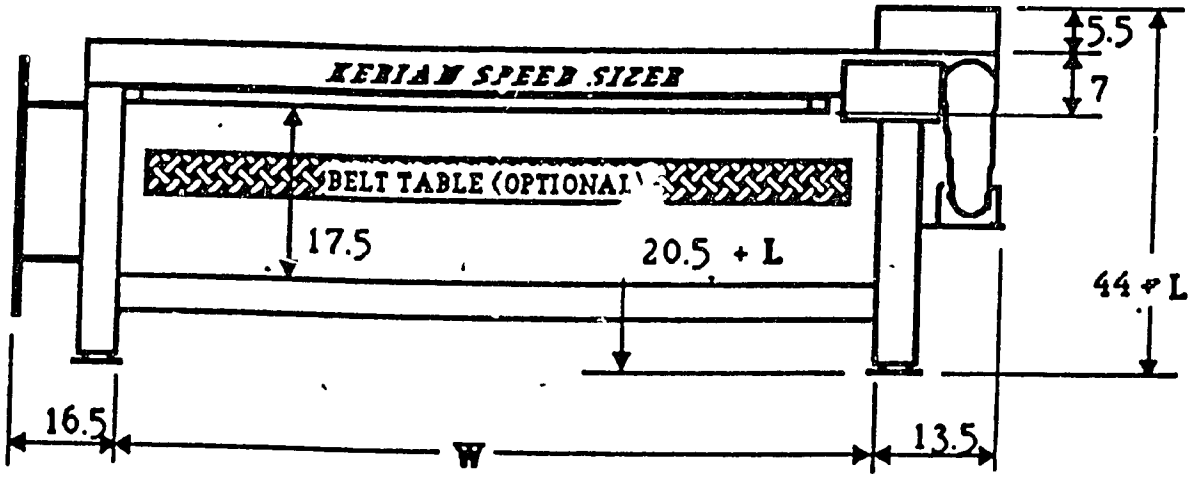
| | | | |
|---|---|---|---|
| Custom Spiral Pattern | 350. | Auto Roller Lubricators | 140. |
| Stainless Contact Points | 1500. | Lube Manifold | 360. |
| Stainless Steel Rollers | 1100. | Rear Damping Assembly | 300. |
| Casters, per set | 140. | Mechanical Vari-Speed | 200. |
| Field Cart | 750. | Over-End Roller | 275. |
| Platform, 1 foot | 78. | Stainless Steel Sizers | |
| Platform, 2 foot | 135. | Belt tables & Elevators | |

**WE REQUIRE ONE-THIRD DOWN PAYMENT WITH ORDER WITH BALANCE DUE WHEN SHIPPED.**


## KERIAN MACHINES, INC.

Hwy 81 South, PO Box 311
Grafton, ND 58237 USA
701/352-0480, FAX 701/352-3776




| | | | |
|---|---|---|---|
| | | Overall Length | |
| W = | 66 | 'M' Series | 96 |
| | 86 | 'L' Series | 116 |
| | 126 | 'X' Series | 156 |

L = 0,2,4,6,8,or 10 ;
(Platform optional for
additional height)

Note: All dimensions in inches.

# STRIP DOORS

## FLEXIBLE SEE T. RU DOOR

### LOWER HEATING BILLS — REDUCE NOISE

Spaces previously too small, too wide, too high, can now be effectively closed off by Rand Strip-dor. This unique transparent closure is the answer for many requirements where swing type impact doors are not feasible. Virtually indestructable, Strip-dor is proudly added to the ever widening line of Rand impact traffic doors and loading dock equipment.

**ENERGY SAVINGS** — Saves energy cost by reducing the amount of heated or cooled air lost through your unprotected opening. Opens only sufficiently to allow foot and power truck to pass through.

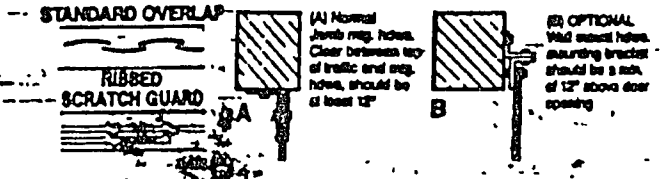
**SAFETY STRIPS** — Rounded edges to prevent cutting. Fire retardant self extinguishing, offers a low cost method to guard openings, protects against dust, drafts, insects, heat, cold and noise. Each opening has special bright orange end strips to prevent accidents.

**NOISE REDUCTION**

Our strip doors and curtains provide a virtually unbreakable sound barrier. Researchers assigned our product a sound transmission rating of Class 13.

**WE WILL MAKE STRIP DOOR TO FIT ANY DOOR OPENING**

STOCK NO. 109 — PRICE INCLUDES STRIP MATERIAL, ALUMINUM ANGLE — SPECIFY MOUNTING A OR B AND OPENING SIZE. 8" Wide strips have 2" of overlap per side, 12" wide have 4" of overlap each side. FOB AL




Models + Strips Air Freight Others UPS

| DOOR OPEN WDH | STRIP SIZE | STANDARD STOCK NUMBER | STANDARD NET EACH | LOW TEMP STOCK NUMBER | LOW TEMP NET EACH | RIBBED STOCK NUMBER | RIBBED NET EACH |
|---|---|---|---|---|---|---|---|
| 3 x 7 | 8" (.080) THICK | 1097X3 | 972 | 1097X3L | 991 | 1097X3R | .687 |
| 4 x 7 | | 1097X4 | 99 | 1097X4L | 121 | 1097X4R | .917 |
| 4 x 8 | | 1098X4 | 110 | 1098X4L | 139 | 1098X4R | 133 |
| 5 x 7 | | 1097X5 | 120 | 1097X5L | 152 | 1097X5R | 146 |
| 5 x 8 | | 1098X5 | 137 | 1098X5L | 173 | 1098X5R | 168 |
| 6 x 7 | | 1097X6 | 144 | 1097X6L | 182 | 1097X6R | 175 |
| 6 x 8 | | 1098X6 | 165 | 1098X6L | 208 | 1098X6R | 200 |
| 7 x 8 | | 1098X7 | 192 | 1098X7L | 243 | 1098X7R | 233 |
| 8 x 8 | | 1098X8 | 220 | 1098X8L | 277 | 1098X8R | 266 |
| 8 x 10 | | 10910X8 | 274 | 10910X8L | 346 | 10910X8R | 333 |
| 9 x 9 | | 1099X9 | 278 | 1099X9L | 351 | 1099X9R | 337 |
| 10 x 10 | 12" (.120) THICK | 10910X10 + | 448 | 10910X10L + | 540 | 10910X10R + | 646 |
| 10 x 12 | | 10912X10 + | 533 | 10912X10L + | 648 | 10912X10R + | 654 |
| 11 x 11 | | 10911X11 + | 542 | 10911X11L + | 653 | 10911 X 11R + | 659 |
| 12 x 12 | | 10912X12 + | 646 | 10912X12L + | 778 | 10912X12R + | 785 |

## STRIP DOOR MATERIAL

**STANDARD MATERIAL**
Withstands temperatures from 0 to +150 degrees. Resists alcohols, acids, oils and alkalies.

**USDA LO TEMP MATERIAL**
Is for Food-Handling. Withstands temperatures from −40 to +100 degrees. Resists alcohols, acids, oils and alkalies.

**RIBBED MATERIAL**
Standard Material with raised ribs on both sides prevent scratching of plexiglas strips. Rib height is .094" — width is .125"

**REPLACEMENT STRIPS** For your own strip door application. Buy strips in bulk rolls. By cutting and punching holes yourself you save money. FOB AL

| SIZE W x THICK. | ROLL LENGTH | STANDARD STOCK NO. | STANDARD ROLL PRICE | USDA LO TEMP STOCK NO. | USDA LO TEMP ROLL PRICE | RIBBED STOCK NO. | RIBBED ROLL PRICE |
|---|---|---|---|---|---|---|---|
| 8" x .080 | 150' | R1090008 | $ 81 | R1092108 | $119 | | |
| 8" x .080 | 150' | R1090008 | $143. | R1092008 | $168. | R1090009 | $184 |
| 12" x 120 | 75 | R1090012 | $161 | R1092012 | $198. | R1090013 | $225. |
| 16" x 160 | 100' | R1090016 | $294 | R1092016 | $348 | R1090017 | $479 |
| 48" x .080 | 60' | R1099080 | $273. | R1099081 | $343 | | |

**CUSTOM CUT REPLACEMENT STRIPS** Can be used on our doors or others. Strips are custom cut to any length you specify. Can be punched (Specify punched) with ⅜" diameter holes on 2" centers ONLY. FOB AL

| SIZE W x THICK. | STANDARD STOCK NO. | STANDARD PER FOOT | USDA LO TEMP STOCK NO. | USDA LO TEMP PER FOOT | RIBBED STOCK NO. | RIBBED PER FOOT |
|---|---|---|---|---|---|---|
| 8" x .080 | 1090008C | $ [illegible] | 1092108C | $ .85 | — | — |
| 8" x .080 | 1090008C | [illegible] | 1092008C | 1.38 | 1090009C | $1.85 |
| 12" x 120 | 1090012C | [illegible] | 1092012C | 2.18 | 1090013C | 3.58 |
| 16" x 160 | 1090016C | [illegible] | 1092016C | 5.28 | 1090017C | 6.18 |
| 48" x .080 | 1099080C | [illegible] | 1099081C | 8.85 | — | — |

over 70 years' experience, we're a
ed leader in the field. Considering
erce competition, why trust your
r your reputation with anything else?

## DE RANGE OF MODELS AND SERVICES

ple analog (strip chart) monitors to
its with PC compatibility, Ryan has
emperature/humidity monitor,
your application. What's more, we
le you with the versatility and
you need to manage the data you
et your charts and graphics
ly, or have us prepare your report
data in the field using your
mputer, terminal or datalogger
it is your IBM PC or compatible
utes. We've got the software to
ost of your data analysis.

## BUILT FOR HARSH CONDITIONS

You can't afford to have a monitor quit when conditions get ugly. In fact, that's when their capability is needed most. At Ryan, we know what our instruments can be subjected to, day-in and day-out. So we build them to resist more than just broiling heat and freezing cold, rough handling is also taken into account.

## DOUBLE VERIFIED FOR ACCURACY

Accuracy is vital in any kind of monitor. No monitor passes through our doors without first being calibrated at *two* or more temperature extremes. Proof of this calibration is available and all Ryan monitors come with tamper-proof seals. So, whether your product goes over the road, under water or in storage, count on Ryan monitors with chart accuracy that has held up in court.

## SALES AND SERVICE WORLDWIDE

With distribution points worldwide, we guarantee quick response, fast shipments and outstanding service. Many customers insist on Ryan Instruments for this reason alone. Shouldn't you?

For a demonstration or more information, call Ryan Instruments at **1-800-999-7926** (U.S. & Canada only) or **206/883-7926**. FAX us at **206/883-3766**. Or simply write us: Ryan Instruments, P.O. Box 599, Redmond, WA 98073-0599.

**RYAN RTM2000**

Digital Temperature/Humidity Monitor
Temperature Range
128° to 111°F (-90° to 600°C)
Humidity Range
5 to 100%

- Quick-reader and weatherproof enclosures available
- Select from wide variety of sensors for thermistor, RTD and humidity probes
- Remote probe capabilities
- Multi-channel

**RYAN MODEL K**

Analog Temperature Monitor
Temperature Range
15° to 95°F (-25° to 35°C)
Monitoring Spans
10, 45, or 90 days

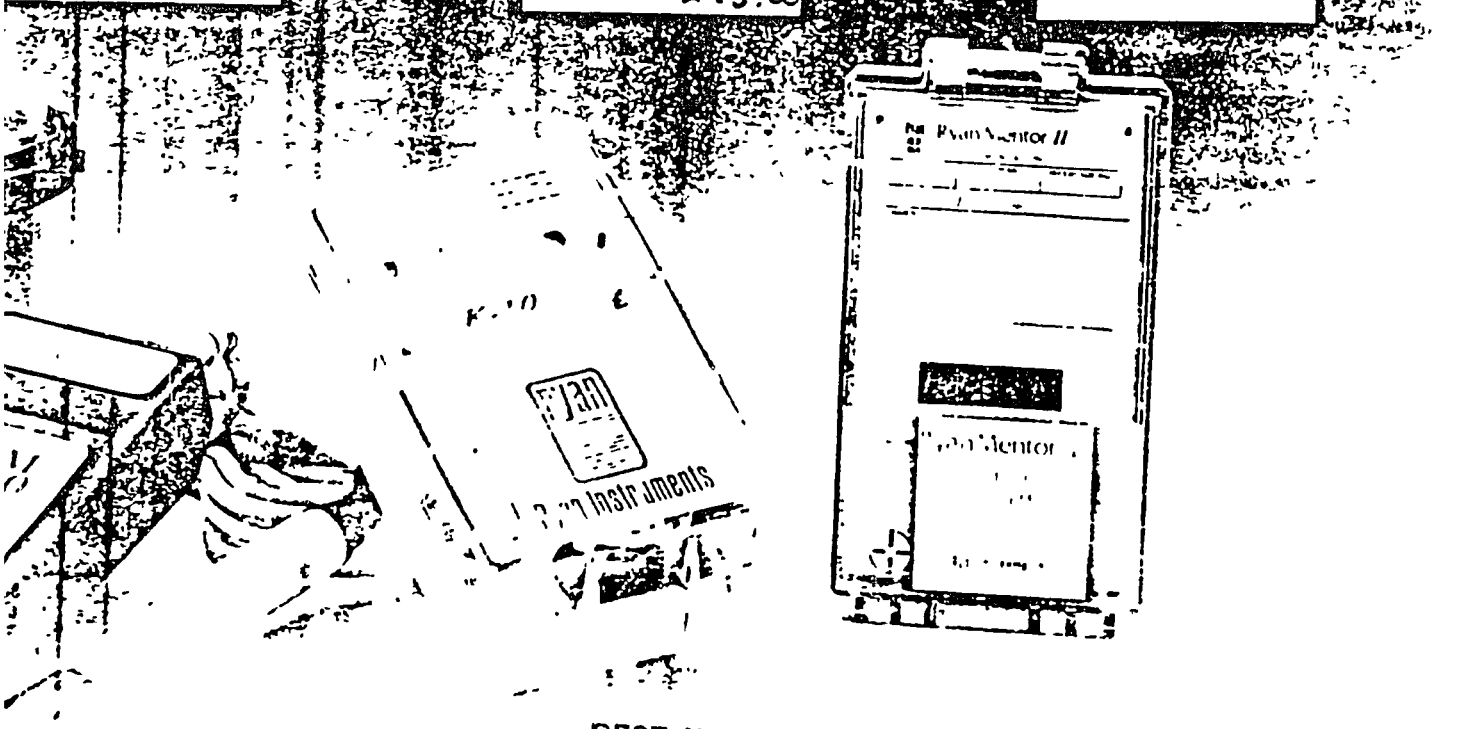
- Produces Strip Chart as it monitors
- On/Off switch allows user to stop, remove chart cassette and start again
- Change chart cassettes in just seconds
- Stop chart visible while monitoring

$275.00

**RYANMENTOR II**

Digital Temperature and/or Humidity Monitor
Temperature Range
10° to 110°F (-10° to 43°C)
Humidity Range
10 to 100%
Monitoring Spans
14, 7, 21, 42 or 84 days

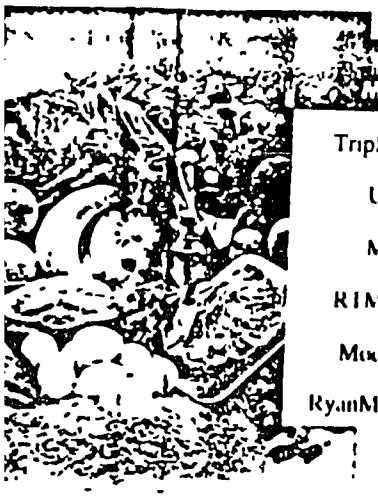
- LCD Display
- Compatible with IBM PC, XT or AT
- All data records processed on screen in low, pointed
- Menu driven software




BEST AVAILABLE DOCUMENT

# SELECT THE RIGHT MONITOR TO FIT YOUR NEEDS.

Below is a guide to help you choose the instrument best suited to your monitoring needs



| MODEL | DAY SPAN | SINGLE OR MULTIPLE CHARTS | ANALOG OR DIGITAL DATA | MONITOR PARAMETERS |
|---|---|---|---|---|
| TripMentor™ | 7, 21, 42, 84 | Multiple | Digital & Analog | Temperature |
| UTI™ | 4, 8, 16, 32, 75 | Single | Analog | Temperature |
| MX™ | 15, 60 | Single | Analog | Temperature |
| RTM2000™ | Programmable | Multiple | Digital | Temperature/RH |
| Model K™ | 10, 45, 90 | Single | Analog | Temperature |
| RyanMentor II™ | Programmable | Multiple | Digital | Temperature/RH |

# TECHNICAL SPECIFICATIONS

## TRIPMENTOR

| | |
|---|---|
| Range | 40° to 110°F (-40° to 43°C) |
| Time Accuracy | ±.01% |
| Temp Accuracy | ±1°F (±.5°C) |
| Sensing Element | Fast response thermistor |
| Sample Rate | 5 minutes 7 days<br>15 minutes 21 days<br>30 minutes 42 days<br>60 minutes 84 days |
| Power | One 1.5 volt alkaline battery |
| Weight | 10 ounces |

## UTI

| | |
|---|---|
| Range | 20° to 100°F (-29° to 37°C) |
| Time Accuracy | ±2% |
| Temp Accuracy | ±2°F (±1°C) |
| Sensing Element | Certified bimetal coil |
| Chart | Pressure sensitive paper |
| Chart Advance | 4 Day 6.0" per day<br>8 Day 3.0" per day<br>16 Day 1.5" per day<br>32 Day .750" per day<br>75 Day .300" per day |
| Paper Width | 2.6 inches |
| Scale Width | 2.4 inches |
| Power | Two 1.5 volt AA alkaline batteries |
| Weight | 15 ounces |

## RYAN MX

| | |
|---|---|
| Range | 20° to 100°F (-29° to 38°C) |
| Time Accuracy | ±2% |
| Temp Accuracy | ±2°F (±1°C) |
| Sensing Element | Certified bimetal coil |
| Chart | Pressure sensitive paper |
| Chart Advance | 15 Day 1.917" per day<br>60 Day .1875" per day |
| Paper Width | 2.6 inches |
| Scale Width | 1.9 inches |
| Power | One 1.5 volt AA alkaline battery |
| Weight | <15 ounces |

## RTM2000

| | |
|---|---|
| Range | Thermistor -72° to 163°F (-58° to 73°C)<br>RTD -328° to 1112°F (-200° to 600°C)<br>RH 5 to 100%, 41° to 122°F (-40° to 50°C) |
| Time Accuracy | ±.01% |
| Sensing Element | Fast response thermistor, RTD and humidity sensors |
| Sample Rate | 5 seconds to 9,999 days |
| Deployment Life | 2 years |
| Power | One 9 volt alkaline battery pack |
| Weight | <12 ounces |

## RYAN MODEL K

| | |
|---|---|
| Range | -15° to 95°F (-25° to 35°C) |
| Time Accuracy | ±.5% |
| Temp Accuracy | ±2°F (±1°C) |
| Sensing Element | Certified bimetal coil |
| Chart | Pressure sensitive paper |
| Chart Advance | 10 Day .42" per day<br>45 Day .3" per day<br>90 Day .15" per day |
| Power | One 1.5 volt AA battery |
| Weight | 12 ounces |

## RYANMENTOR II

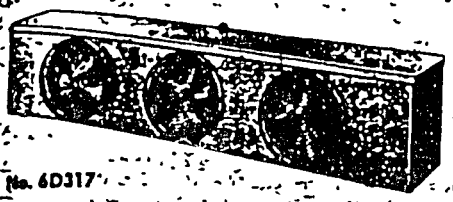
| | |
|---|---|
| Range | -40° to 110°F (-40° to 43°C)<br>RH 10 to 100% |
| Time Accuracy | ±1% |
| Temp Accuracy | ±1°F (±.5°C) |
| Sensing Element | Fast response thermistor |
| Sample Rate | 1 minute 1.4 days<br>5 minutes 7 days<br>15 minutes 21 days<br>30 minutes 42 days<br>60 minutes 84 days |
| Power | One 1.5 volt alkaline battery |
| Weight | 12 ounces |

BEST AVAILABLE DOCUMENT


Ryan Instruments

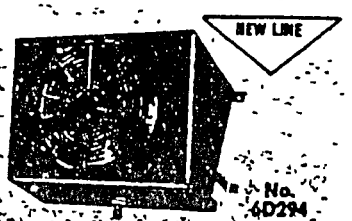
8801 148th Avenue N.E., P.O. Box 599 Redmond, WA 98073-0599 USA (206) 883-7926 FAX (206) 883-3766
In Europe Liethstkade 12C P.O. Box 169 2170 AD Sassenheim The Netherlands 31 2522-11108 FAX 31 2522-31032

# REFRIGERATION UNIT COOLERS



No. 6D317

CLIMATE CONTROL



NEW LINE

No. 6D294

- Functional replacements for many leading brands
- Air and electric defrost models
- Aluminum collared plate fins and copper tube
- Expansion valve mounts inside cabinet

## MEDIUM-TEMPERATURE APPLICATIONS (AIR DEFROST) 35° TO 55°F

### WALK-IN MODELS

| Rated Capacity @ 18°F TD | Fan Qty | Fan Dia | CFM | Motor Amps 115V | Connections (In) Inlet | Suction | Drain | Dimensions (In) L | W | H | Mfr Model | Stock No | List | Each | Shpg Wt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4000 | 1 | 12" | 800 | 1.8 | ½FN | ⅝ODS | ¾ | 32¼ | 13 15/16 | 14¾ | LSC0401 | 6D324 | $844.00 | $322.00 | 38.0 |
| 5200 | 1 | 12 | 800 | 1.8 | ½FN | ⅝ODS | ¾ | 32¼ | 13 15/16 | 14¾ | LSC0521 | 6D323 | 706.00 | 353.00 | 42.0 |
| 6500 | 1 | 12 | 710 | 1.8 | ½FN | ⅝ODS | ¾ | 32¼ | 13 15/16 | 14¾ | LSC0651 | 6D322 | 814.00 | 407.00 | 44.0 |
| 9000 | 2 | 12 | 1430 | 3.6 | ½FN | ⅝ODS | ¾ | 44¼ | 13 15/16 | 14¾ | LSC0901 | 6D321 | 1076.00 | 538.00 | 58.0 |
| 10300 | 2 | 12 | 1520 | 3.6 | ½FN | ⅞ODS | ¾ | 52¼ | 13 15/16 | 14¾ | LSC1051 | 6D320 | 1150.00 | 575.00 | 66.0 |
| 12000 | 2 | 12 | 1520 | 3.6 | ½FN | ⅞ODS | ¾ | 52¼ | 13 15/16 | 14¾ | LSC1201 | 6D319 | 1272.00 | 636.00 | 66.0 |
| 14000 | 2 | 12 | 1460 | 3.6 | ½FN | ⅞ODS | ¾ | 52¼ | 13 15/16 | 14¾ | LSC1401 | 6D318 | 1410.00 | 705.00 | 74.0 |
| 16000 | 3 | 12 | 2270 | 5.4 | ½FN | ⅞ODS | ¾ | 72¼ | 13 15/16 | 14¾ | LSC1601 | 6D317 | 1658.00 | 829.00 | 92.0 |
| 20000 | 4 | 12 | 3030 | 7.2 | ½FN | 1⅛ODS | ¾ | 92¼ | 13 15/16 | 14¾ | LSC2001 | 6D316 | 2094.00 | 1047.00 | 120.0 |
| 27000 | 5 | 12 | 3790 | 9.0 | ½FN | 1⅛ODS | ¾ | 112¼ | 13 15/16 | 14¾ | LSC2701 | 6D315 | 2690.00 | 1345.00 | 218.0 |
| 31000 | 6 | 12 | 4390 | 10.8 | ⅞ODS | 1⅜ODS | ¾ | 132¼ | 13 15/16 | 14¾ | LSC3101 | 6D314 | 3006.00 | 1503.00 | 232.0 |
| 40000 | 6 | 12 | 4390 | 10.8 | ⅞ODS | 1⅜ODS | ¾ | 132¼ | 13 15/16 | 14¾ | LSC4001 | 6D313 | 3786.00 | 1893.00 | 270.0 |

### REACH-IN MODEL

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 | 1 | 8 | 235 | 1.0 | ½FN | ⅜ID | ½OD | 14¼ | 15¾ | 8⅞ | L13A | 6D333 | 390.00 | 195.00 | 16.0 |
| 1700 | 1 | 8 | 250 | 1.0 | ½FN | ⅜ID | ½OD | 17¼ | 15¾ | 8⅞ | L17A | 6D332 | 406.00 | 203.00 | 17.0 |
| 2300 | 1 | 8 | 265 | 1.0 | ½FN | ⅜ID | ½OD | 22¾ | 15¾ | 8⅞ | L23A | 6D331 | 480.00 | 240.00 | 22.0 |
| 3000 | 2 | 8 | 480 | 2.0 | ½FN | ½ID | ½OD | 27¾ | 15¾ | 8⅞ | L30A | 6D330 | 614.00 | 307.00 | 27.0 |
| 4300 | 2 | 8 | 520 | 2.0 | ½FN | ½ID | ½OD | 37 13/16 | 15¾ | 8⅞ | L43A | 6D329 | 768.00 | 384.00 | 40.0 |
| 600 | 1 | 5½ | 135 | 0.8 | ½FN | ⅜ID | ½OD | 12½ | 8½ | 6⅞ | LAC06A | 6D328 | 258.00 | 129.00 | 9.0 |
| 800 | 1 | 5½ | 130 | 0.8 | ½FN | ⅜ID | ½OD | 12½ | 8½ | 6⅞ | LAC08A | 6D327 | 272.00 | 136.00 | 9.0 |
| 1200 | 2 | 5½ | 265 | 1.6 | ½FN | ⅜ID | ½OD | 18 | 8½ | 8 | LAC12A | 6D326 | 370.00 | 185.00 | 14.0 |
| 1700 | 1 | 8 | 245 | 1.0 | ½FN | ⅜ID | ½OD | 14 | 10½ | 9¾ | LAC17A | 6D325 | 418.00 | 209.00 | 11.0 |
| 1000 | 1 | 15½ | 110 | 0.8 | ½FN | ⅜ID | ½OD | 16½ | 15½ | 4½ | SRC10A | 6D295 | 304.00 | 152.00 | 14.0 |
| 1300 | 2 | 15½ | 205 | 1.6 | ½FN | ⅜ID | ½OD | 20½ | 15½ | 4½ | SRC13A | 6D294 | 394.00 | 197.00 | 17.0 |
| 1700 | 2 | 15½ | 205 | 1.6 | ½FN | ⅜ID | ½OD | 24 | 16½ | 4½ | SRC17A | 6D293 | 458.00 | 229.00 | 21.0 |
| 2300 | 3 | 15½ | 315 | 2.4 | ½FN | ⅜ID | ½OD | 31⅝ | 16½ | 4½ | SRC23A | 6D292 | 584.00 | 292.00 | 28.0 |
| 3000 | 3 | 15½ | 320 | 2.4 | ½FN | ½ID | ½OD | 40 | 16½ | 4½ | SRC30A | 6D291 | 724.00 | 362.00 | 33.0 |
| 4300 | 4 | 15½ | 425 | 3.2 | ½FN | ⅝ID | ½OD | 53⅜ | 16½ | 4½ | SRC43A | 6D290 | 974.00 | 487.00 | 44.0 |
| 5500 | 5 | 15½ | 545 | 4.0 | ½FN | ⅝ID | ½OD | 53⅜ | 16½ | 6½ | SRC55A | 6D289 | 1240.00 | 620.00 | 33.0 |

## LOW TEMPERATURE APPLICATIONS (ELECTRIC DEFROST) −20° TO 34°F

### WALK-IN MODELS

| Rated Capacity @ 18°F TD | Fan Qty | Fan Dia | CFM | Motor Amps 115V | Connections (In) Inlet | Suction | Drain | Dimensions (In) L | W | H | Mfr Model | Stock No | List | Each | Shpg Wt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4000 | 1 | 12" | 810 | 0.9 | ½FN | ⅝ODS | ¾ | 32¼ | 13 15/16 | 14¾ | LSF0402 | 6D312 | $1066.00 | $533.00 | 42.0 |
| 5500 | 2 | 12 | 1535 | 1.8 | ½FN | ⅝ODS | ¾ | 44¼ | 13 15/16 | 14¾ | LSF0552 | 6D311 | 1320.00 | 660.00 | 56.0 |
| 7000 | 2 | 12 | 1455 | 1.8 | ½FN | ⅞ODS | ¾ | 44¼ | 13 15/16 | 14¾ | LSF0702 | 6D310 | 1428.00 | 714.00 | 60.0 |
| 9400 | 2 | 12 | 1535 | 1.8 | ½FN | ⅞ODS | ¾ | 52¼ | 13 15/16 | 14¾ | LSF0942 | 6D309 | 1618.00 | 809.00 | 74.0 |
| 12000 | 3 | 12 | 2295 | 2.7 | ½FN | 1⅛ODS | ¾ | 72¼ | 13 15/16 | 14¾ | LSF1202 | 6D308 | 2014.00 | 1007.00 | 96.0 |
| 14000 | 3 | 12 | 2275 | 2.7 | ½FN | 1⅛ODS | ¾ | 72¼ | 13 15/16 | 14¾ | LSF1402 | 6D307 | 2272.00 | 1136.00 | 102.0 |
| 16000 | 4 | 12 | 3060 | 3.6 | ½FN | 1⅛ODS | ¾ | 92¼ | 13 15/16 | 14¾ | LSF1602 | 6D306 | 2690.00 | 1345.00 | 128.0 |
| 18400 | 4 | 12 | 3060 | 3.6 | ½FN | 1⅛ODS | ¾ | 92¼ | 13 15/16 | 14¾ | LSF1802 | 6D305 | 2970.00 | 1485.00 | 130.0 |
| 24000 | 6 | 12 | 4485 | 5.4 | ½FN | 1⅛ODS | ¾ | 132¼ | 13 15/16 | 14¾ | LSF2402 | 6D304 | 3702.00 | 1851.00 | 232.0 |
| 28000 | 6 | 12 | 4485 | 5.4 | ½FN | 1⅛ODS | ¾ | 132¼ | 13 15/16 | 14¾ | LSF2802 | 6D303 | 4380.00 | 2190.00 | 232.0 |

### REACH-IN MODELS

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | 1 | 15½ | 110 | — | ½FN | ⅜ID | ½OD | 16½ | 15½ | 4½ | SFC09A | 6D302 | 504.00 | 252.00 | 14.0 |
| 1200 | 2 | 15½ | 210 | — | ½FN | ⅜ID | ½OD | 20½ | 15½ | 4½ | SFC12A | 6D301 | 608.00 | 304.00 | 19.0 |
| 1600 | 2 | 15½ | 210 | — | ½FN | ½ID | ½OD | 24 | 16½ | 4½ | SFC16A | 6D300 | 754.00 | 377.00 | 23.0 |
| 2100 | 1 | 15½ | 240 | — | ½FN | ½ID | ½OD | 24 | 18½ | 6¾ | SFC21A | 6D299 | 854.00 | 427.00 | 24.0 |
| 2800 | 3 | 15½ | 335 | — | ½FN | ⅝ID | ½OD | 31⅝ | 16½ | 6¾ | SFC28B | 6D298 | 1076.00 | 538.00 | 27.0 |
| 3500 | 2 | 15½ | 420 | — | ½FN | ⅝ID | ½OD | 38⅜ | 18½ | 6¾ | SFC35B | 6D297 | 1210.00 | 605.00 | 38.0 |
| 5300 | 3 | 15½ | 595 | — | ½FN | ⅞ID | ½OD | 49⅛ | 18½ | 6¾ | SFC53B | 6D296 | 1670.00 | 835.00 | 53.0 |

SEE WARRANTY INFORMATION ON PAGE OPPOSITE INSIDE BACK COVER



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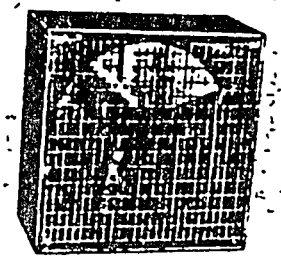
# ADJUSTABLE SPEED AGRICULTURAL DUTY FAN AND POULTRY LIGHT TRAP

## 24" ADJUSTABLE SPEED DIRECT-DRIVE AGRICULTURAL DUTY FAN

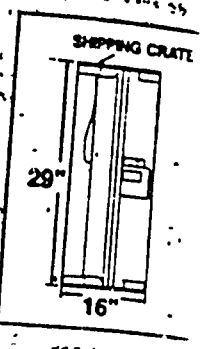
- Speed adjustable when used with No. 3C960 controller (see page 2768)
- All galvanized fan construction for corrosion protection
- Automatically maintains minimum winter ventilation requirements and house temperature

Fan is shipped completely assembled in crate for fast, simple installation. Shipping crate can be used as a mounting frame 1 x 2" Wire mesh intake and exhaust screens

TENV, 1/2 HP, 230V, permanent split capacitor thermally protected motor with sealed and shielded ball bearings, and automatic thermal protection Direct-drive eliminates belts or pulleys that need adjusting or replacing. Gasketed motor conduit box has wire leads for easy connection



Dayton Electric Mfg Co. certifies that No. 3C996 agricultural fan shown here is licensed to bear the AMCA seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings Program




| Blade Dia | Fan RPM | Max Fan BHP† | CFM at Static Pressure Shown* 0.8" SP | 0.85" SP | 0.10" SP | 0.15" SP | Stock No | List | Each |
|---|---|---|---|---|---|---|---|---|---|
| 24" | 1075 | 0.57 | 5870 | 5560 | 5410 | 5150 | 3C996 | $388.50 | $259.00 |

(*) Performance shown is for fan mounted in crate without intake or discharge screens and without ducts. (†) BHP (Brake Horsepower) is maximum horsepower required at air delivery shown.

## POULTRY BUILDING LIGHT TRAP

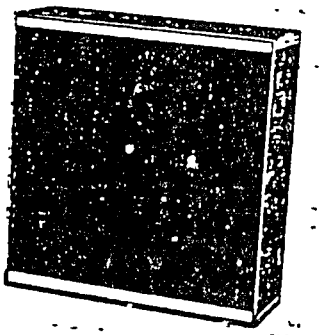
- Fully assembled light trap works with agricultural building fans to maintain good ventilation and keep unwanted sunlight out
- 22,000 to 1 light reduction
- No enhancer required
- 4" Wide draw along full width of bottom
- Durable weather-resistant black ABS plastic blades

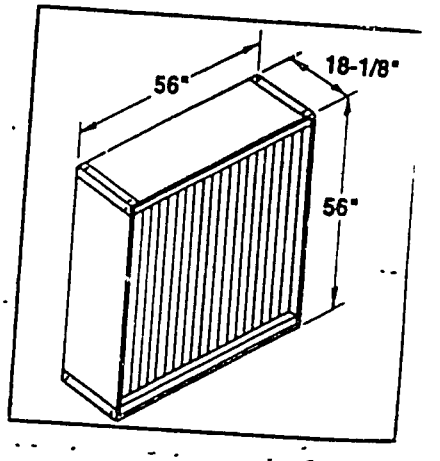
No. 3F529 Light Trap Shpg wt. 101.0 lbs
List $516.00 Each $333.50

TO DETERMINE THE NUMBER OF LIGHT TRAPS NEEDED—The proper number of light traps must be used to avoid the effects of excessive air restriction

1. Overheating motor/nuisance tripping
2. Insufficient air flow (CFM)
3. Excessive building structural load

Use the table at right to determine the correct number of light traps needed for your application






FOR EXAMPLE.

If (8) fans rated at 20,160 were used

| | |
|---|---|
| Multiplier | 2.9 |
| × No of Fans | 8 |
| 23.2 or 24* 3F529 Light Traps | |

Use 1 or 2 more Light Traps at Exhaust, ie

| | |
|---|---|
| Light Traps at exhaust end | 13 |
| Light Traps at entrance | 11 |
| Total | 24 |

| FAN PERFORMANCE AT 0.0 IN. W.G. (CFM) | 16,000 to 16,999 | 17,000 to 17,999 | 18,000 to 18,999 | 19,000 to 19,999 | 20,000 to 20,999 |
|---|---|---|---|---|---|
| No. 3F529 MULTIPLIER | 2.1 | 2.3 | 2.5 | 2.7 | 2.9 |

(*) Always use the next full number ie if results were 20.2 use 21

MANY BRANDS OF MAINTENANCE EQUIPMENT AVAILABLE

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# AGRICULTURAL DUTY DIRECT-DRIVE CONE FAN AND STRAIGHT-WALL FANS

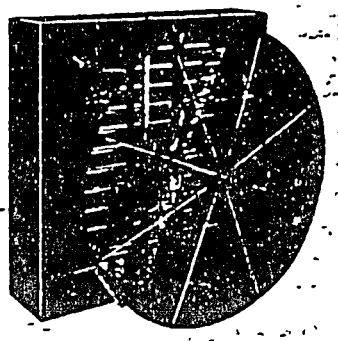
## 48" DIRECT-DRIVE CONE FAN

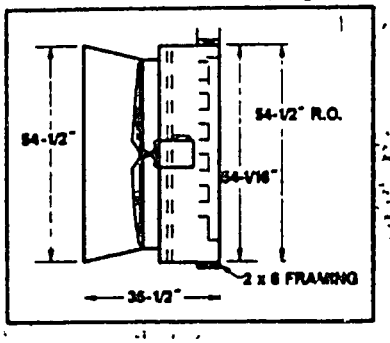
- Discharge cone increases fan performance and efficiency
- All galvanized steel housing fits flush to beside of building
- Totally enclosed motor with automatic reset thermal protection has wire leads for easy connection

Cone fan for use in greenhouses, poultry houses and other agricultural applications. Housing and fan feature all galvanized construction to resist corrosion in agricultural and livestock applications

Corrosion resistant shutter is held in place by quick-release latches to allow ready access for maintenance

Direct-drive fan has no belts or pulleys to adjust or replace Moisture resistant TENV 1 HP, 230V, permanent split capacitor motor with sealed and shielded ball bearings Fan comes complete with housing, intake shutter, discharge cone, and outlet screen

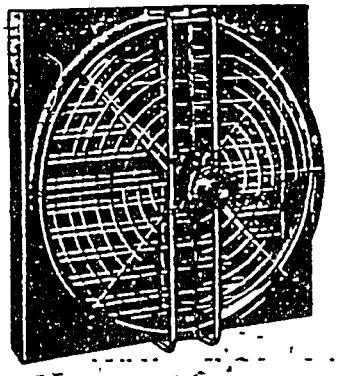


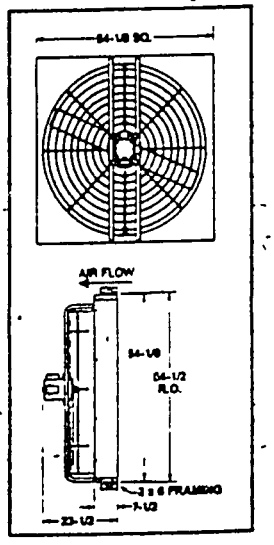



| Blade Dia | No Fan Blades | CFM @ RPM Shown/CFM per Watt Free Air | 0.05" SP | 0.10" SP | 0.15" SP | Motor RPM | Volts | HP | Max HP† | Stock No | List | Each | Shpg Wt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48" | 2 | 20 160/21 5 | 18,650/19 2 | 17,175/17 2 | 15,075/14 7 | 850 | 230 | 1 | 0 97 | 3F521 | $1177.50 | $785.00 | 200 0 |

†BHP (Brake Horsepower) is maximum horsepower required at the air delivery shown.

## 36 AND 48" DIRECT-DRIVE STRAIGHT-WALL FANS






- High volume, heavy-duty wall mounted fan
- Galvanized steel venturi panel, housing and 2 blade propeller are designed for extended life in high humidity and corrosive conditions
- Totally enclosed motor with automatic reset thermal protection

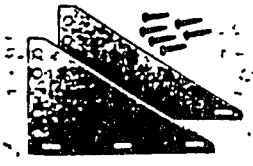
Direct drive, wall mounted unit for ventilating livestock and poultry houses Fan comes completely assembled motor has wire leads for fast installation and connection

Moisture resistant TENV, 230V, 60 Hz ball bearing, permanent split capacitor motor Shaft and bearing slinger keeps out dirt and moisture

**WARNING** OSHA complying guards are strongly recommended when fan is installed within 7 ft of floor, working level, or within reach of personnel-Review of OSHA codes.

| Blade Dia | No of Blades | CFM @ RPM Shown/CFM per Watt Free Air | 0.05" SP | 0.10" SP | 0.125" SP | 0.15" SP | RPM | Volts | HP | Stock No | List | Each | Shpg Wt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36" | 2 | 9620/20 3 | 9040/18 6 | 8295/16 4 | 7930/15 4 | 7570/14 5 | 850 | 230 | 1/2 | 3F527 | $768 00 | $508.00 | 96 0 |
| 48 | 2 | 19010/20 0 | 17660/18.1 | 16555/16 8 | 16005/16 1 | 15385/15 3 | 850 | 230 | 1 | 3F525 | 1016 00 | 672.00 | 195 0 |

## POULTRY FAN HANGING BRACKET

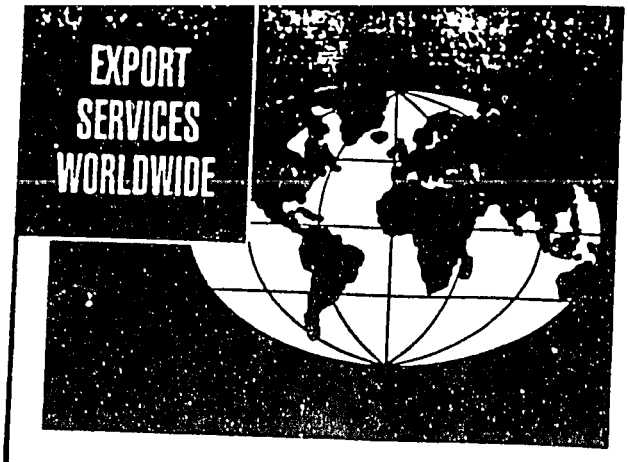


- Replaces eyebolts, simplifies poultry fan installation
- All galvanized construction resists corrosion
- For use with all Dayton crate mounted poultry fans

Sold in pairs in boxes of 50

No. 3F522 Shpg wt. 27 0 lbs List $447 00
Per Box of 50 Pairs $298 00

SEE WARRANTY INFORMATION ON PAGE OPPOSITE INSIDE BACK COVER

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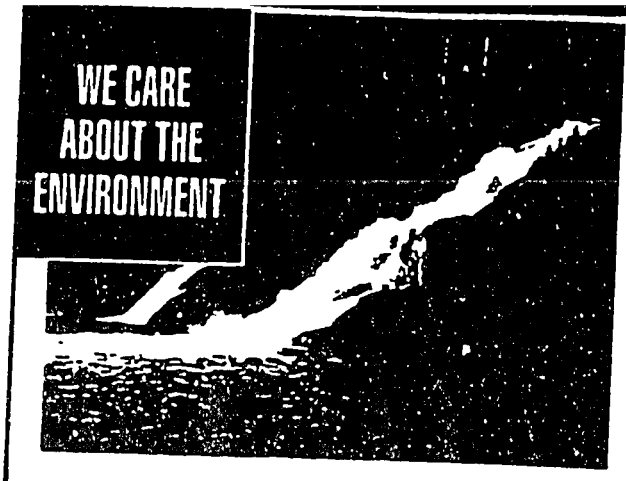


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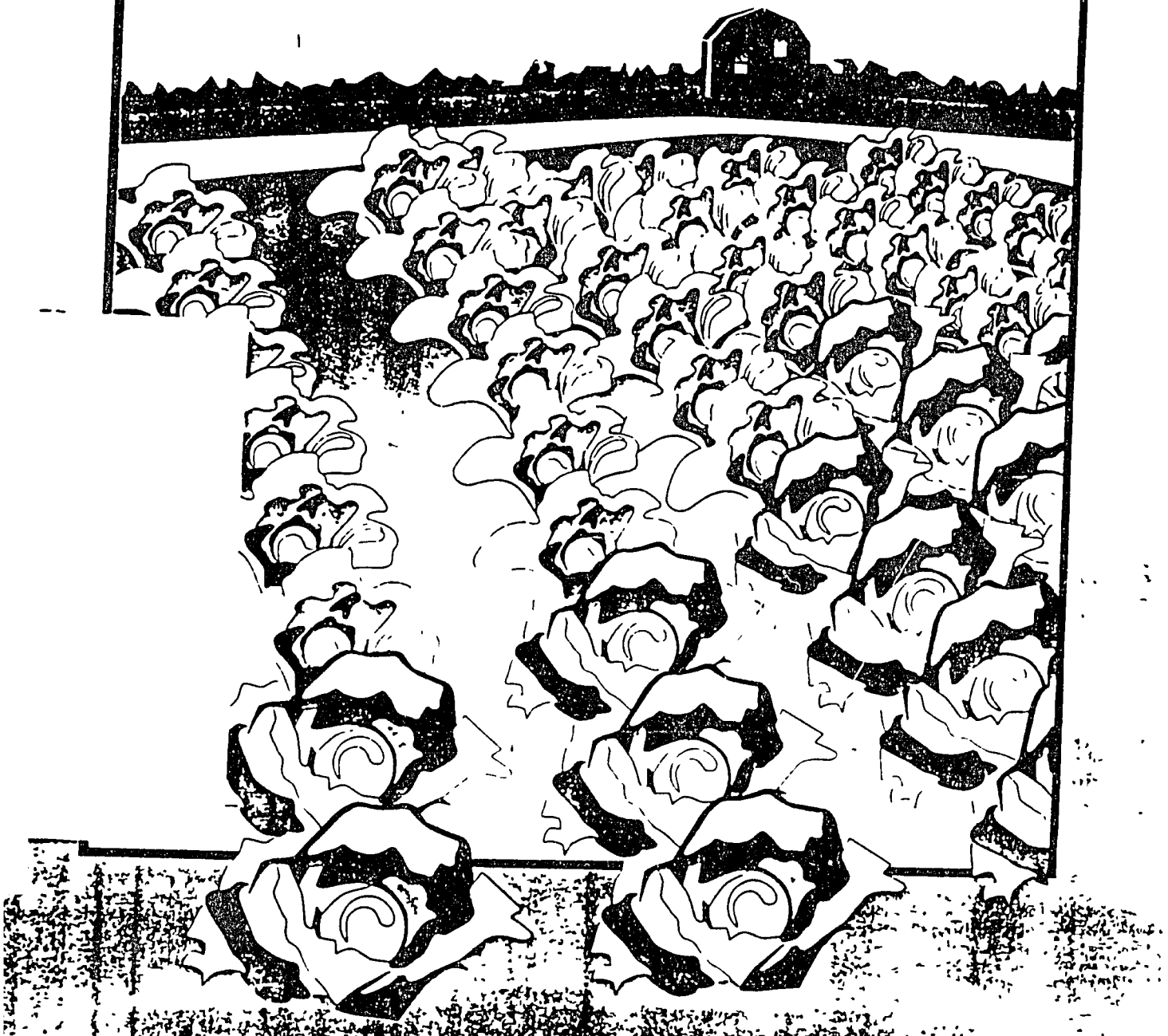

# '93 BUYERS' GUIDE

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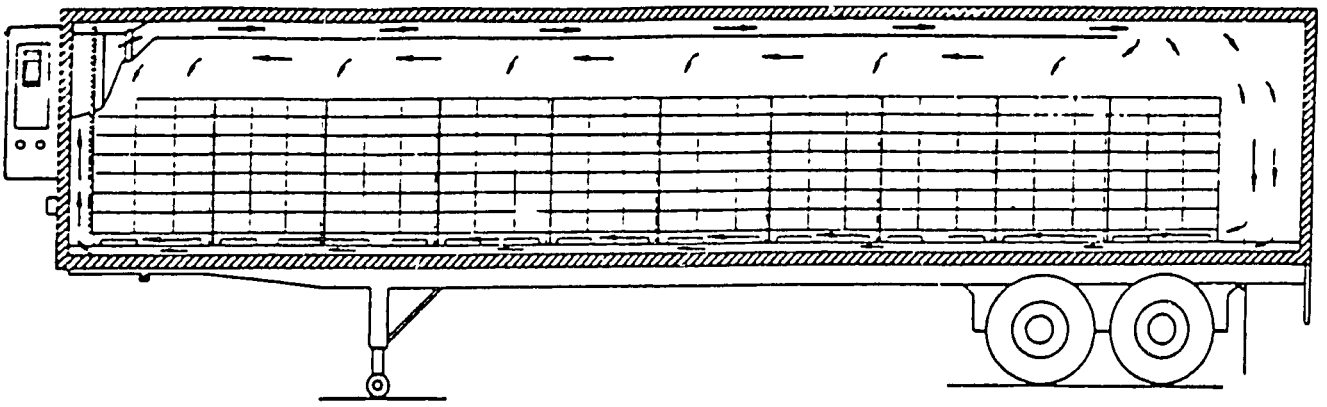
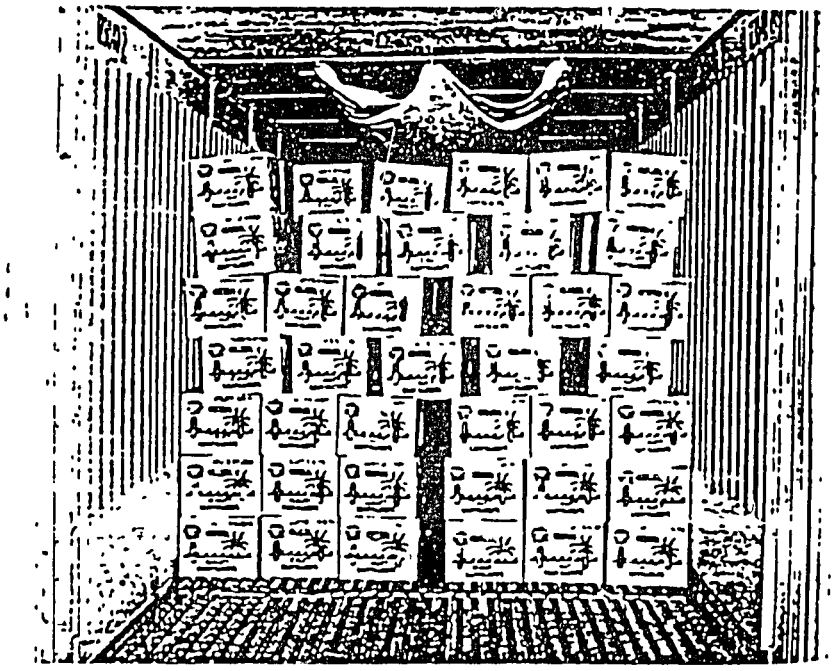


**Fig. 13.** *Top:* Air circulation in and around a solid load directly on the trailer floor.



Un patron de carga para flujo de aire horizontal fue empleado en este contenedor refrigerado cargado con cantalupos.

Figure 1 b.

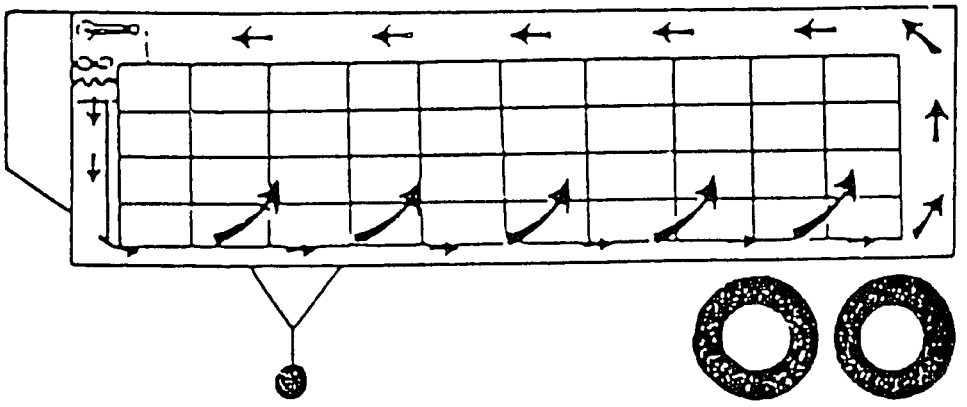


Fig. 2. Air circulation in a bottom-air circulation trailer.

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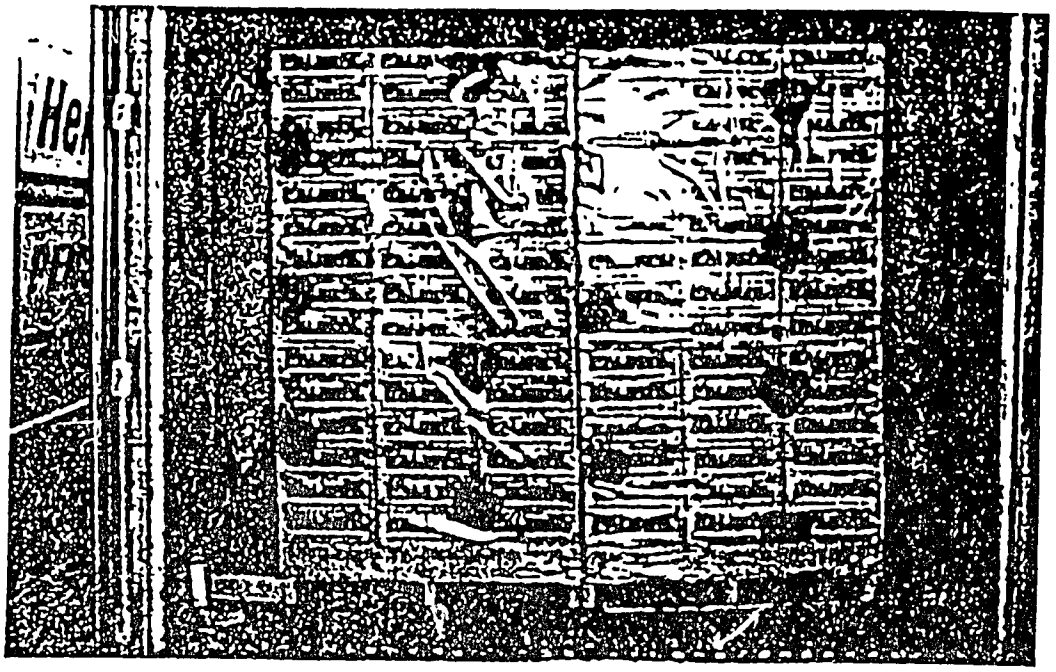
Figure 3.



Un patron de carga en linea central es empleado para embarques de cargas unitarias de fresas en remolques con paredes laterales planas. Las fresas estan cubiertas con bolsas de plastico para tarimas e inyectadas con una atmosfera modificada con altos niveles dioxido de carbono. Las tarimas estan apuntaladas una contra la otra por bolsas de aire inflables de papel kraft y con maderos.

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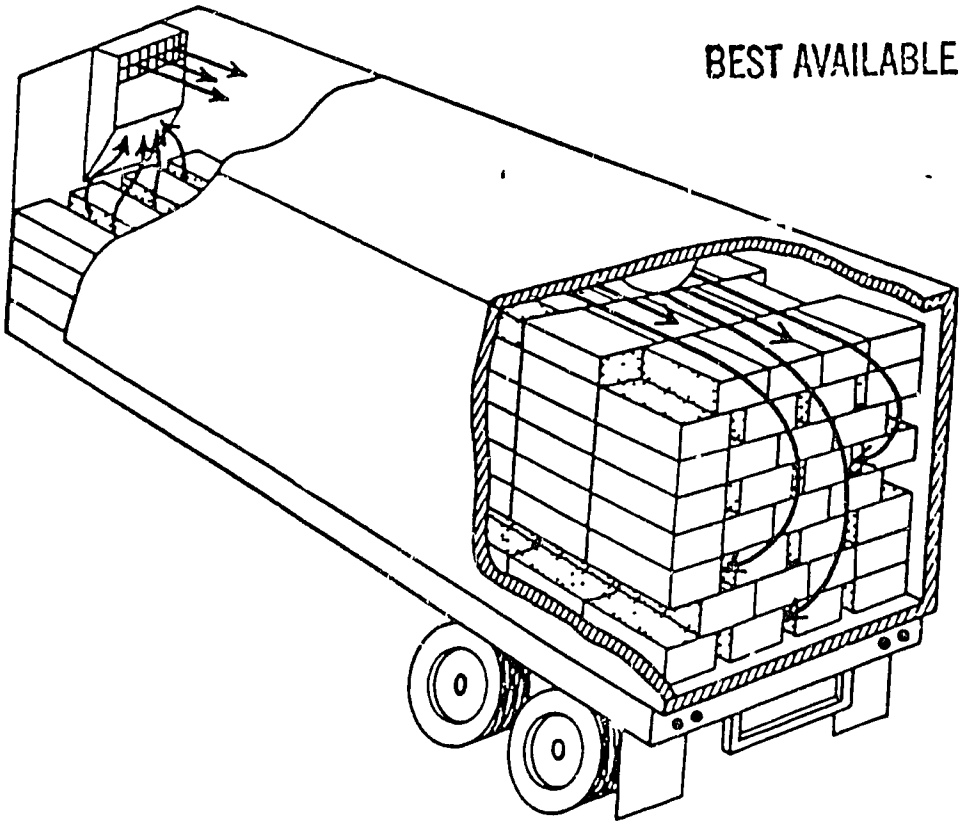

Figure 4 .--Pigeon hole pattern with channels in alternate layers and channels down side wall.

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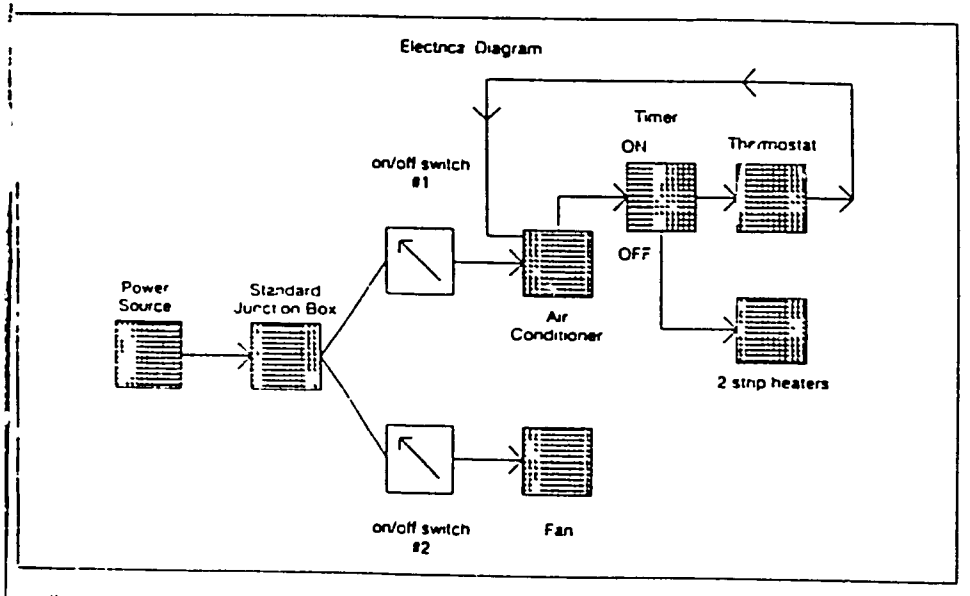



All electrical components should be properly grounded and wiring should comply with national and local electrical codes. Consult a licensed electrician for more information about how to install any components of the electrical system.

The Portacooler can be powered from either an electrical wall outlet or a gasoline powered generator. The main electrical connection from the power source is split to the individual switches. From the switches, the power travels to the blower and to the air conditioner. The strip heaters and the thermostat are wired from the timer. The timer creates a defrost cycle by alternating power from the compressor to the strip heaters. (An interval of compressor shutdown time should be approximately 2.5 minutes during every 10 minutes.)

Once the cooler is assembled and the electrical components hooked up, mount the air flow bulkhead. Mount the bulkhead with blower discharge hole flush with the edge of the blower discharge, allowing a 6 inch high return air gap along the floor.

All wood surfaces should be coated with polyurethane and an all weather sealer to prolong the useful equipment life.

When completed, the Portacooler will provide farmers and small marketers with an inexpensive way to remove field heat and prolong the shelf life of their fruits and vegetables.

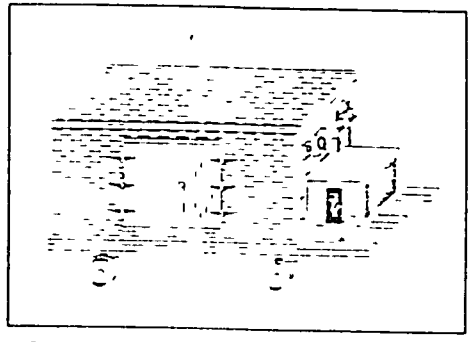
**General Material List**

| | |
|---|---|
| ❑ air conditioner 12,000 Btu 115 V | 1 |
| ❑ centrifugal blower 1/3 hp 1210 c f m | 1 |
| ❑ 20 amp wall switch with boxes and covers | 2 |
| ❑ 4 by 8 ft exterior AC 1/4 in plywood | 11 |
| ❑ lumber 2 by 3 in 8 ft long | 30 |
| ❑ lumber 2 by 4 in 12 ft long | 3 |
| ❑ lumber 2 by 6 in 8 ft long | 1 |
| ❑ industrial wheels 5 in diameter | 2 |
| ❑ industrial wheels 5 in diameter swivel | 2 |
| ❑ dry wall screws 2 1/2 in long | 5 lb |
| ❑ dry wall screws 1 in long | 1 lb |
| ❑ water sealer | 1 gal |
| ❑ polyurethane coating | 1 gal |
| ❑ weather stripping 1 in wide roll | 1 |
| ❑ insulation 2 in 4 by 8 ft sheets | 5 |
| ❑ 1/4 in plywood 4 in wide strips | 12 ft |
| ❑ door latch sliding bolt | 2 |
| ❑ thermostat 115 V 16 amp remote bulb | 1 |
| ❑ strap hinges screw fastened 3 in long | 4 |
| ❑ lumber 2 by 10 in 4 ft long | 1 |
| ❑ standard junction box | 1 |
| ❑ strip heaters 150 watt 8 in 115 V | 2 |
| ❑ insulated wire | 20 ft |
| ❑ cycle timer SPDT 115 V 20 amp 1 hour | 1 |

United States Department of Agriculture

# Transportation Tip

## The Portacooler



*A Portable, Inexpensive, Farm Built Precooler*

From the time of harvest, fruits and vegetables begin a natural decline in quality. When a product is harvested, field heat—the heat that the product holds from the sun and outside temperature—is usually high, which results in an increased rate of respiration and greater deterioration. This decrease in quality cannot be prevented, but can be slowed by rapid temperature reduction or precooling soon after harvesting.

Farmers and marketers can protect their harvested fruits and vegetables, such as berries and other high value crops, by building and using their own portable precooler. The Portacooler can easily be utilized by small farmers and roadside marketers.

The design of the Portacooler is simple. It can be built with tools commonly found in most workshops. A hammer, drill, screwdriver, circular saw, and a few other construction essentials are the only tools needed for the project. Most of the materials can be found around the farm, bought from a local hardware store, or purchased from an equipment catalog. A general list of the materials is on page 4.

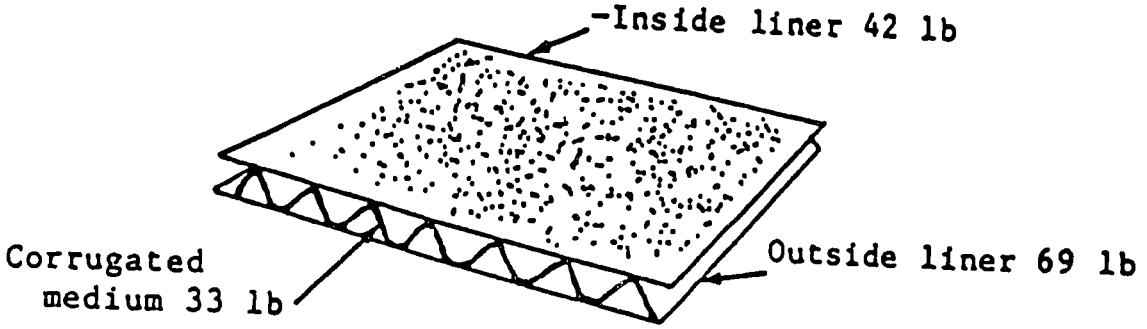
The material cost for construction should be around $1,200 (July 1997 prices). Since an air conditioner is the most expensive component, a used air conditioner will greatly decrease the $1,200 initial investment. The initial cost can be expected to be recovered through increased sales and profits from a higher quality product that has a longer shelf life.

The structure of the Portacooler is a basic wood frame and plywood panel construction (see diagram on inside pages). The outside dimensions of the cooler are 4 feet high by 4 feet wide by [illegible] feet long. The frame is made of 2 by 2's spaced 2 feet on center, excluding the doorway and the air conditioner space. The frames are sheathed with 1/4 inch plywood. The frame and sheathing are fastened using 2 1/2 inch and 1 inch dry wall screws respectively. Insulate the precooler with 2 inch thick plastic foam that fits firmly between the frame studs.

After the frame and sheathing steps are completed, install the electrical components (see diagram on page 4). The standard junction box, power switches, daily cycle timer, and industrial thermostat control box should be mounted on the outside of the front wall near the air conditioner. An adjustable industrial thermostat must be connected to the air conditioner to replace the existing thermostat. Mount strip heaters using copper wire so that they contact the cooling coils of the air conditioner. Mount the blower on the front inside wall centered above the air conditioner so that the blower discharge is 12 inches below the inside ceiling.

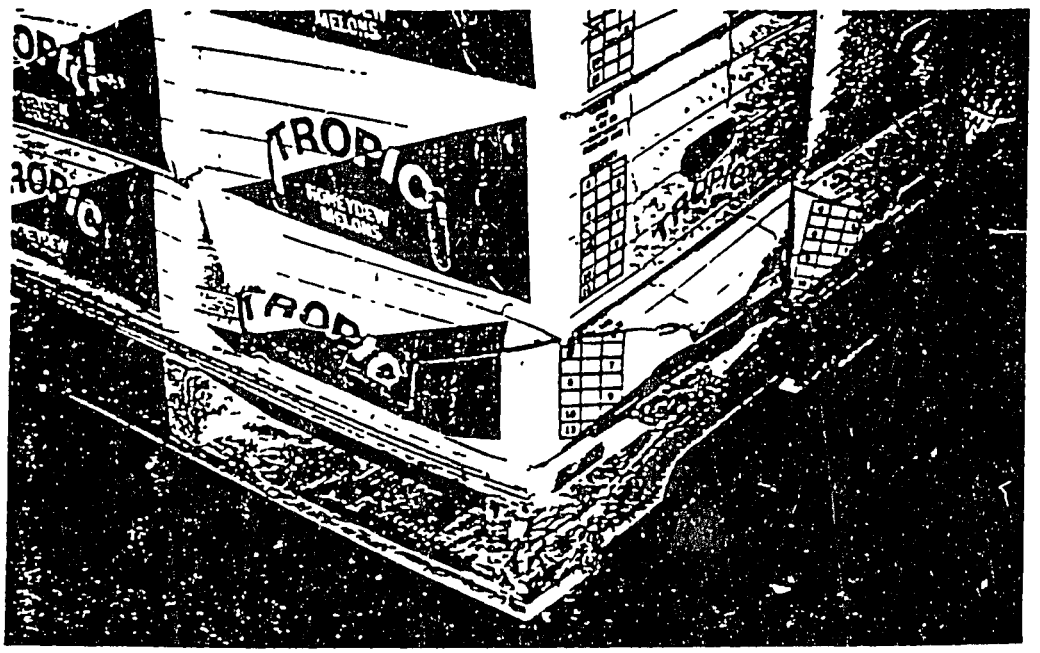
*USDA/ARS is conducting final tests of the Portacooler. Identical coolers are located on farms in different States. A publication will be released in early 1994 with information on precooling, compilation and analysis of the collected data, grower comments, and an economic analysis.*

*The design, construction, and research was conducted by Joseph Anthony, Gerald Berney, William Craig, and Daniel P. Scholer. For further information, contact USDA-Agricultural Marketing Service-TMD, Distribution Service Branch, P.O. Box 96456, Washington, D.C. 20090-6456 or call (202) 720-8357 or (301) 504-3084.*




Single wall corrugated

Figure 1.




**Compresion. Estas cajas de melones no tienen suficiente fuerza para resistir mucho manipuleo y el peso de los demas contenedores encima.**

Figure 2.

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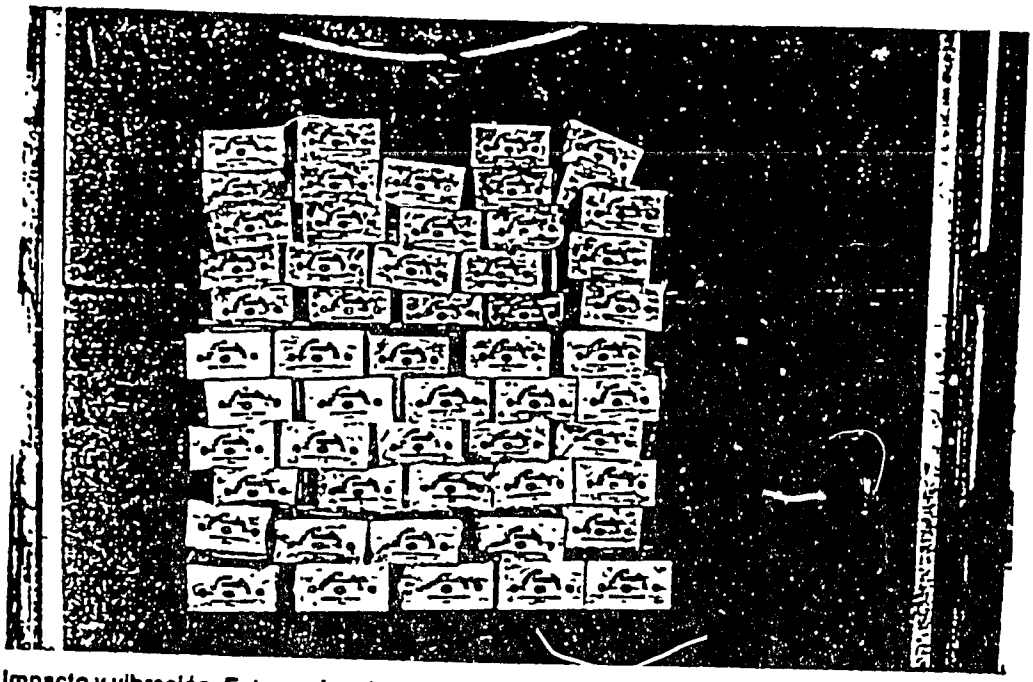
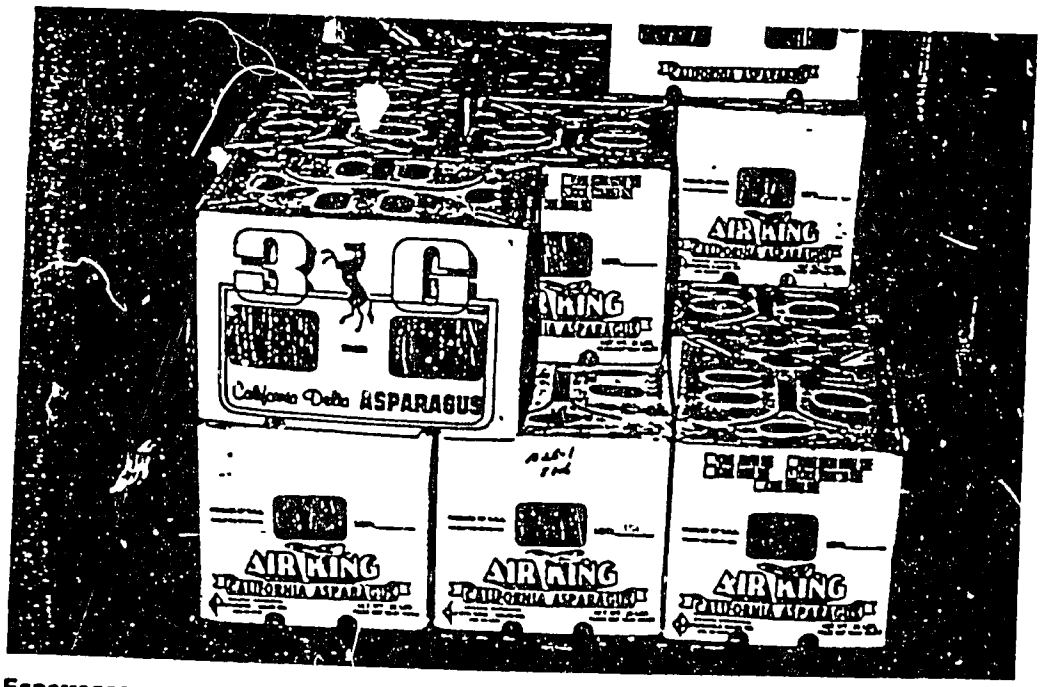
Figure 3.



Impacto y vibración. Estas cajas de melones se movieron durante el transporte. Las cajas no tienen suficiente fuerza de compresión para el apilamiento traslapado que se empleó para proporcionar suficiente circulación de aire entre la cajas.




Esparragos empacados verticalmente en cajas de plancha de fibra impregnadas de cera, totalmente telescopiables con apertura para permitir la ventilación del calor de la respiración del producto. Una almohadilla humeda se encuentra en el fondo de la caja.

Figure 4.

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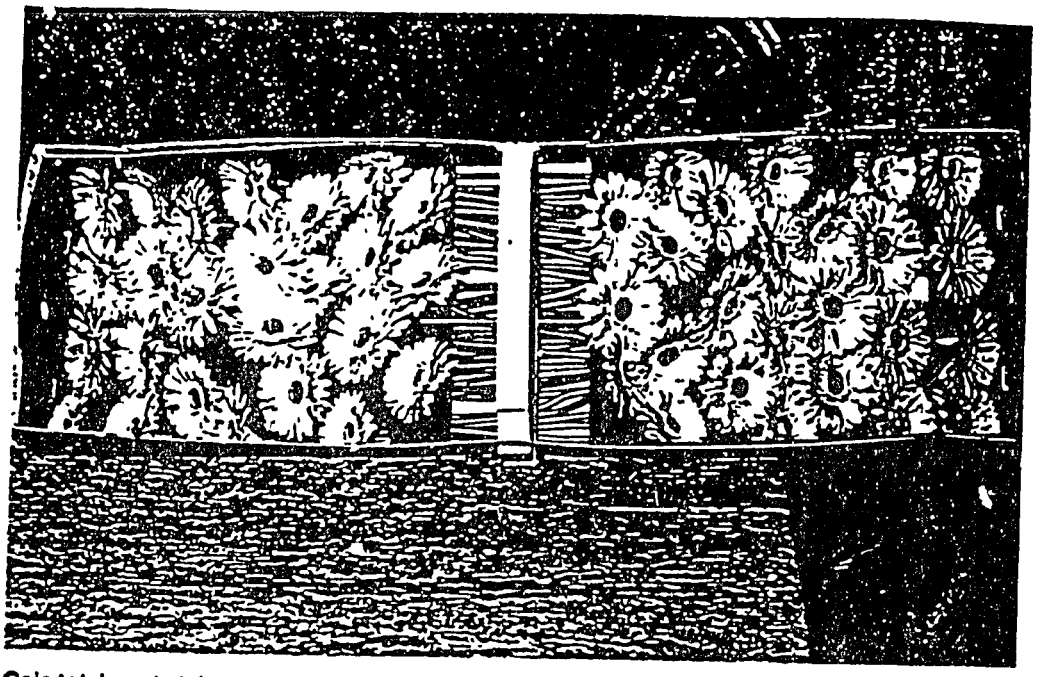
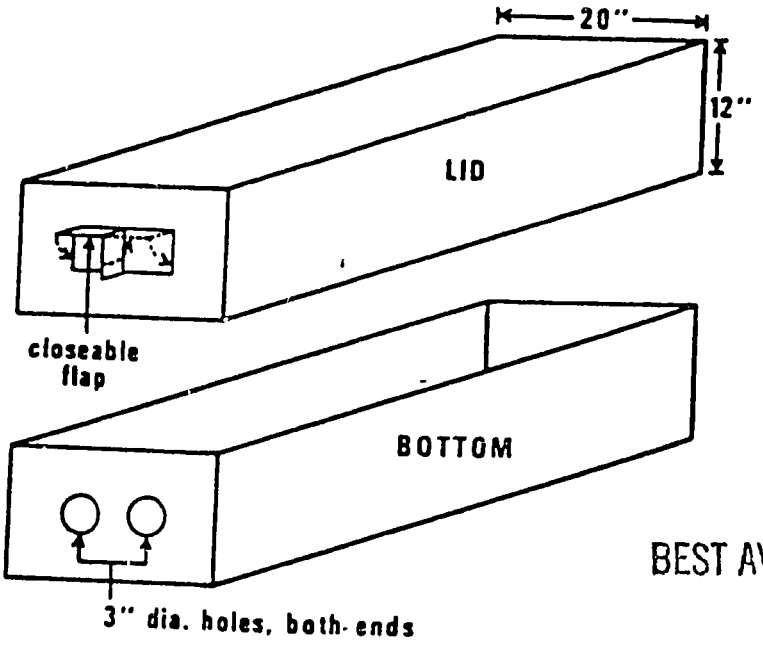
Figure 5.



Caja totalmente telescopiable de margaritas gerbera. Cada tallo se pasa a través de un agujero de un sostén de plancha de fibra que posteriormente se engrapa a los lados de la caja. Los tallos son asegurados por una abrazadera de espuma de poliestireno que también proporciona fuerza de compresión a la caja cuando se apila.

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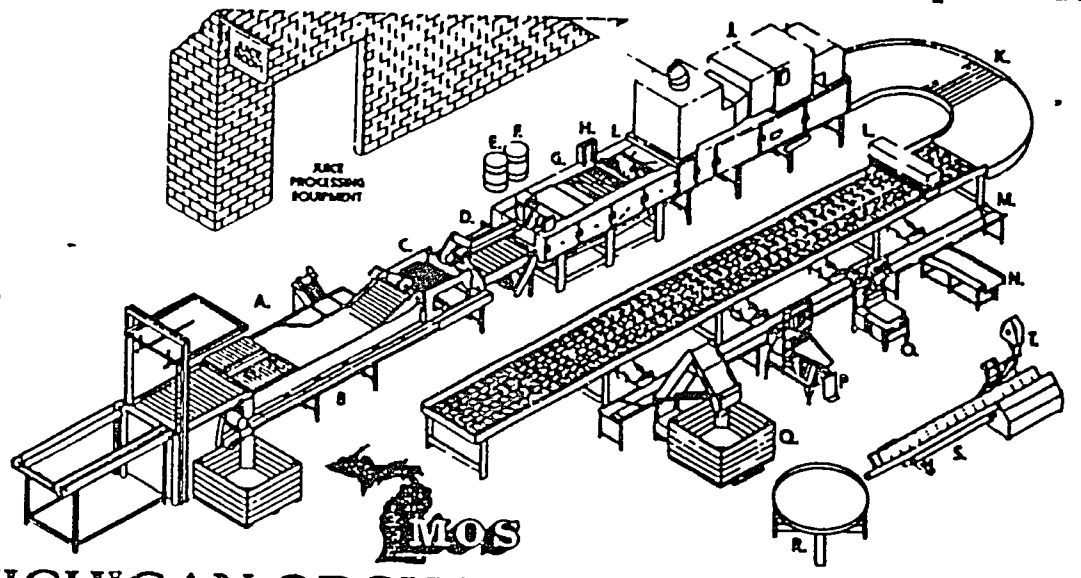
Full telescope design box with vent holes

Figure 6.

# FRUIT & VEGETABLE, PACKING & PROCESSING EQUIPMENT

A. WATER DUMPER
B. CONVEYORS
C. CHAIN SIZE
D. SORTING ROLLS
E. CLEANERS
F. WAX
G. WASHER
H. WATER ELIMINATOR
I. WAXER
J. HOT AIR DRYER
K. POWER TURNS
L. COMPUTERIZED SIZER • COLOR SORTING
M. TWO WAY BELT
N. TRAY PACKER
O. CARTON FILLER
P. ELECTRONIC BAGGER
Q. BIN FILLER
R. ROUND TABLE
S. BAG CONVEYOR
T. BAG CLOSURES

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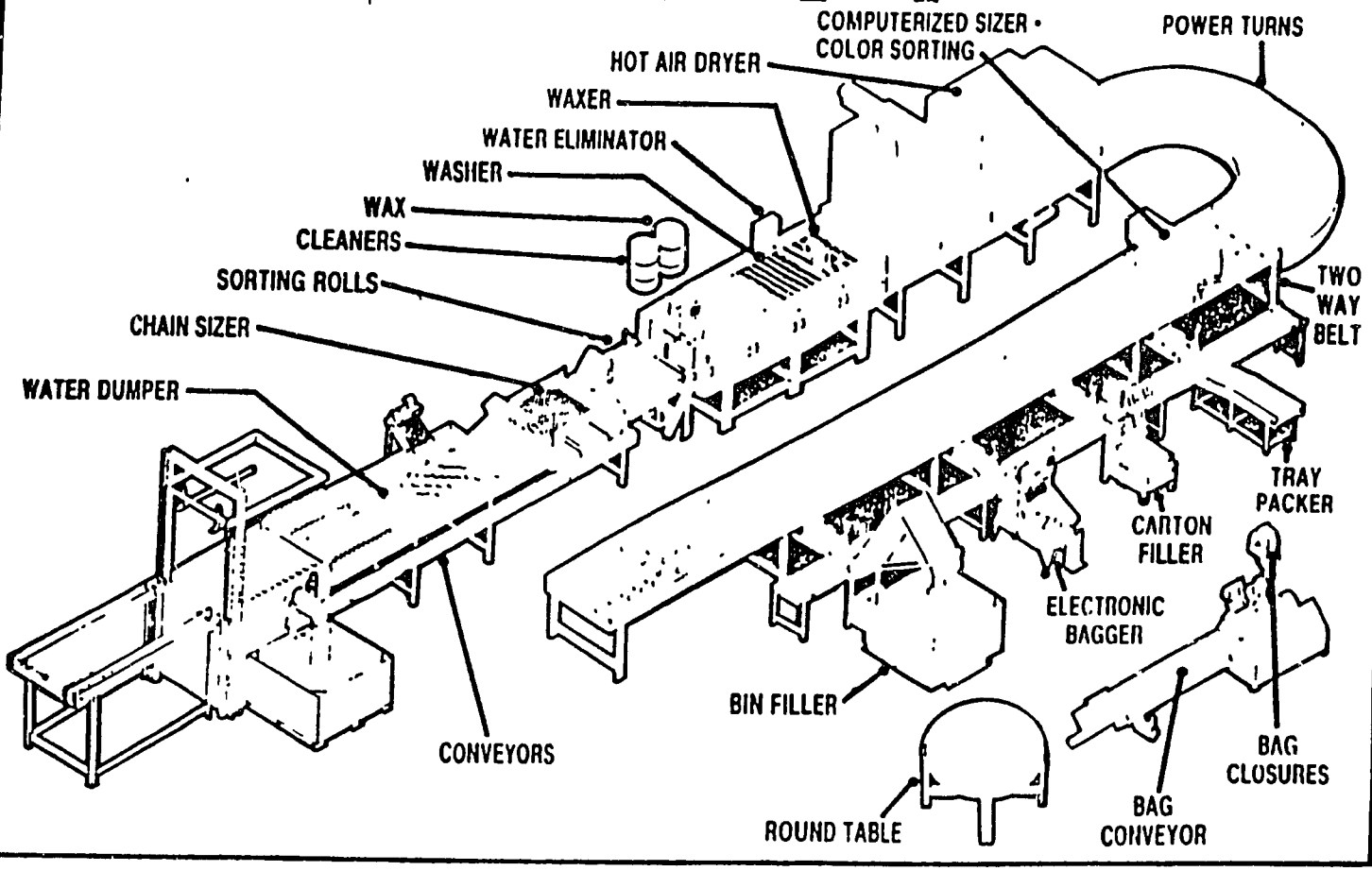


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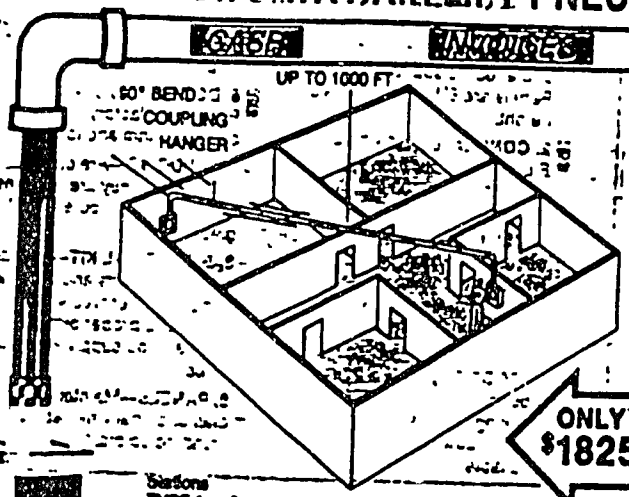
# QUALITA TWO WAY AIR-LIFT PNEUMATIC CONVEYOR




- SPEED-25 Feet per Second
- DISTANCE-Up to 1,000 Feet
- CAPACITY-Up to 1 lb. per carrier
- CARRIER-Useable 2¼" x 10"

**SIMPLE TO OPERATE**

Cargo is loaded in plastic carrier, inserted in the station and press the button. This starts a positive air flow which quickly pushes the carrier to the opposite station. Once the carrier reaches its destination the system shuts off and a signal light tells the person at the other end that the carrier has arrived.

**ONLY $1825**

**SIMPLE TO INSTALL**
NO TECHNICIANS
NO SPECIAL TOOLS

1. Mount two stations
2. Install straight tube
3. Install 90° turns
4. Plug in station, 115V
5. Start to use

No interconnecting wiring
No special fitting

Stations
TYPE 1 or 2
16 GA. steel
automatic door lock and red signal light indicate carrier in transit

White light indicates carrier is in station

TYPE 1 STATION
9¼"W x 10¼"D x 28¼"H

**STK. NO. 503AC-1 $1825 FOB FL**
**COMPLETE SYSTEM INCLUDES**

- Two stations. Specify TYPE 1 or TYPE 2
- Four 10" x 3" carriers
- 100 feet of PVC tubing (ten 10' lengths)
- Two 90° bends
- Couplings, hangers and hardware

**OPTIONAL EQUIPMENT**

TUBING - 10' long with coupling and hanger, per running ft. ..... $1.93
90° BENDS
45° radius w/2 couplings ..... $39.00
24" radius w/2 couplings ..... 39.00
Extra carriers 10" x 3" .....ea. 13.15

TYPE 2 STATION
17¼"W x 9¼"D x 15¼"H

# RAN-FLEX ACCORDIAN SKATE CONVEYOR

Cut Your Handling Costs! Our conveyor extends up to 4 times its minimum length, it goes around corners it bends in either direction around a 12" radius, moves easily on 5" diam. swivel casters with lock. It's height is adjustable from 28" to 44". It's 44" height allows conveyor to reach the floor level of most delivery trucks. With the optional 5' swing stick that extends the conveyor right into a 45' trailer a 24' long conveyor can be used to unload trucks from ground level.

**CHOOSE FROM 3 TYPES OF WHEELS:** Red Nylon with sleeve bearings, Blue Plastic with Ball bearings, Steel Skates with ball bearings.

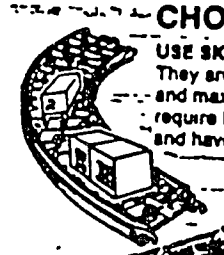
| Stock Number | Adj. Lgth | Width | Capac. per Ft. | Skate Wheels Per Side | Wt Lbs. | -01 Nylon Net Ea. | -02-Plastic Net Ea. | -03 Steel Net Ea. |
|---|---|---|---|---|---|---|---|---|
| 14221 | 2'-8' | 14" | 175 lbs. | 7 | 150 | $291 | $321 | $347 |
| 14222 | 3'-12' | | | | 180 | 536 | 585 | 621 |
| 14223 | 4½'-18' | | | | 220 | 725 | 787 | 835 |
| 14224 | 6'-24' | | | | 250 | 921 | 1011 | 1370 |
| 14225 | 2'-8' | 18" | 175 lbs. | 8 | 240 | $347 | $364 | $380 |
| 14226 | 3'-12' | | | | 270 | 612 | 651 | 690 |
| 14227 | 4½'-18' | | | | 310 | 844 | 913 | 988 |
| 14228 | 6'-24' | | | | 350 | 1106 | 1182 | 1242 |
| 14229 | 2'-8' | 24" | 175 lbs. | 9 | 260 | $420 | $454 | $488 |
| 142210 | 3'-12' | | | | 300 | 787 | 819 | 879 |
| 142211 | 4½'-18' | | | | 350 | 1062 | 1161 | 1225 |
| 142212 | 6'-24' | | | | 400 | 1487 | 1599 | 1701 |

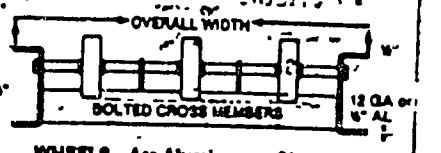
OPTIONAL Swing Stick Steelwheels, 14" Wide 142214ST $285, 18" Wide 142218ST $220.

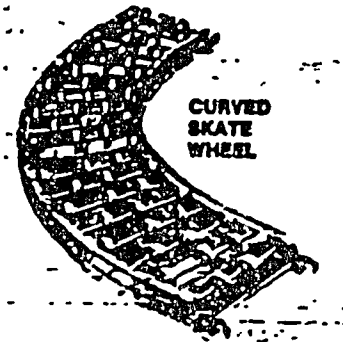
# GRAVITY WHEEL CONVEYOR

## CHOICE OF STEEL OR ALUMINUM

**USE SKATE WHEEL WITH PRODUCTS WITH FLAT BOTTOMS**
They are used where fast installation and maximum versatility is desired. They require less pitch than roller conveyor and have better tracking.



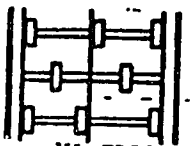



**WHEELS**—Are Aluminum or Steel 1 15/16" diam. sealed ball bearings with hardened raceways. Axles are 1/4" diam. galvanized steel bolt w/lock nut.

**FRAMES**—Are 2½"H x 1"W channel.
**STEEL**—is 12 gauge galvanized steel.
**ALUMINUM**—is ⅛" thick heat treated formed channel. Both types come with bolted cross members and hook on one end and rod on other.

**CAPACITY**—
**STEEL UNITS**—50 Lbs. per wheel. Frame is 60 Lbs. per foot.
**ALUMINUM UNITS**—25 Lbs. per wheel. Frame is 45 Lbs. per foot.



The selection of wheels per foot is determined by your smallest package. There should be a minimum of six wheels under item.

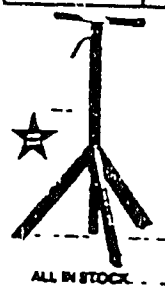
## STRAIGHT SECTIONS 5' or 10' LONG

FOB ARK

| OVERALL WIDTH | WHEELS PER FT | 10' LONG CONVEYOR MODEL NO. | WT. | PRICE | 5' LONG CONVEYOR MODEL NO. | WT. | PRICE |
|---|---|---|---|---|---|---|---|
| **STEEL WHEEL CONVEYOR** | | | | | | | |
| 12" | 10 | 1800S12110• | 70 | $121.00 | 1800S1215• | 37 | 64.00 |
| | 12 | 1800S12210 | 74 | 131.00 | 1800S1225 | 39 | 69.00 |
| 18" | 12 | 1800S18310 | 78 | 147.00 | 1800S1835 | 41 | 78.00 |
| | 16 | 1800S18410• | 88 | 197.00 | 1800S1845• | 44 | 87.00 |
| 24" | 18 | 1800S24510 | 98 | 186.00 | 1800S2455 | 52 | 98.00 |
| | 20 | 1800S24610• | 105 | 206.00 | 1800S2465• | 57 | 107.00 |
| **ALUMINUM WHEEL CONVEYOR** | | | | | | | |
| 12" | 10 | 1800A12110• | 37 | 101.00 | 1800A121• | 20 | 64.00 |
| | 12 | 1800A12210 | 39 | 174.00 | 1800A122 | 21 | 90.00 |
| 18" | 12 | 1800A18310 | 42 | 192.00 | 1800A183 | 22 | 101.00 |
| | 16 | 1800A18410• | 46 | 218.00 | 1300A184• | 25 | 113.00 |
| 24" | 18 | 1800A24510 | 51 | 242.00 | 1800A245 | 28 | 126.00 |
| | 20 | 1800A24610• | 55 | 268.00 | 1800A246• | 30 | 140.00 |

## CURVED SECTIONS 4' OUTSIDE RADIUS

| OVERALL WIDTH | DEGREE OF CURVE | MODEL NUMBER | WT. LBS. | PRICE EACH |
|---|---|---|---|---|
| **STEEL WHEEL CONVEYOR** | | | | |
| 12" | 90° | 1800SC1290• | 70 | $118.00 |
| | 45° | 1800SC1245• | 36 | 71.00 |
| 18" | 90° | 1800SC1890• | 80 | 152.00 |
| | 45° | 1800SC1845• | 43 | 92.00 |
| 24" | 90° | 1800SC2490• | 92 | 188.00 |
| | 45° | 1800SC2445• | 49 | 114.00 |
| **ALUMINUM WHEEL CONVEYOR** | | | | |
| 12" | 90° | 1800AC1290• | 44 | 153.00 |
| | 45° | 1800AC1245• | 22 | 90.00 |
| 18" | 90° | 1800AC1890• | 50 | 189.00 |
| | 45° | 1800AC1845• | 26 | 114.00 |
| 24" | 90° | 1800AC2490• | 54 | 231.00 |
| | 45° | 1800AC2445• | 29 | 141.00 |



ALL IN STOCK

## ADJUSTABLE HT. TRIPOD STAND

For fast installation of gravity wheel or 1⅝" diameter roller conveyor. Always order one more stand than conveyor sections. Shipped via truck only. FOB ARK

| ADJUST. RANGE | 12" WIDE MODEL NO. | 18" WIDE MODEL NO. | 24" WIDE MODEL NO. | PRICE EACH |
|---|---|---|---|---|
| 9" TO 15" | W1800T12-1 | W1800T18-1 | W1800T24-1 | $23.00 |
| 15" TO 27" | W1800T12-2 | W1800T18-2 | W1800T24-2 | 24.00 |
| 21" TO 37" | W1800T12-3 | W1800T18-3 | W1800T24-3 | 25.00 |
| 27" TO 49" | W1800T12-4 | W1800T18-4 | W1800T24-4 | 28.00 |
| 37" TO 69" | W1800T12-5 | W1800T18-5 | W1800T24-5 | 30.00 |
| 57" TO 107" | W1800T12-6 | W1800T18-6 | W1800T24-6 | 37.00 |

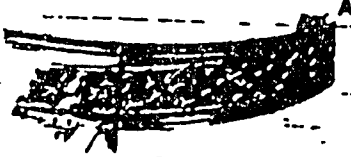
ALL IN STOCK

## ADJUSTABLE "H" SUPPORTS

For permanent installation. Channel construction with pivot plate that bolts to conveyor rail. Base may be bolted to floor. All in stock. FOB ARK

HEIGHT IS TO TOP OF SUPPORT

| ADJUST. RANGE | 12" WIDE MODEL NO. | 18" WIDE MODEL NO. | 24" WIDE MODEL NO. | PRICE EACH |
|---|---|---|---|---|
| 10" TO 13" | W1800H12 | W1800H22 | W1800H32 | $20.00 |
| 13" TO 16" | W1800H13 | W1800H23 | W1800H33 | 22.00 |
| 16" TO 22" | W1800H14 | W1800H24 | W1800H34 | 23.00 |
| 20" TO 26" | W1800H15 | W1800H25 | W1800H35 | 26.00 |
| 24" TO 30" | W1800H16 | W1800H26 | W1800H36 | 28.00 |
| 34" TO 46" | W1800H17 | W1800H27 | W1800H37 | 30.00 |



## ADJUSTABLE GUARD RAIL

Prevent packages from sliding off wheel conveyor.
Inner and outer rails for curved and straight sections. Adjust up/down and in/out.

FOB ARK

| TYPE OF CONVEYOR | ONE GUARD RAIL OUTSIDE | PRICE | PAIR OF GUARDS BOTH SIDES | PRICE |
|---|---|---|---|---|
| 90° CURVE | 1800GC81• | $52.00 | 1800GC82• | $82.00 |
| 45° CURVE | 1800GC41 | 43.00 | 1800GC42 | 67.00 |
| 10' LONG | 1800GC101• | 44.00 | 1800GC102• | 83.00 |
| 5' LONG | 1800GC51 | 22.00 | 1800GC52 | 32.00 |

## CONVEYOR FLOW RAILS

You can create your own conveyor system or floor rack by using our galvanized steel rails with 1 5/16" wheels on 3" centers.

| MODEL NUMBER | CAPACITY | 16' LONG PRICE |
|---|---|---|
| 1800RA• | 60 lbs. | $38.00 |
| 1800RC• | 180 lbs. | 41.00 |
| 1800RU• | 140 lbs. | 38.00 |

MODEL 1800 RA — MODEL 1800 RC — MODEL 1800 RU

## HOW TO ORDER

SUPPORTS—Order one or more than total number of conveyor sections.

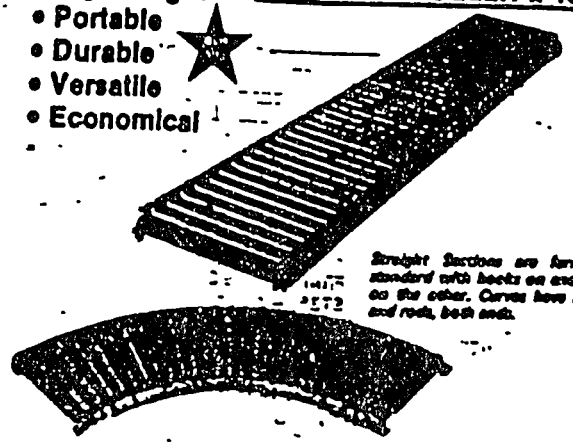
**SUGGESTED PITCHES FOR WHEEL CONVEYOR**

| LOAD WT. | PITCH/CONVEYOR |
|---|---|
| 3-7 LBS. | 7½" PER 10' |
| 8-15 LBS. | 6¼" PER 10' |
| 16-50 LBS. | 5" PER 10' |

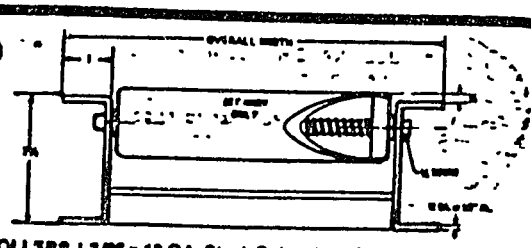
# GRAVITY ROLLER CONVEYOR

- Lightweight
- Portable
- Durable
- Versatile
- Economical

**1⅜" DIAM. ROLLER x 18 GA.**



*Straight Sections are furnished standard with hooks on end, rods on the other. Curves have hooks and rods, both ends.*



**ROLLERS** 1 3/8" x 18 GA. Steel, Galvanized Steel, or heat treated Aluminum tubing with smooth swaged ends.
**FRAMES** Formed Galvanized Steel Channel 2 1/2" x 1" x 12 GA., formed heat-treated Aluminum channel 2 1/2" x 1" x 1/8".
**BEARINGS** Integral plain ball bearings, zinc plated, grease packed.
**COUPLINGS** Hook and Rod
**AXLES** 1/4" dia. galvanized steel shaft, spring loaded.
**CAPACITY STEEL**—50 lbs. per roller or max. distributed live load of 750 lbs per 10' section or 1200 lbs. per 5' section.
**ALUMINUM**—35 lbs. per roller or max. distributed live load of 500 lbs. per 10' section or 800 lbs. per 5' section.

## STRAIGHT SECTIONS—5' or 10' LONG

FOB ARK.

### STEEL ROLLER—STEEL FRAME

| OVERALL WIDTH | ROLLER CENTERS | MODEL NO. | 10' LENGTH WT | 10' LENGTH PRICE | 5' LENGTH WT | 5' LENGTH PRICE |
|---|---|---|---|---|---|---|
| 12" | 1½" | • 138G-12-1.5 | 100 | $229.00 | 53 | $118.00 |
| | 3" | • 138G-12-3 | 73 | 135.00 | 39 | 70.00 |
| | 4½" | • 138G-12-4.5 | 62 | 105.00 | 33 | 55.00 |
| | 6" | • 138G-12-6 | 55 | 89.00 | 30 | 47.30 |
| | 9" | • 138G-12-9 | 50 | 78.00 | 29 | 43.00 |
| | 12" | • 138G-12-12 | 48 | 68.00 | 25 | 36.00 |
| 18" | 1½" | • 138G-18-1.5 | 140 | $277.00 | 77 | $143.00 |
| | 3" | • 138G-18-3 | 87 | 163.00 | 51 | 85.00 |
| | 4½" | • 138G-18-4.5 | 73 | 125.00 | 42 | 65.00 |
| | 6" | • 138G-18-6 | 67 | 105.00 | 35 | 57.00 |
| | 9" | • 138G-18-9 | 58 | 90.00 | 30 | 50.00 |
| | 12" | • 138G-18-12 | 54 | 71.00 | 23 | 42.00 |
| 24" | 1½" | • 138G-24-1.5 | 180 | $329.00 | 86 | $168.00 |
| | 3" | • 138G-24-3 | 115 | 190.00 | 61 | 100.00 |
| | 4½" | • 138G-24-4.5 | 92 | 145.00 | 43 | 78.00 |
| | 6" | • 138G-24-6 | 81 | 121.00 | 43 | 65.00 |
| | 9" | • 138G-24-9 | 71 | 104.00 | 33 | 56.00 |
| | 12" | • 138G-24-12 | 64 | 86.00 | 35 | 47.00 |

### ALUMINUM ROLLER—ALUM. FRAME

| OVERALL WIDTH | ROLLER CENTERS | MODEL NO. | 10' LENGTH WT. | 10' LENGTH PRICE | 5' LENGTH WT | 5' LENGTH PRICE |
|---|---|---|---|---|---|---|
| 12" | 1½" | 138A-12-1.5 | 52 | $285.00 | 28 | $148.00 |
| | 3" | 138A-12-3 | 34 | 175.00 | 19 | 91.00 |
| | 4½" | 138A-12-4.5 | 28 | 140.00 | 16 | 71.00 |
| | 6" | 138A-12-6 | 25 | 121.00 | 14 | 63.00 |
| | 9" | 138A-12-9 | 22 | 106.00 | 13 | 58.00 |
| | 12" | 138A-12-12 | 21 | 90.00 | 11 | 49.00 |
| 18" | 1½" | 138A-18-1.5 | 68 | $360.00 | 37 | $185.00 |
| | 3" | 138A-18-3 | 49 | 216.30 | 28 | 112.00 |
| | 4½" | 138A-18-4.5 | 38 | 189.00 | 19 | 87.00 |
| | 6" | 138A-18-6 | 31 | 144.00 | 17 | 77.00 |
| | 9" | 138A-18-9 | 28 | 126.00 | 15 | 69.00 |
| | 12" | 138A-18-12 | 25 | 104.00 | 13 | 58.00 |
| 24" | 1½" | 138A-24-1.5 | 63 | $436.00 | 48 | $223.00 |
| | 3" | 138A-24-3 | 54 | 257.00 | 29 | 133.00 |
| | 4½" | 138A-24-4.5 | 44 | 200.00 | 23 | 102.00 |
| | 6" | 138A-24-6 | 39 | 168.00 | 21 | 89.00 |
| | 9" | 138A-24-9 | 34 | 146.00 | 18 | 80.00 |
| | 12" | 138A-24-12 | 31 | 113.00 | 17 | 66.00 |

## CURVED SECTIONS

### STEEL ROLLERS AND FRAMES

| OVERALL WIDTH | DEGREES OF CURVE | MODEL NO. | WT LBS. | PRICE EACH |
|---|---|---|---|---|
| 12" | 45° | • 138GC-1245 | 38 | $83.00 |
| | 90° | • 138GC-1290 | 76 | 161.00 |
| 18" | 45° | • 138GC-1845 | 48 | 110.00 |
| | 90° | • 138GC-1890 | 89 | 177.00 |
| 24" | 45° | • 138GC-2445 | 86 | 154.00 |
| | 90° | • 138GC-2490 | 152 | 252.00 |

ALL CURVES HAVE A 4" OUTSIDE RADIUS

CURVES HAVE ROLLERS ON 3" ROLLER CENTERS

### ALUM. ROLLERS AND FRAMES

| OVERALL WIDTH | DEGREES OF CURVE | MODEL NO. | WT LBS. | PRICE EACH |
|---|---|---|---|---|
| 12" | 45° | 138AC-1245 | 22 | $112.00 |
| | 90° | 138AC-1290 | 44 | 187.00 |
| 18" | 45° | 138AC-1845 | 28 | 134.00 |
| | 90° | 138AC-1890 | 59 | 224.00 |
| 24" | 45° | 138AC-2445 | 32 | 164.00 |
| | 90° | 138AC-2490 | 64 | 301.00 |

C-04

### ADJUSTABLE HT. TRIPOD STAND

For fast installation of gravity wheel or 1⅜" diameter roller conveyor. Always order one more stand than conveyor sections. Shipped via truck only.

ALL IN STOCK. FOB ARK.

| ADJUST RANGE | 12" WIDE MODEL NO. | 18" WIDE MODEL NO. | 24" WIDE MODEL NO. | PRICE EACH |
|---|---|---|---|---|
| 9" TO 15" | 1800T12-1 | 1800T18-1 | 180024-1 | $23.00 |
| 15" TO 27" | 1800T12-2 | 1800T18-2 | 180024-2 | 24.00 |
| 21" TO 37" | 1800T12-3 | 1800T18-3 | 180024-3 | 25.00 |
| 27" TO 49" | 1800T12-4 | 1800T18-4 | 180024-4 | 28.00 |
| 37" TO 69" | 1800T12-5 | 1800T18-5 | 180024-5 | 30.00 |
| 57" TO 107" | 1800T12-6 | 1800T18-6 | 180024-6 | 37.00 |

### ADJUSTABLE "H" SUPPORTS

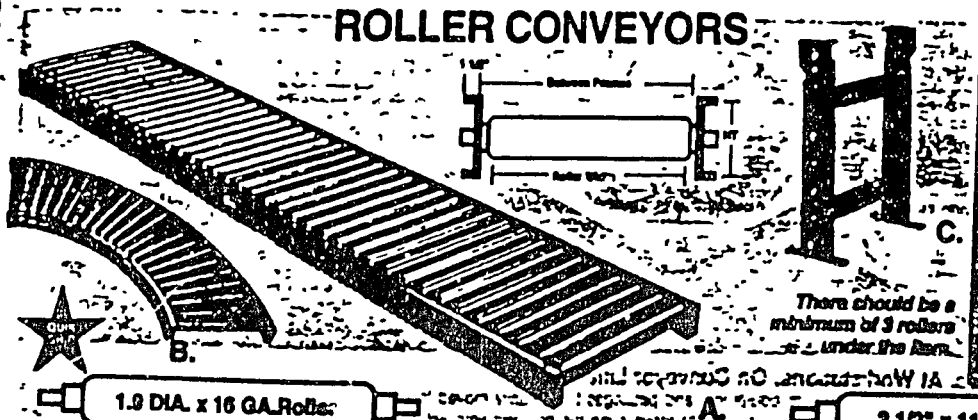
For permanent installation. Channel construction with pivot plate that bolts to conveyor rail. Base may be bolted to floor. All in stock.

FOB ARK.

HEIGHT IS TO TOP OF SUPPORT

| ADJUST RANGE | 12" WIDE MODEL NO. | 18" WIDE MODEL NO. | 24" WIDE MODEL NO. | PRICE EACH |
|---|---|---|---|---|
| 10" TO 13" | 1800H12 | 1800H22 | 1800H32 | $20.00 |
| 13" TO 18" | 1800H13 | 1800H23 | 1800H33 | 22.00 |
| 18" TO 22" | 1800H14 | 1800H24 | 1800H34 | 23.00 |
| 20" TO 28" | 1800H15 | 1800H25 | 1800H35 | 26.00 |
| 24" TO 36" | 1800H16 | 1800H26 | 1800H36 | 28.00 |
| 34" TO 46" | 1800H17 | 1800H27 | 1800H37 | 30.00 |

# ROLLER CONVEYORS



1.9 DIA. x 16 GA. Roller

2 1/2" x 11 GA Roller

**CAPACITY:** 250 lbs. per roller with 1300 lbs. maximum distributed live load per 10' section. 3200 lbs. maximum distributed live load per 5' section. All capacities based on 3" centers and 2 supports per section. Formed steel channel frames 3 1/2 x 1 1/2 x 10 ga. with 7/16 hex spring loaded rollers. Butt couplings permits bolting section together. FOB AR

**CAPACITY:** 540 lbs. per roller with 3400 lbs. maximum distributed live load per 10' section. 7,000 lbs. maximum distributed live load per 5' section. All capacities based on 3" centers and 2 supports per section. Formed steel channel frames 4" x 1 1/2 x 7 ga. with 11/16 hex spring loaded rollers. Butt couplings permits bolting sections together. FOB AR

| Roller Width | Width Between Frames | Stock Number | Roller Centers | STRAIGHT SECTION 10 FT. Wgt. Lbs. | 10 FT. Price | 5 FT. Wgt. Lbs. | 5 FT. Price |
|---|---|---|---|---|---|---|---|
| 12" | 13" | 196S133☆ | 3" | 166 | $190. | 84 | $89. |
| | | 196S134☆ | 4.5" | 140 | 154. | 77 | 78. |
| | | 196S136☆ | 6" | 118 | 128. | 60 | 67. |
| | | 196S139☆ | 9" | 102 | 111. | 52 | 60. |
| | | 196S1312☆ | 12" | 93 | 93. | 48 | 49. |
| 14" | 15" | 196S153☆ | 3" | 178 | $212. | 90 | $107. |
| | | 196S154☆ | 4.5" | 152 | 161. | 78 | 82. |
| | | 196S156☆ | 6" | 124 | 134. | 64 | 70. |
| | | 196S159☆ | 9" | 108 | 116. | 55 | 62. |
| | | 196S1512☆ | 12" | 97 | 93. | 50 | 51. |
| 18" | 19" | 196S193☆ | 3" | 202 | $228. | 102 | $117. |
| | | 196S194☆ | 4.5" | 169 | 172. | 86 | 87. |
| | | 196S196☆ | 6" | 137 | 142. | 70 | 74. |
| | | 196S199☆ | 9" | 117 | 121. | 60 | 65. |
| | | 196S1912☆ | 12" | 103 | 99. | 53 | 52. |
| 24" | 25" | 196S253☆ | 3" | 240 | $257. | 122 | $131. |
| | | 196S254☆ | 4.5" | 184 | 192. | 96 | 96. |
| | | 196S256☆ | 6" | 156 | 157. | 79 | 81. |
| | | 196S259☆ | 9" | 112 | 132. | 65 | 71. |
| | | 196S2512☆ | 12" | 112 | 107. | 57 | 58. |
| 30" | 31" | 196S313☆ | 3" | 276 | $279. | 140 | $142. |
| | | 196S314☆ | 4.5" | 225 | 208. | 114 | 104. |
| | | 196S316☆ | 6" | 174 | 170. | 88 | 89. |
| | | 196S319☆ | 9" | 147 | 143. | 72 | 77. |
| | | 196S3112☆ | 12" | 122 | 115. | 62 | 60. |
| 36" | 37" | 196S373☆ | 3" | 317 | $302. | 160 | $154. |
| | | 196S374☆ | 4.5" | 257 | 224. | 130 | 111. |
| | | 196S376☆ | 6" | 193 | 182. | 98 | $93. |
| | | 196S379☆ | 9" | 155 | 152. | 79 | 81. |
| | | 196S3712☆ | 12" | 131 | 122. | 67 | $63. |

| Roller Width | Width Between Rails | Stock Number | Roller Centers | STRAIGHT SECTION 10 FT. Wgt. Lbs. | 10 FT. Price | 5 FT. Wgt. Lbs. | 5 FT. Price |
|---|---|---|---|---|---|---|---|
| 12" | 13" | 251S133☆ | 3" | 342 | $450. | 174 | $226. |
| | | 251S134☆ | 4.5" | 281 | 327. | 144 | 160. |
| | | 251S136☆ | 6" | 240 | 281. | 114 | 132. |
| | | 251S139☆ | 9" | 188 | 214. | 97 | 113. |
| | | 251S1312☆ | 12" | 161 | 167. | 84 | 85. |
| 14" | 15" | 251S153☆ | 3" | 373 | $476. | 191 | $239. |
| | | 251S154☆ | 4.5" | 305 | 345. | 157 | 180. |
| | | 251S156☆ | 6" | 237 | 274. | 123 | 138. |
| | | 251S159☆ | 9" | 200 | 224. | 104 | 118. |
| | | 251S1512☆ | 12" | 169 | 174. | 89 | $88. |
| 18" | 19" | 251S193☆ | 3" | 436 | $529. | 223 | $266. |
| | | 251S194☆ | 4.5" | 353 | 392. | 181 | 187. |
| | | 251S196☆ | 6" | 270 | 302. | 140 | 152. |
| | | 251S199☆ | 9" | 222 | 245. | 116 | 130. |
| | | 251S1912☆ | 12" | 187 | 183. | 99 | $96. |
| 24" | 25" | 251S253☆ | 3" | 530 | $609. | 271 | $306. |
| | | 251S254☆ | 4.5" | 425 | 436. | 219 | 213. |
| | | 251S256☆ | 6" | 340 | 343. | 166 | 173. |
| | | 251S259☆ | 9" | 257 | 278. | 135 | 146. |
| | | 251S2512☆ | 12" | 214 | 210. | 113 | 106. |
| 30" | 31" | 251S313☆ | 3" | 625 | $693. | 320 | $348. |
| | | 251S314☆ | 4.5" | 497 | 495. | 256 | 241. |
| | | 251S316☆ | 6" | 300 | 369. | 192 | 196. |
| | | 251S319☆ | 9" | 206 | 312. | 156 | 165. |
| | | 251S3112☆ | 12" | 242 | 238. | 128 | 119. |
| 36" | 37" | 251S373☆ | 3" | 718 | $775. | 368 | $389. |
| | | 251S374☆ | 4.5" | 568 | 551. | 293 | 268. |
| | | 251S376☆ | 6" | 419 | 431. | 218 | 217. |
| | | 251S379☆ | 9" | 330 | 345. | 174 | 182. |
| | | 251S3712☆ | 12" | 260 | 298. | 143 | 151. |

B. Curved Sections: Have 2' 8 1/2" inside radius
up to 30" rollers 30" and 36" have 4' inside radius

| Nominal Roller Length | Width Between Rails | 1.9" Diam. x 16 GA. 90° Stock Number | 90° Price | 2 1/2" Diam. x 11 GA. 90° Stock Number | 90° Price |
|---|---|---|---|---|---|
| 12" | 13" | 196SC139S☆ | $181. | 251SC139S☆ | $265. |
| 14" | 15" | 196SC159S☆ | 168. | 251SC159S☆ | 278. |
| 18" | 19" | 196SC199S☆ | 131. | 251SC199S☆ | 312. |
| 24" | 25" | 196SC259D☆ | 248. | 251SC259S☆ | 258. |
| 30" | 31" | 196SC319D☆ | 368. | 251SC319D☆ | 634. |
| 36" | 37" | 196SC379D☆ | 396. | 251SC379D☆ | 690. |

C. Adjustable Height Supports-Bolt To Floor.

| For 1.9" Diam. Roller Conveyor Stock Number | Height To Top Support | Price Each | For 2 1/2" Diam. Roller Conveyor Stock Number | Height To Top Support | Price Each |
|---|---|---|---|---|---|
| SM1 | 7 1/4-10 1/4" | $28.00 | SH2☆ | 7 3/4-10 3/4" | $22.00 |
| SM2☆ | 10 1/4-13 1/4" | 23.00 | SH3☆ | 10 3/4-13 3/4" | 25.00 |
| SL3☆ | 13 1/4-18 1/4" | 25.00 | SH4☆ | 13 3/4-18 3/4" | 28.00 |
| SH5☆ | 20 1/4-26 1/4" | 31.00 | SH5☆ | 18 3/4-19 3/4" | 33.00 |
| SM6☆ | 24 1/4-36 1/4" | 32.00 | SH6☆ | 19 3/4-25 3/4" | 33.00 |
| SM7☆ | 34 1/4-46 1/4" | 38.00 | SH7☆ | 25 3/4-31 3/4" | 38.00 |

Specify Width Between Frames.

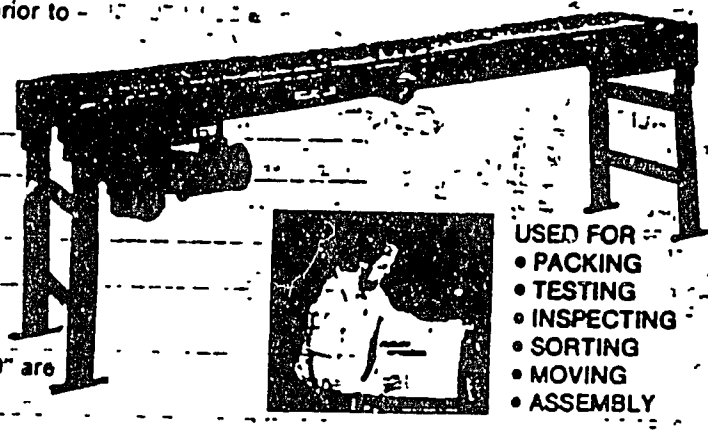
# HORIZONTAL POWER BELT CONVEYOR

**CAPACITIES FROM 300 to 1300 LBS.**
**BELT SPEED 60 FEET PER MINUTE**

**MODEL 1800 350SB**
**• ECONOMICAL • VERSATILE**
**• QUIET • ATTRACTIVE**

SHIPPED IN 48 HOURS

Modular construction—can be added to for future expansion All units are shipped partially assembled and are tested prior to shipment.



### INCLUDED IN PRICE STANDARD SPECIFICATIONS

**BELT:** Black friction surface —PVC 120

**BED:** 3½" x 1½" x 10 GA. channel frame with 14 GA. slider bed

**SUPPORTS:** Adjustable legs 31" to 40" are included in price

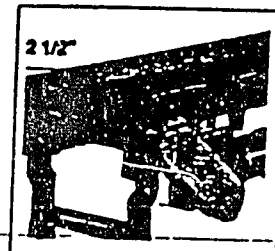
**MOTOR:** Standard 1/3 H P. motor (one direction) 230/460/3/60 optional 115/1/60 add $88 00 STK. NO 1800 H115

**BELT SPEED:** Standard 60 feet per minute

**CONTROLS:** Not included—see options

USED FOR
- PACKING
- TESTING
- INSPECTING
- SORTING
- MOVING
- ASSEMBLY

### OPTIONAL: HORIZONTAL TROUGH BED CONVEYOR




Same specifications and prices as conveyor above, except sides are 2 1/2" high.

To handle small parts, cartons or scrap paper.

Units supplied with floor supports or ceiling hangers

Specify Stk. No 1800250TB Belt width and length.

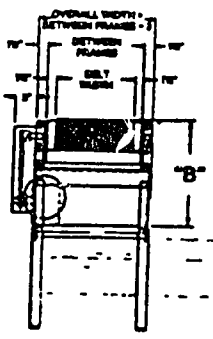
## CONVEYOR SHIPPED COMPLETE ONLY OPTION REQUIRED IS CONTROLS

**NET PRICING FOR COMPLETE CONVEYOR—**
SPECIFY BED LENGTH & BELT WIDTH—SHIPPED K.D., CRATED, FOB ARX

| OVERALL LENGTH "A" | BELT 12" BED | 15" BELT 15" BED | 18" BELT 24" BED | 24" BELT 32" BED | 30" BELT 38" BED |
|---|---|---|---|---|---|
| 5' | $1129.00 | $1160.00 | $1242.00 | $1320.00 | $1414.00 |
| 10' | 1190.00 | 1311.00* | 1436.00* | 1566.00* | 1708.00 |
| 15' | 1303.00 | 1464.00 | 1631.00 | 1810.00 | 2001.00 |
| 20' | 1403.00 | 1591.00* | 1812.00* | 2044.00* | 2295.00 |
| 25 | 1515.00 | 1713.00 | 2007.00 | 2289.00 | 2589.00 |
| 30' | 1616.00 | 1870.00* | 2187.00* | 2523.00* | 2882.00 |
| 35 | 1728.00 | 2022.00 | 2381.00 | 2768.00 | 3176.00 |
| 40' | 1828.00 | 2148.00* | 2563.00* | 3003.00* | 3469.00 |
| 45 | 1941.00 | 2300.00 | 2757.00 | 3248.00 | 3763.00 |
| 50' | 2042.00 | 2428.00* | 2939.00* | 3480.00* | 4057.00 |
| 55 | 2155.00 | 2580.00 | 3133.00 | 3726.00 | 4351.00 |
| 60' | 2331.00 | 2800.00* | 3421.00* | 4082.00* | 4788.00 |

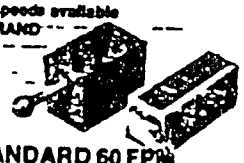
For in between size use next larger size price
Greater lengths and widths available

### GREATER CAPACITIES ONE DIRECTION END-DRIVE*




| CAPACITY AT TOTAL LOAD | HP MOTOR | STOCK NUMBER | OPTIONAL PRICE |
|---|---|---|---|
| 300 Lbs. | 1/3 | | Standard |
| 400 Lbs. | 1/2 | 1800 H1 | $23.00 |
| 575 Lbs. | 3/4 | 1800 H2 | 78.00 |
| 725 Lbs. | 1 | 1800-H3 | 210.00 |
| 1100 Lbs. | 1 1/2 | 1800 H4 | 373.00 |
| 1300 Lbs | 2 | 1800 H5 | 412.00 |

*60 FPM Standard
Slower and faster speeds available
Consult RAND



### CONTROLS for 230/460/3/60 conveyors

MAGNETIC STARTER—One direction for 230/460/3/60 volt conveyor NEMA 1 STK. NO 1800 MSO ..... $238.00
110 Volt Pushbutton (ON/OFF) STK. NO. 1800 PB01 $74.00

MAGNETIC STARTER—Reversing for 230/460/3/60 volt conveyor NEMA 1 STK. NO. 1800 RMSO ..... $491.00
110 Volt Pushbutton (ON/OFF/REVERSE) STK. NO. 1800 PBR ..... $67.00

### CONTROLS for 115/1/60

PUSHBUTTON—One direction for 115/1/60 conveyor STK. NO. 1800 PBM ..... $74.00
DRUM SWITCH—Reversing for 115/1/60 conveyor STK. NO 1800 DS-1 ..... $50 00

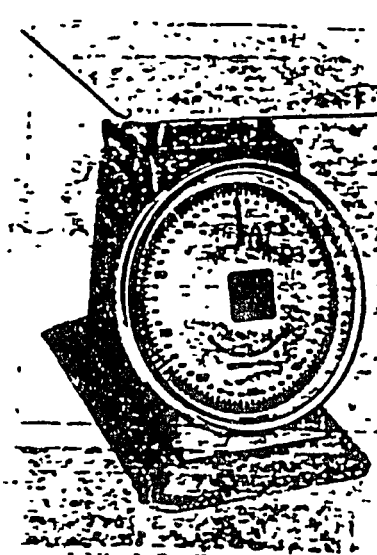
### OPTIONAL BELT SPEED-STANDARD 60 FPM

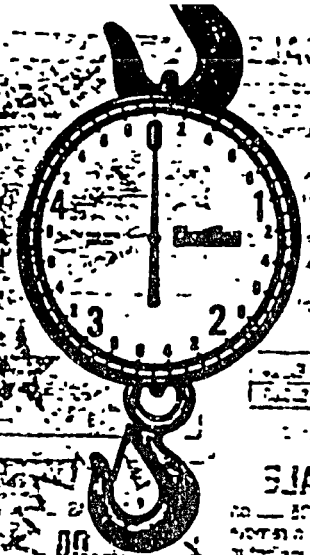
| 2.8 to 1 VARIABLE SPEED | STOCK NO. | PRICE |
|---|---|---|
| Min speed 8 FPM, Max. 22 FPM | 1800 VS1 | $378.00 |
| Min speed 16 FPM Max 45 FPM | 1800 VS2 | 378 00 |
| **6.8 to 1 VARIABLE SPEED** | | |
| Min speed 8 FPM, Max. 35 FPM | 1800 VS3 | $1050 |
| Min speed 11 FPM Max. 66 FPM | 1800 VS4 | 1050 |

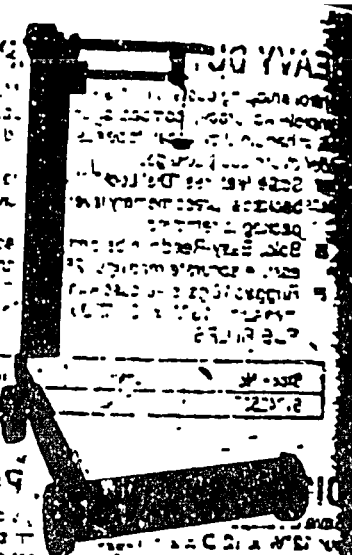
### FOR REVERSIBLE CONVEYORS OPTION B

CENTER DRIVE IS REQUIRED

| | | STK. NO. | | PRICE |
|---|---|---|---|---|
| 1/3 H P 300 lb cap | 1800 CDB1 | Add | $349.00 |
| 1/2 H.P 400 lb cap | 1800 CDB2 | Add | 369 00 |
| 3/4 H P 575 lb cap | 1800 CDB3 | Add | 433.00 |
| 1 H P 725 lb cap | 1800 CDB4 | Add | 576.00 |







## HEAVY DUTY DIAL SCALES

**100 LB. CAPACITY; 4 OZ. INCREMENTS** Large 13"wx13"d platform is used for UPS and Postal packages, or for batch weighing and counting by weight. Easy to read slanted 10 1/2" slanted dial, reduce reading errors. Temperature compensated springs give consistent accurate readings. Ruggedly built enamel finish. Wt.27lbs FOB RI UPS

STK NO. 2023101 Ea $150.00 2+ $148.69

## PORTABLE CRANE SCALE

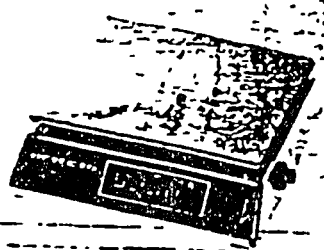
Just hang Scale on hoist and weigh loads up to 20,000lbs. Easy to read 12" diam. shatter proof dial with 200 graduations and a single pointer that returns to zero automatically or retains pointer at maximum reading. Ruggedly dependable, and accurate to within 1/2% of 1% of total capacity Scale can sustain 25% overload without damage to calibration. Case is cast aluminum with non swivel eye hook.FOB NY UPS

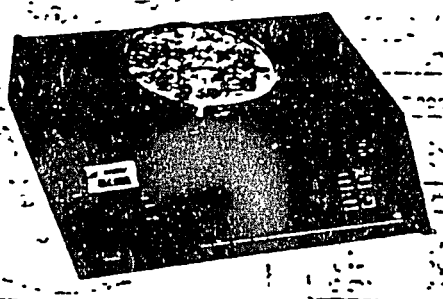
| Stk. No. | Cap.Lbs/Grad. | Hd.Rm | Wt | Each | 2+ |
|---|---|---|---|---|---|
| 303500 | 500 x 2 lb | 17 3/4" | 24 | $830. | $765. |
| 30311M | 1000 x 5 lb | 17 3/4" | 24 | 830. | 765. |
| 30324M | 2000 x 10lb | 17 3/4" | 24 | 830. | 765. |
| 30354M | 5000 x 20lb | 17 3/4" | 24 | 839. | 839. |
| 30310M | 10000x 50lb | 23 5/16" | 31 | 1075. | 986. |
| 30320M | 20000x100lb | 23 5/16" | 40 | 1095. | 1018. |

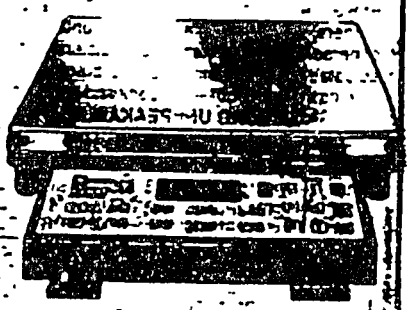
## PORTABLE BEAM SCALES

**1,000 LB. CAPACITY, 1/2LB INCREMENTS.** Built tough for rugged handling in shipping and receiving depart is dependable, accurate and portable. Welded steel construction for greater durability, die cast beam with easy to read numbers from front or rear with pointer that shows exact weight. Legal for trade,platform is only 7½"high, 19"wide x 28" deep Wt 132lbs FOB MO Stk. No. 4022545 $595. 2+ $568.

Low As $293.







## STAINLESS STEEL DIGITAL SCALE

Designed for laboratories, pharmacies, food operations any application where the need for a accurate filling operation or portion control is required. Legal for trade it meets all the requirements of UL,USDA and NBS handbook 44. Rugged stainless steel construction with easy to read LED digitals, pushbutton tare, it plugs into any 115V outlet Platform size is 6 3/4"x5 1/4" scale is 2 3/4"high. Wt 3.5 lbs FOB MO UPS

| Stk. No. | Cap/ Grad. | Each |
|---|---|---|
| 402AP-K | 4kilos 1 gram | $293. |
| 4[illegible] | 8lb x 5 oz. | 293. |
| 402AP8 | 8lb x .002lb | 293. |
| 402AP10 | 10lb x .005lb | 293. |
| 402AP20 | 20lb x .01lb | 384 |

## ELECTRONIC COUNTING AND WEIGHING SCALE

Weigh and Count small Parts Faster and more accurately. Easy to use just place sample pieces on scale and press sample button. Weight and count are recorded. Continue to add like parts and the scale keeps accumulated weights and counts up to 999,999 pcs. Easy to read 1/2" blue fluorescent digits, readout rate is 4 seconds. Scale is 4" H x 14.5"wx 12"d w/22 Stainless steel dish or platform 8.25" x14.5" It plugs into any 115/Volt AC outlet. Meets UL,NSF Std. 944, FOB MO Wt 18 lbs UPS

| Stock No. | Cap.Lb/Grad. | Plat | Each |
|---|---|---|---|
| 4022215A | 2.5x0005lb | 6"Rd. | $895. |
| 4022215B | 5 x.001lb | 6"Rd. | 895. |
| 4022215C | 10 x.002lb | 6"Rd. | 895. |
| 4022215D | 50 x.01 lb | 8.25"x14.5" | 895. |
| 4022215E | 100 x.02 lb | 8.25"x14.5" | 895. |

## DIGITAL PARCEL POST/UPS SCALE

COMPUTE and COMPARE rates for quick selection of the most economical shipping method. Just enter a zone on the panel of this electronic scale to automatically compute UPS Next Day Air/UPS 2nd Day Air/UPS Air Hawaii, UPS Ground and Surface Parcel Post (4th Class)/Priority Air Parcel Post. Versatile design enables you to position the platform at one level for easy reading. Tare button weighs containers and contents separately. Capacity: 100 lbs x 1/10 lb/45 kg x 50 g. 13" wide x 18" deep x 3 1/2" high In Office Tan Color with stainless steel platform.

Stk. No. 1618PS100PR Wt. 20 lbs. Each $785.69

# STRIP DOORS

## FLEXIBLE SEE THRU DOOR

**LOWER HEATING BILLS — REDUCE NOISE**

Spaces previously too small, too wide, too high, can now be effectively closed off by Rand Strip-dor. This unique transparent closure is the answer for many requirements where swing type impact doors are not feasible. Virtually indestructable, Strip-dor is proudly added to the ever widening line of Rand impact traffic doors and loading dock equipment.

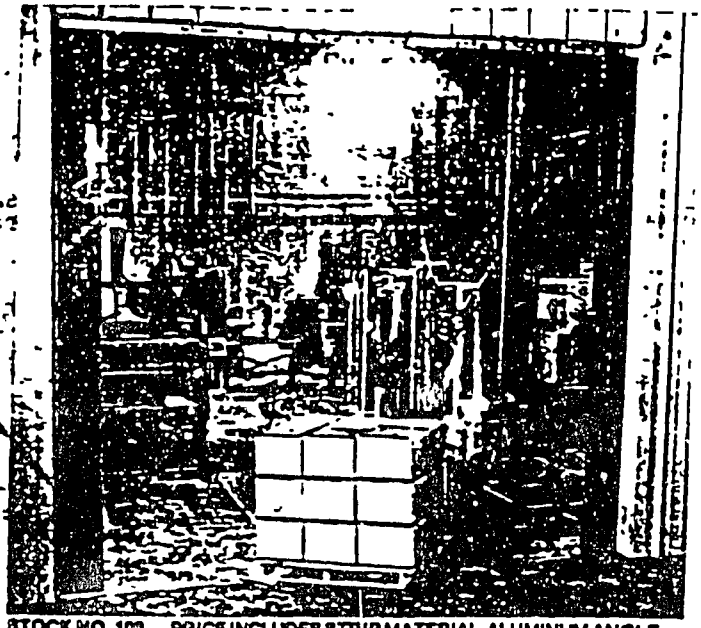
**ENERGY SAVINGS** — Saves energy cost by reducing the amount of heated or cooled air lost through your unprotected opening. Opens only sufficiently to allow foot and power truck to pass through.

**SAFETY STRIPS** — Rounded edges to prevent cutting. Fire retardant self extinguishing, offers a low cost method to guard openings, protects against dust, drafts, insects, heat, cold and noise. Each opening has special bright orange end strips to prevent accidents.

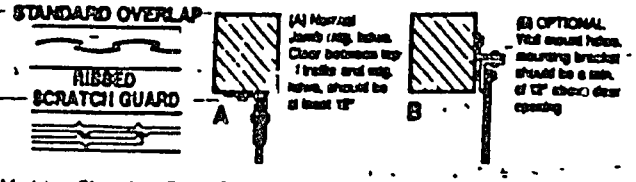
**NOISE REDUCTION**

Our strip doors and curtains provide a virtually unbreakable sound barrier. Researchers assigned our product a sound transmission rating of Class 13.

**WE WILL MAKE STRIP DOOR TO FIT ANY DOOR OPENING**



STOCK NO. 109 — PRICE INCLUDES STRIP MATERIAL, ALUMINUM ANGLE — SPECIFY-MOUNTING A OR B AND OPENING SIZE. 6" Wide strips have 2" of overlap per side, 12" wide have 4" of overlap each side. FOB AL




(A) Normal Jamb mtg. holes. Door between top / trolls and mtg. holes, should be at least 18"

(B) OPTIONAL Wall mount holes, mounting bracket should be a min. of 12" above door opening

*Models + Ships Mtr Frt. All Others UPS*

| DOOR OPENI WIDH | STRIP SIZE | STANDARD STOCK NUMBER | STANDARD NET EACH | LOW TEMP STOCK NUMBER | LOW TEMP NET EACH | RIBBED STOCK NUMBER | RIBBED NET EACH |
|---|---|---|---|---|---|---|---|
| 3 x 7 | 6" (.090) THICK. | 1097X3 | 872 | 1097X3L | 891 | 1097X3R | 887 |
| 4 x 7 | | 1097X4 | 98 | 1097X4L | 121 | 1097X4R | 117 |
| 4 x 8 | | 1098X4 | 110 | 1098X4L | 139 | 1098X4R | 133 |
| 5 x 7 | | 1097X5 | 120 | 1097X5L | 152 | 1097X5R | 146 |
| 5 x 8 | | 1098X5 | 137 | 1098X5L | 173 | 1098X5R | 166 |
| 6 x 7 | | 1097X6 | 144 | 1097X6L | 182 | 1097X6R | 175 |
| 6 x 8 | | 1098X6 | 165 | 1098X6L | 208 | 1098X6R | 200 |
| 7 x 8 | | 1098X7 | 192 | 1098X7L | 243 | 1098X7R | 233 |
| 8 x 8 | | 1098X8 | 220 | 1098X8L | 277 | 1098X8R | 266 |
| 8 x 10 | | 1098X10 | 274 | 1098X10L | 346 | 1098X10R | 333 |
| 9 x 9 | | 1098X9 | 276 | 1098X9L | 351 | 1098X9R | 337 |
| 10 x 10 | 12" (.129) THICK. | 1098X10 + 448 | | 1098X10L + | 540 | 1098X10R + | 546 |
| 10 x 12 | | 1098X10 + 538 | | 1098X10L + | 646 | 1098X10R + | 654 |
| 11 x 11 | | 1098X11 + 542 | | 1098X11L + | 653 | 1098X11R + | 669 |
| 12 x 12 | | 1098X12 + 645 | | 1098X12L + | 778 | 1098X12R + | 785 |

## STRIP DOOR MATERIAL

**STANDARD MATERIAL**
Withstands temperatures from 0 to +150 degrees. Resists alcohols, acids, oils and alkalies.

**USDA LO TEMP MATERIAL**
Is for Food-Handling. Withstands temperatures from -40 to +100 degrees. Resists alcohols, acids, oils and alkalies.

**RIBBED MATERIAL**
Standard Material with raised ribs on both sides prevent scratching of plastic strips. Rib height is .094" — width is .125"

**REPLACEMENT STRIPS** For your own strip door application. Buy strips in bulk rolls. By cutting and punching holes yourself you save money. FOB AL

| SIZE W x THICK. | ROLL LENGTH | STANDARD STOCK NO. | STANDARD ROLL PRICE | USDA LO TEMP STOCK NO. | USDA LO TEMP ROLL PRICE | RIBBED STOCK NO. | RIBBED ROLL PRICE |
|---|---|---|---|---|---|---|---|
| 6" x .090 | 150' | R1090006 | $ 81. | R1092106 | $118. | | |
| 6" x .090 | 150' | R1090009 | $143. | R1092009 | $168. | R1090009 | $184 |
| 12" x .130 | 75 | R1090012 | $161 | R1092012 | $188. | R1090013 | $228. |
| 16" x .160 | 100' | R1090016 | $294 | R1092016 | $346. | R1090017 | $479 |
| 48" x .090 | 60' | R1090060 | $273. | R1092061 | $349 | | |

**CUSTOM CUT REPLACEMENT STRIPS** Can be used on our doors or others. Strips are custom cut to any length you specify. Can be punched (Specify punched) with ¼" diameter holes on 2" centers ONLY. FOB AL

| SIZE W x THICK. | STANDARD STOCK NO. | STANDARD PER FOOT | USDA LO TEMP STOCK NO. | USDA LO TEMP PER FOOT | RIBBED STOCK NO. | RIBBED PER FOOT |
|---|---|---|---|---|---|---|
| 6" x .090 | 1090006C | $ 75 | 1092106C | $ .85 | — | — |
| 6" x .090 | 1090009C | 1.18 | 1092009C | 1.38 | 1090009C | $1.55 |
| 12" x .120 | 1090012C | 2.38 | 1092012C | 2.18 | 1090013C | 2.58 |
| 16" x .160 | 1090016C | 4.58 | 1092016C | 5.38 | 1090017C | 6.18 |
| 48" x .090 | 1090060C | 8.88 | 1092061C | 8.98 | — | — |