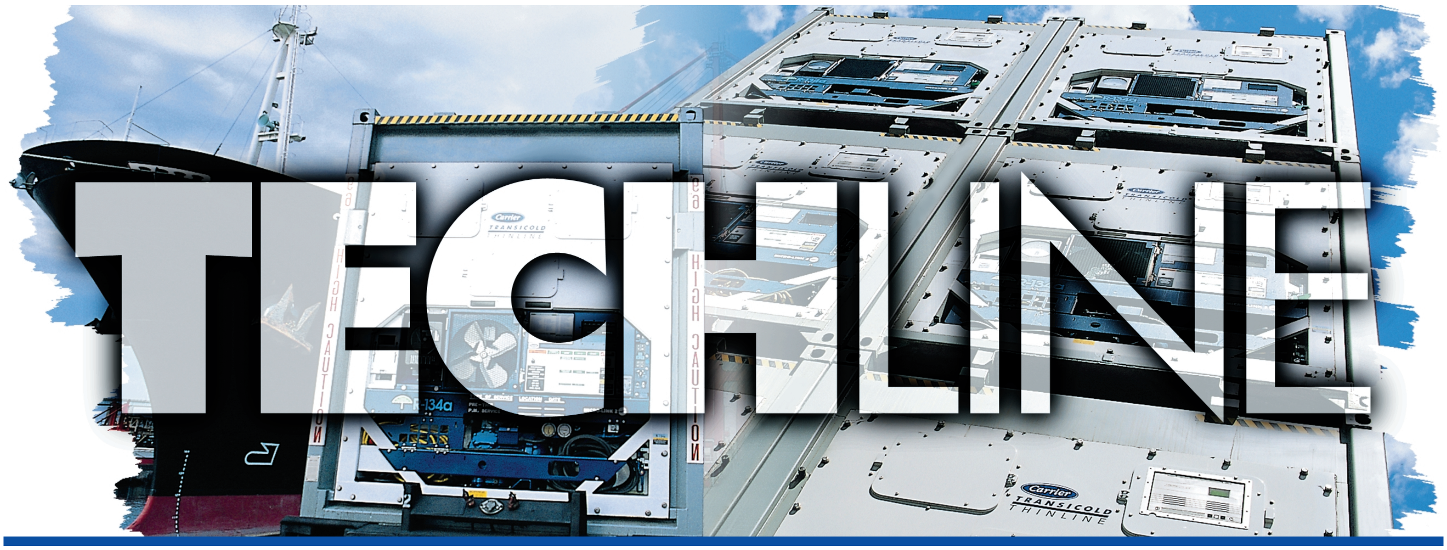

AN EXCHANGE OF TECHNICAL INFORMATION ABOUT CARRIER TRANSICOLD CONTAINER PRODUCTS

VOLUME 7 NUMBER 1

1st Quarter 2002

Inside This Issue

Tech *Tip*

CA Guide to Food Transport

For those looking for practical information on and about controlled atmosphere there is available, from Mercantila Publishers (printed in Denmark by BB Grafik), a "Guide to Food Transport – Controlled Atmosphere" (ISBN 87 890 1096-5), by Michael S. Reid and Margrethe Serek.

This book covers the basics of the biology of controlled atmospheres related to respiration, aging, low oxygen, high carbon dioxide, ethylene, mold growth, insect quarantine, and other informative topics. It also covers information on gas-tight enclosures, fixed stores, oxygen removal, nitrogen flushing, calibration, and much more about the techniques in CA storage and modified atmosphere packaging.

The book rounds itself out with practical information on requirements, recommendations, and descriptions of many commonly transported floras, fruits, fungi, and vegetables.

N. LaCount

Tech *Tip*

Generator Bearing O-Ring

When inspecting/replacing the bearing on the Lima generator the O-ring, located inside the machined recess of the end bearing housing, is often over looked. The purpose of this O-ring is two fold. First, with a single bearing design, such as is used in the 69UG & RG models, the rotor shaft must be able to float. This float assures proper alignment, in the axial direction, of the generator's rotor drive discs and that of the engine's flywheel. The second is to allow the outer race of the bearing to rotate slightly within the housing to minimize the possibility of Brinelling[I] the race during over the road trucking. It is suggested that whenever inspecting/replacing a bearing the O-ring be included, P/N 42-50010-00.

G. Barkowski

[I] Refers to indentations made in a bearings raceway caused by the rollers when they are subjected to loads that exceeds the strength of the raceways material.

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Carrier TRANSICOLD

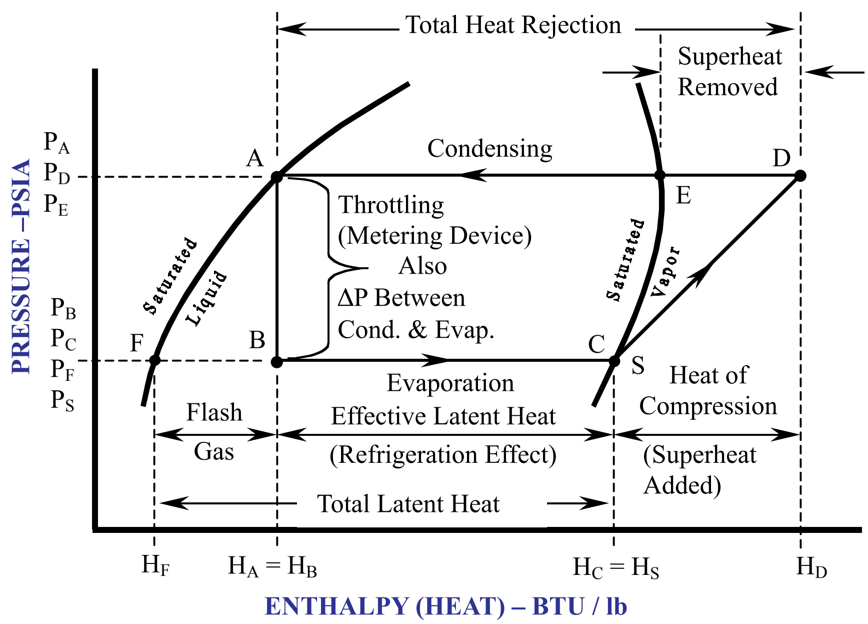
Please circulate this newsletter to all of your support personnel

Feature Article

The Pressure-Enthalpy (Heat) Diagram

"Pulling together just how the refrigeration cycle really works!"
Or
"An invaluable aide to trouble-shooting system operating conditions!"

Don't let the below diagram scare you away. Over the past couple of years **Tech***Line* has covered just about all of what is being represented. This article will serve to pull all of the basic principles of refrigeration, heat transfer, pressure, temperature, specific heat, latent heat, sub-cooling, superheating, and enthalpy together to illustrate how and why a refrigeration system operates*.

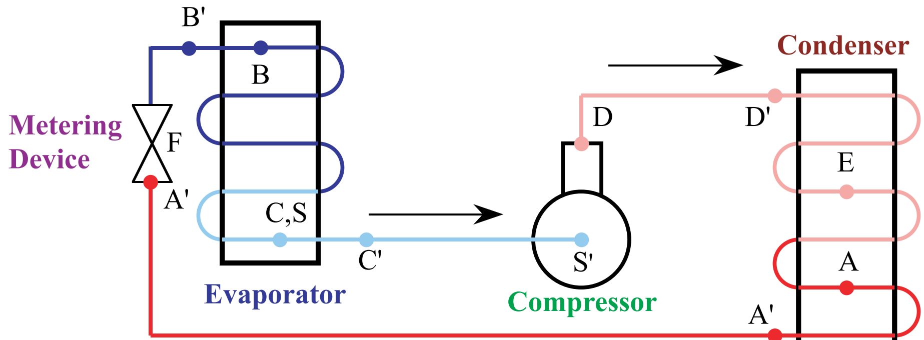


(Ideal Refrigeration Cycle)

Note: This discussion is based on generalizations and of using a pure refrigerant and neglects any effect lubricating oil or other materials and items in a system may have on influencing the refrigerants behavior.

The principles of refrigeration, and ultimately how and why a refrigerant system works, are based on the science of Thermodynamics, which deals with the relationship between heat and work (mechanical action vs reaction) and conversion of one into the other. The refrigeration cycle is very simple, as can be seen in the following **System Diagram** and the accompanying explanation. The above is a plot of this cycle on what is referred to as a **Pressure-Enthalpy (Heat) diagram (P-H diagram)** showing the physical property changes of a refrigerant as it cycles around the system. Remember, Enthalpy is a measure of the total heat energy content of a substance.

A thorough understanding of this Pressure-Heat diagram can be an invaluable aide to the service technician when trouble-shooting system operating conditions. As we discuss the refrigeration cycle using these two diagrams, you can refer to each based on the labeled points, which have been placed at the relevant discussion areas.



System Diagram

A - Condenser Outlet (No sub-cooling)
A' - Cond Outlet / Meter Inlet (Subcooled)
B/B' - Evaporator Inlet (B' Result of sub-cooling)
C/S - Evap Outlet / Compr Inlet
(No pressure drop, no Super Heat)
C' – Evaporator Outlet (Super Heated)

S' - Compr Inlet (With pressure drop)
D - Compressor Outlet (Discharge)
D' - Condenser Inlet (Pressure drop)
E - Saturated Vapor
(Condensing begins, SH removed)
F - Flash Gas Effect

Starting at the metering device (F), as the refrigerant enters the evaporator coil, passing through the small opening in the metering device, some of the refrigerant vaporizes (flashes) as a result of the pressure differential between the high side pressure in the liquid line and the low side pressure in the coil. This *Flash Gas* effect (throttling) acts to cool the remainder of the refrigerant as it continues to flow into the evaporator coil (B), in a liquid state. Once in the coil, the refrigerant vaporizes at a lower constant pressure[1] (P_B,P_C,P_F,P_S), as the remaining liquid begins to absorb (removes) heat from the enclosed space around the coil. The metering device and evaporator coil act to change the "state" of the refrigerant, that is to say their purpose is to turn a refrigerant liquid into a vapor. Referring to the P-H diagram, this is accomplished by increasing the total heat energy (enthalpy) of the refrigerant as it flows from the metering device (F) through the evaporator coil (B) and into the suction side of the compressor (S). The amount of heat absorbed/removed from just the enclosed space is referred to as the "Effective Latent Heat" or "Refrigeration Effect." The total amount of heat absorbed, which includes the initial amount that vaporized as it passed through the metering device, is referred to as the "Total Latent Heat of Vaporization"—increases the enthalpy of the refrigerant from H_F to H_S.

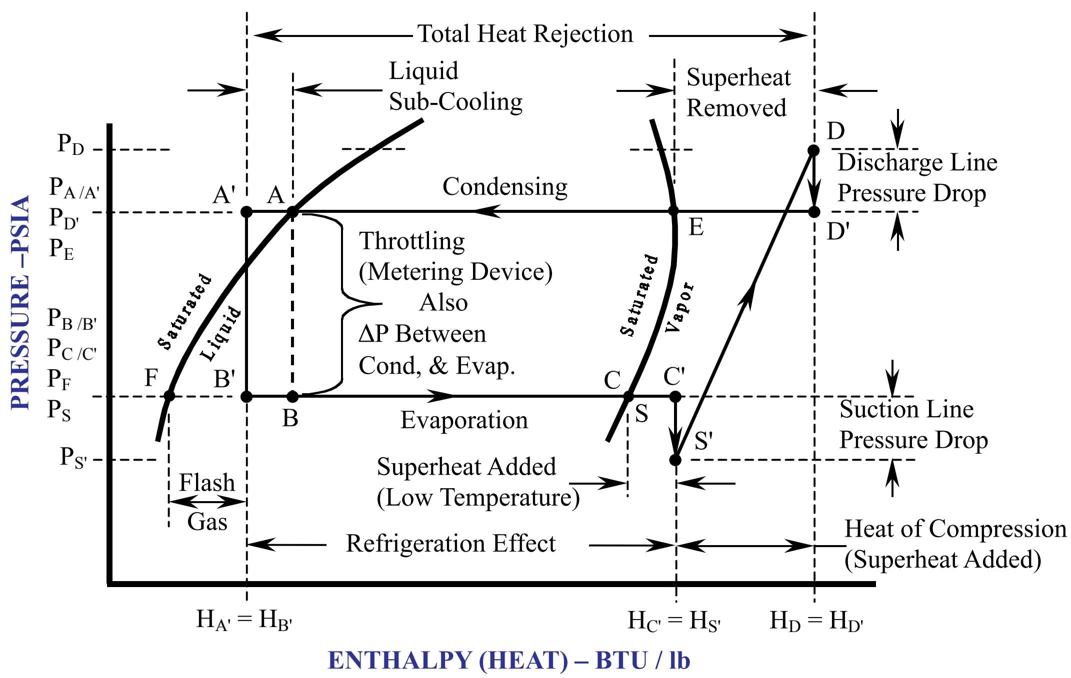
> Note: The metering device ensures that only refrigerant vapor leaves the coil before entering the suction side of the compressor. And remember, the compressor and metering device are the separation points between the systems high and low pressure sides.

The compressor takes this low-pressure vapor and converts it into a high pressure, superheated vapor (D), which as a result of the compression cycle, raises the refrigerant temperature and increases the enthalpy from H_S to H_D. As the refrigerant vapor enters the condenser coil, it gives up this heat (D to A), condensing (E) into a high pressure and temperature liquid (A) that flows to the metering device to begin the cycle all over again.

[1] Remember, temperature and pressure are intimately related, as one changes (e.g.: increases or decreases) so does the other, thus constant for one means constant for the other.

The above explanation, while general in nature, works quite well to describe an ideal system. The below P-H diagram is very similar, but here we show some slight differences that more closely apply to what one might encounter with a typical refrigeration cycle.

Starting at (D), compressor discharge, as the refrigerant flows through the condenser line to the coil inlet (D'), a pressure drop[2] occurs. Note that there is no change in enthalpy associated with this pressure drop. The superheat (increase in enthalpy) that was added during the compression cycle is removed from D' to E. This (E) represents the point within the condenser coil where the refrigerant reaches its saturated vapor point and begins to turn from a pure vapor to a liquid as it continues to give up its heat energy content (enthalpy). This change of "state" continues from E to A, or until the refrigerant reaches it saturated liquid temperature (A). In actuality the line from D' to A is not straight because of the pressure drop that occurs as the refrigerant passes through the coil, as well as, the loss in temperature due to the dissipation of heat as the refrigerant flows through the condenser line from the compressor to the coil. However, these losses are generally considered insignificant in typical systems and thus it is common to refer to the condensing temperature as the saturation temperature at the pressure entering the condenser coil.



(Typical Refrigeration Cycle)

Most condenser coils in our application provide some amount of refrigerant sub-cooling. As seen above this sub-cooling (A') has several effects. One, it reduces the amount of "flash gas" (F to B'), which means more refrigerant will enter the evaporator coil as a liquid. Thus, when changing its "state" from a liquid to a vapor, as it absorbs the heat from the load, there will be more refrigerant available to accomplish this process. This then results in an increase in the "Total Heat Rejection" and "Refrigeration Effect" of the system—capacity is increased.

[2] Pressure drops are the result of the pressure differentials created by the system components (e.g.: compressor, metering device, coils, interconnecting piping, etc.) required to cause refrigerant flow throughout the system, as well as, the loses associated with normal fluid flow friction within these components.

In the "Ideal Cycle" diagram, the metering device and evaporator coil acted to change the "state" of the refrigerant from a liquid to a vapor (B to C). These functions are true as well with our "Typical Cycle" as shown above (B' to C), however, the metering device takes on an added function. In fact, most ensure that the vapor leaving the coil is slightly "superheated" to ensure that no liquid enters the compressor. By additionally controlling the amount of superheat that the refrigerant leaving the coil has above its saturation point, the metering device also helps to effectively increase the "Refrigeration Effect" (B' to C'). As the refrigerant flows through the suction line to the compressor (C' to S') another significant pressure drop occurs, which again does not result in any loss of enthalpy, but sets up the refrigerant vapor to go through the compression cycle and start the system cycle again. Here line B' to C' is not really straight mainly due to the pressure drop through the evaporator coil, but as with the condenser side these losses are generally considered small.

As you can see, the biggest effects on our "Typical Cycle" are the result of the pressure drops associated with moving the refrigerant around the system, sub-cooling the refrigerant in the condenser coil, and superheating it in the evaporator.

Using the P-H diagram to Troubleshoot

So what good does all this do in helping to troubleshoot a refrigeration problem?

Well, the first thing that a technician must do to locate the problem area is to understand what is happening inside the refrigeration system. What makes this difficult is that the system is sealed. To accurately determine what is happening inside requires the use of gauges, thermometers, and the system sight glass to get the operating pressures, temperatures and to look inside to see the refrigerant level, as well as its dryness. Next, the technician needs to know what is supposed to be going on inside and what each part of the system is supposed to be doing. Armed with this information, the technician can use logic to narrow down the cause of the problem. This is where understanding the P-H and System diagrams, along with component functions, can provide invaluable assistance.

Example: System with a low charge

If a system is sufficiently undercharged, the refrigerant will not be able to reach point (A), its saturated liquid temperature—the enthalpy for line A/B is shifted to the right. As a result, the refrigerant does not completely liquefy and much more vapor refrigerant is passed through the metering device. This causes a "loss" in the "Effective Latent Heat" or "Refrigeration Effect" and the unit may have to run longer and work hard to remove the same amount of heat.

Example: Air in the system

Air in a refrigeration system increases the total head pressure, which will equal the refrigerant condensing pressure plus the pressure of the air in the condenser. In other words, point (D) goes much higher, resulting in the refrigerant condensing at a much higher temperature (line D' to A' is higher) since the pressure is higher. This higher pressure results in the compressor having to work harder, and the potential for the corresponding temperatures to be high enough to cause oil breakdown may also exist. Depending on the actual pressures encountered damage can also occur with the compressor valve plates, valve seats, head gaskets, pistons, etc.

☞

Example: Dirty condenser coil

With effects similar to those seen with air in the system, a dirty condenser coil can also result in higher condenser pressures and the losses associated with the compressor having to work harder. Losses can also result from lower than normal sub-cooling capability of the coil, which will cause more "flash gas" effect thus reducing the "Refrigeration Effect."

These are only a few examples of how having an understanding of the P-H diagram can be used by technicians to augment their training and experience in identifying and understanding the effect a refrigeration problem can have on a system.

❑ *N. LaCount*

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* For those who would like to refresh themselves on some of these topics, the following **Tech***Line*'s can be referenced:

- June 1999, Vol. 4 No. 1 – **"What is Refrigeration?", "What is Heat?", "How is Heat measured?"**
- July 1999, Vol. 4 No. 2 – **"What is Cold?", "How does Heat energy flow?", "What are the methods of Heat transfer?"**
- August 1999, Vol. 4 No. 3A – **"What is Temperature", "What is Pressure", "What is a refrigerant"**
- September 1999, Vol. 4 No. 4 – **"Specific Heat", "Sensible and Latent heat"**
- November 1999, Vol. 4 No. 6 – **"Saturation Temperature", "Sub-cooling", "Superheating"**
- December 1999, Vol. 4 No. 7 – **"What is Enthalpy?"**
- March/April 2000, Vol. 5 No. 2 – **"Mechanical Refrigeration (The Basics)"**

These articles can be found within the **Container Product Groups Information Library** on our web site at **www.container.carrier.com** . The information library section is a user restricted site, you must have an ID and password to access it. If you do not have access to this site you can also contact your nearest CTD field service engineering representative who will be happy to supply you with copies.

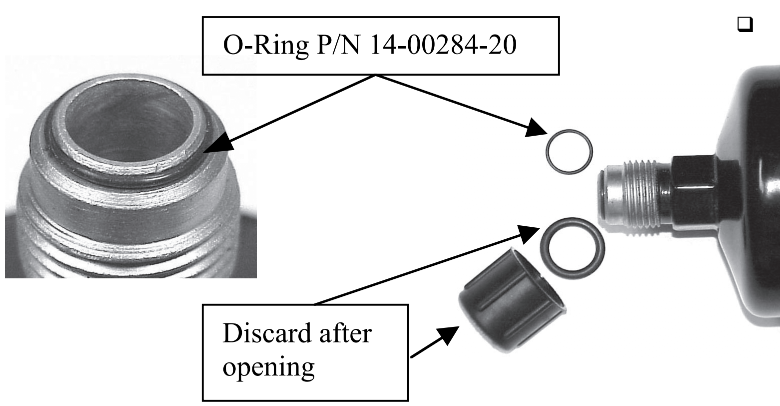
Tech *Tip*

Filter-Drier O-Ring Installation

It has been brought to our attention that the filter-drier (P/N 14-00311-02SV), which comes with O-rings, has been reported as "difficult to install." The investigation into the root cause of this "difficult-to-fit" problem found that the wrong O-ring was being used.

As shown below, the filter-drier is shipped with dust caps that also have O-rings inside. The dust cap O-rings also serve to help preserve the slight positive pressure each filter-drier is charged with when manufactured. Included with each filter-drier package is a new set of installation O-rings, P/N 14-00284-02. In the event that these installation O-rings are lost or separated from the drier package, the end user can mistakenly try to use the dust cap O-rings. As can be seen below, these O-rings are quite a bit different in size and will consequently lead to the "difficult-to-install" problem being reported.

❑ *Z. Asprovski and M. Rogers*



FAQ

WebClaim – Unit Serial Number Usage

It is my understanding that when using **WebClaim**, to file a warranty claim, a unit serial number must be entered. However, there are several instances in which a unit serial number may not apply for a particular claim. The specific questions I have are:

Q1: How does one submit a claim for an RCG service part that is found defective while installing it, or say upon shipment acceptance by my parts department?

Q2: How does one submit a claim for freight charges not necessarily associated with a unit claim, but say as a result of a special request from Service Engineering to return something?

Q3: How does one submit a claim for an RCG service part that is still under its parts warranty, but the unit it is in is not under warranty?

In the cases of questions 1 & 2 there isn't a unit serial number that can really be used and in the case of question 3 if the unit serial number is used the claim will likely be rejected.

A: Question one pertains to what is referred to as "defective shelf" claims, question two "freight" claims, and question three refers to "service parts" claims. The following procedures should be used for submitting claims for these cases:

- At the **"***Unit Screen***"** enter into the **Unit Serial Number** field either:

  000000001 for Defective Shelf or 000000002 for Service Parts or 000000003 for Freight

  Then click the "*Find or Verify*" button. When the system responds, you will see "Defective Shelf", "Service Parts", or "Freight" displayed in the **Unit Model Number** field.
- In the **Date of Failure** and **Install Date** fields, enter the appropriate dates.
- Since the **Container # Prefix** and **Container #** fields are required, but do not pertain in these situations, you can use your keyboard *"space bar"* to get by these two fields—by hitting the space bar once in each field. For parts that have serial numbers, please place the defective parts' serial number in the appropriate field.
- On the *"Part Number Screen"* enter the part number in the **Enter Part #** field and verify correct number. For *"freight"* claims skip this screen.
- On the *"Job Code Screen"* enter your company in the **Customer Name** field.
- For *"freight"* claims the **Enter Failure Code** field will also appear, select *"01-Other."*
- In the **Condition and Cause of Failure** field box enter a brief description of what the part defect was, or in the case of *"freight"* claims enter reason for freight charges.
- From the *"Calculation Screen"* submit the claim.

Note: Items with core value will need to be returned under the normal core procedures.

❑ *M. Donahoe*

Tech *Tip*

Avoid Damaging the Electronic Partlow Drive

Analysis of damaged recorders has shown that the largest percentage can be attributed to mishandling during the changing of the chart. This mishandling appears to occur from either over tightening the chart-retaining hub nut, or from physically moving the stylus arm up or down along the chart, apparently to verify its function. Either of these actions can result in the motor drive gear stripping.

To properly remove and install a new chart, it is recommended that the stylus be carefully lifted by grasping the arm near the base and pulling the arm away from the chart until it snaps into its retracted position. Then hold the chart in place and turn the chart-retaining nut counter-clockwise. Then **finger-tighten only** the new chart in place with the retaining nut. Gently lower the arm until the pen tip comes in contact with the chart.

The stylus arm should never be manually moved up and down the chart face!

Further details on recorder operation and trouble-shooting can be found in the Operation & Service Manual.

❑ *P Hoover*

General

2001 **Tech***Line* Newsletters

Volume 6

Number 1 (March)

FAQ – Gasket Materials
Tech *Tip* – Stepper Motor O-Ring
Tech *Tip* – DataView for DOS Tips
Tech *Tip* – Combination Return Air Sensor
General – Training School Schedule
General – 2000 Newsletter Listing

Number 2 (September)

FAQ – Megohm Readings on Heaters
Tech *Tip* – Control Transformer Replacement
Tech *Tip* – Cd29 Failure Action / Response Mode
General – Troubleshooting Electronic Chart Recorders
General – New Container Web Site
General – DataLine for Windows

Number 3 (November – Special Edition)

Feature Article:
EliteLINE & StreamLINE Scroll Units

- Components
  - ✓ The Economizer
  - ✓ The Expansion module
  - ✓ The Refrigerant / Oil Separator
  - ✓ The Scroll Compressor
- Modes of Operation
  - ✓ Economized
  - ✓ Standard
  - ✓ Unloaded
- Software
- Troubleshooting

Notes: Copies of each of these articles can be found under the **Container Products Group (CPG) Information Center** located on our web site at: www.container.carrier.com or they can be ordered by contacting our **Technical Publications Department** at 315-432-6485 (fax at 315-432-7683).

General

Training School Schedule

Here is a brief look at the some upcoming container training being offered around the world this year. Refer to the *2002 Worldwide Customer Training* brochure (62-03198 Rev. AH) for the full schedule and program descriptions, enrollment details, and fees.

Date	Program	Location	Class I.D.	Language
APRIL				
3 – 5	3-Day Container	Guatemala	661	Spanish
8 – 12	1-Week Container	Rotterdam, NL	662	English
8 – 12	1-Week Container	San Jose, Costa Rica	663	Spanish
15 – 17	3-Day Container	Rotterdam, NL	664	English
18 – 19	2-Day Cont./Genset	Rotterdam, NL	665	English/Dutch
22 – 23	2-Day CA Update	Long beach, CA	666	English
22 – 24	3-Day Container	Las Vegas, NV	673	English
24 – 26	3-Day Container	Hong Kong	669	English
29 – May 3	1-Week Container	Qingdao, China	671	English/Mandarin
MAY				
6 – 10	1-Week Container	Long Beach, CA	674	English
13 – 17	1-Week Container	Athens, Greece	678	English/Greek
20 – 22	3-Day Container	Agadir, Morocco	682	English/French
21 – 22	2-Day Cont./Genset	Montreal, Canada	681	English
22 – 23	2-Day CA Update	Fremantle, Australia	683	English
JUNE				
10 - 12	3-Day Container	Elizabeth, NJ	685	English
17 – 18	2-Day Cont./Genset	Yokohama, Japan	688	English/Japanese
19 - 21	3-Day Container	Pusan, Korea	686	English/Korean
20 – 21	2-Day Cont./Genset	Pusan, Korea	687	English/Korean
24 – 25	2-Day Cont./Genset	Seattle, WA	670	English
24 - 28	1-Week Container	Christchurch, NZ	689	English