Johnson Controls

Absorption Chiller Training for Technicians

7066DV001

Agenda

Day 1 | Day 2 | Day 3 | Day 4 | Resources

Assessment

Section 1 Review

Section 2 System Components

Agenda

Day 1 | **Day 2** | Day 3 | Day 4 | Resources

Section 2a
ParaFlow
Purge System

Section 3
Micropanel

Section 4
Chiller
Startup

Agenda

Day 1 | Day 2 | **Day 3** | Day 4 | Resources

Section 5
Crystallization

Section 6
Operations and
Maintenance
PM and Tools

Section 7
Troubleshooting

Agenda

Day 1 | Day 2 | Day 3 | Day 4 | Resources

Section 8 Repair

Assessment

Assessment

Please open up Eclicker on your iPad to take the Assessment

Section 1: Review

Welcome to

YIA/YPC Single-Stage/Two-Stage Absorption Chiller Training

YORK
BY JOHNSON CONTROLS

Our Policy prohibits printing. Save GREEN.

Welcome to the Absorption Chiller Training!

Let's introduce ourselves

- Participant introduction
  - Name, location, years with the company
  - Types of chiller systems worked on, including brands and types
  - Years of experience working on these
- Your Expectations
  - What do you want to learn this week? Instructor introduction
- Instructor introduction

Housekeeping Issues

Tent Name Cards

- Security Policies
  - Daily sign in
- Bathrooms
- Smoking
- Class/Lunch (map)
- Break areas
- Fill out paperwork
  - Class Roster
  - Data Verification
- Binder material
- Tour lab facility
- Lab safety requirements
- Cell Phones

YIA Absorption Cycle

Review

Now let's review some important concepts.

Section 1: Review

First Law of Thermodynamics:

Energy cannot be created or destroyed, it can only be transferred from one form to another.

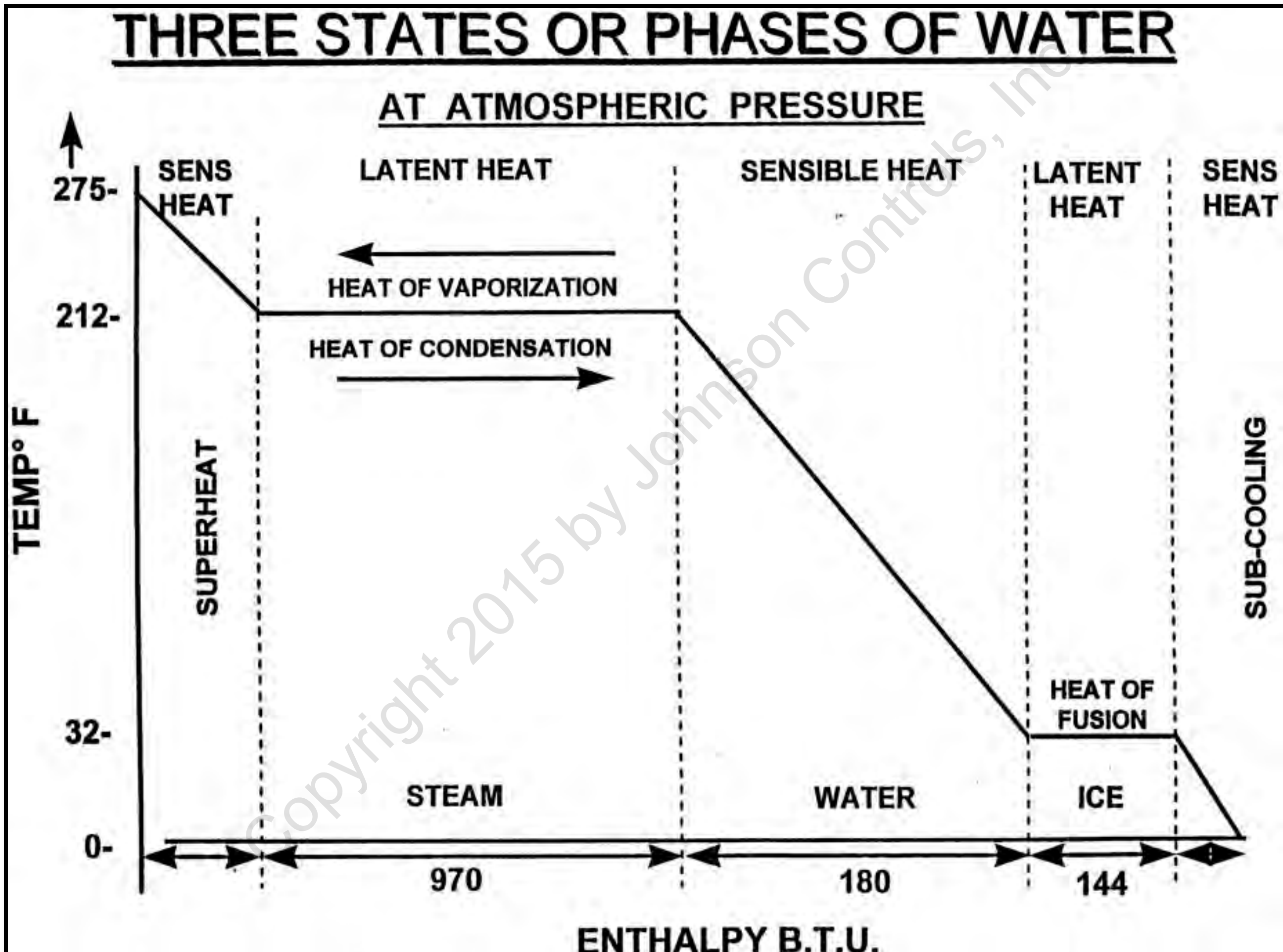
Second Law of Thermodynamics:

Heat moves from a warmer body to a cooler body.

Types of Heat:

1. Specific Heat
2. Sensible Heat
3. Latent Heat
4. Latent Heat of Fusion
5. Latent Heat of Condensation
6. Latent Heat of Dilution

R-718


THREE STATES OR PHASES OF WATER
AT ATMOSPHERIC PRESSURE
TEMP° F
275-
212-
32-
0-
SENS HEAT
LATENT HEAT
SENSIBLE HEAT
LATENT HEAT
SENS HEAT
HEAT OF VAPORIZATION
HEAT OF CONDENSATION
SUPERHEAT
SUB-COOLING
HEAT OF FUSION
STEAM
WATER
ICE
970
180
144
ENTHALPY B.T.U.

Ethylene Glycol Density/Specific Heat

Based on 40°F / 4ft / sec / 8” pipe			
%	**SH**	**DEN** (lb/cu.ft)	**Freeze**
15	.929	63.98	22.7
20	.911	64.47	17.9
25	.891	64.96	12.7
30	.861	65.65	3.7
35	.839	66.13	-3.7
40	.817	66.59	-12.6
45	.794	67.04	-22.7
50	.770	67.47	-34.7
55	.746	67.90	-48.2
60	.722	68.31	-57.0

Specific Gravity (SG)

What is it?

- For a liquid or a solid, it's the ratio of the substance's density compared to water. For vapor, it's the ratio of its density to air, e.g., weight per unit volume

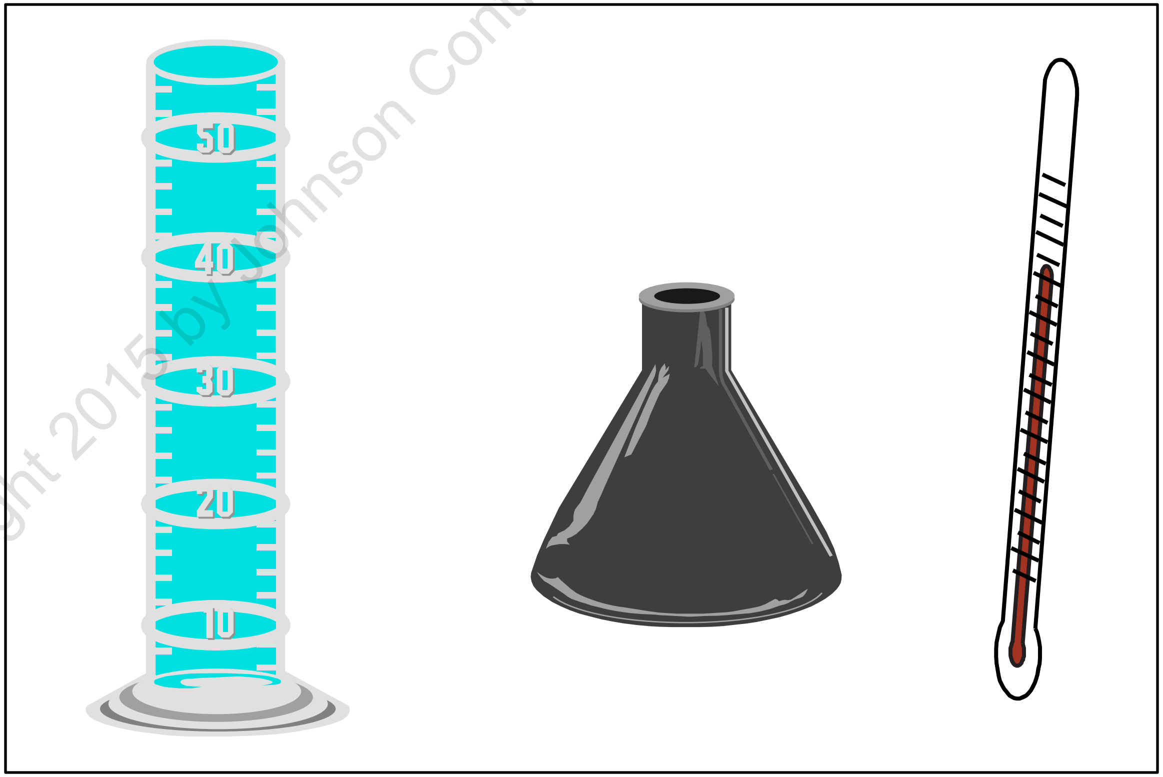
Why is it important?

- The greater the SG of a solution, the more work the pump will have to do to provide circulation

How do you measure it?

Concentrations

Solution concentrations can be determined by using instruments known as hydrometers to determine the specific gravity of the solution and by also measuring the temperature of the solution. This information can then be applied to a chart to determine the concentration of the sample.



Hydrometers

Specific Gravity (SG)

Substance	Density (lb/ft3)	Specific Gravity
Mercury	848	13.60
Brass	530	8.50
Steel	486	7.80
Glass	175	2.80
Lithium Bromide (53%)		1.70
Water	62.4	1.00
Alcohol		0.83
Wood (oak)	50	0.80
Oil (fuel)	48.6	0.78
Gasoline	41.2	0.66
Ammonia (liquid @ 60° F)	38.5	0.62
Wood (pine)	34.2	0.55

All substances at room temperature.

Pressure

- Absolute Pressure
- 14.7 psia at sea level
- 1 Bar
- 760 mm Hg
- 212° F Boiling Point

Pike's Peak

14,110 ft above sea level167° F boiling point

Pressure Conversions

Absolute Pressure = Gauge Pressure + Atmospheric Pressure

Gauge Pressure = Absolute Pressure - Atmospheric Pressure

Example:

Convert 8 PSIG to Absolute Pressure

P Abs = P gauge + P atm

P Abs = 8 PSIG + 14.7 = 22.7 PSIA

Pressure Measurements

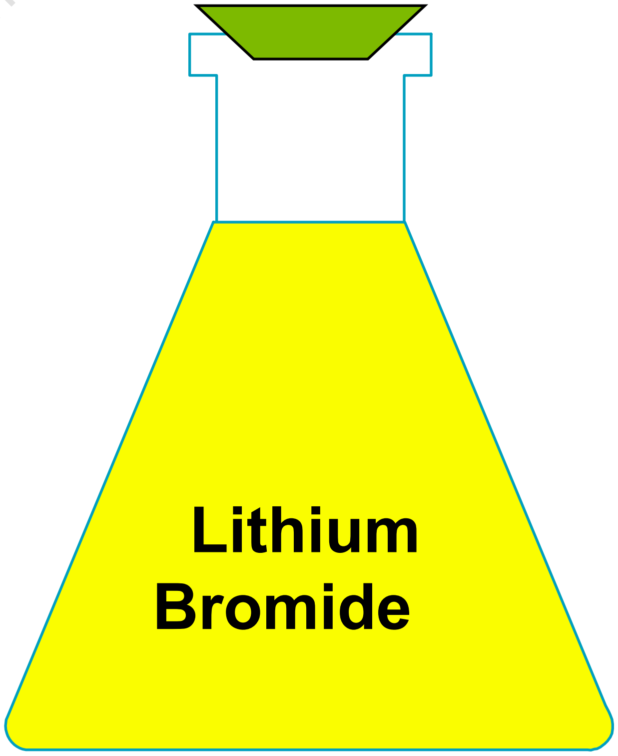
*GAUGE	ABSOLUTE			BOILING TEMPERATURES OF WATER °F
INCHES OF MERCURY (HG) BELOW ONE STANDARD ATMOSPHERE	PSIA	MILLIMETERS OF MERCURY (HG)	MICRONS	
0	14.696	760.	760,000	212
10.24"	9.629	500.	500,000	192
22.05"	3.865	200.	200,000	151
25.98"	1.935	100.	100,000	124
27.95"	.968	50.	50,000	101
28.94"	.481	25.	25,000	78
29.53"	.192	10.	10,000	52
29.67"	.122	6.3	6,300	40
29.72"	.099	5.	5,000	35 WATER FREEZES
29.842"	.039	2.	2,000	15
29.882"	.019	1.0	1,000	+1
29.901"	.010	.5	500	–11
29.917"	.002	.1	100	–38
29.919"	.001	.05	50	–50
29.9206"	.0002	.01	10	–70
29.921"	0	0	0	

*One standard atmosphere = 14.696 PSIA
= 760 mm Hg. absolute pressure at 32°F
= 29.921 inches Hg. absolute at 32°F

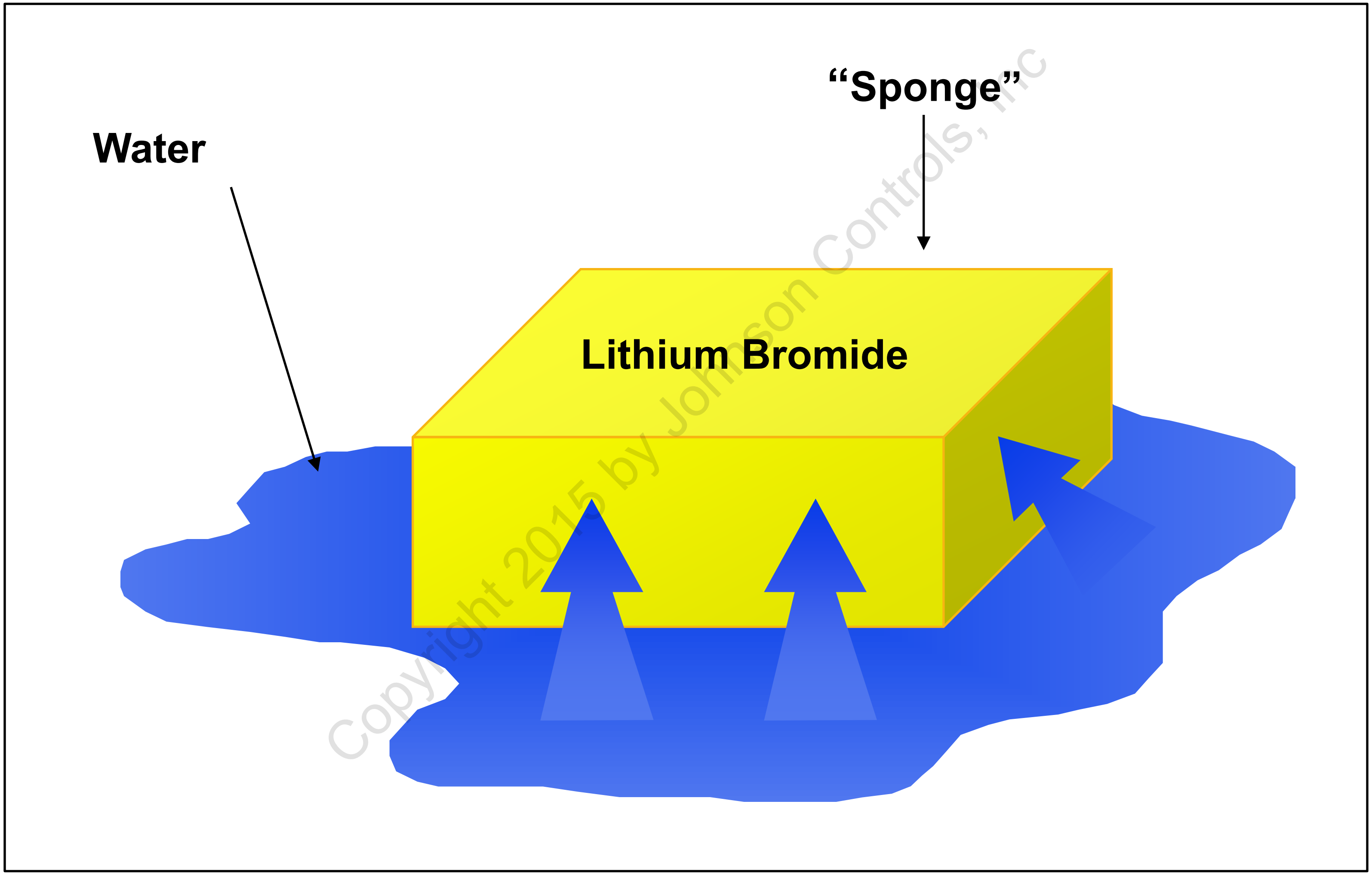
NOTES: PSIA = Lbs. per sq. in. gauge pressure
= Pressure above atmosphere
PSIA = Lbs. per sq. in. absolute pressure
= Sum of gauge plus atmospheric pressure

Absorbent = Lithium Bromide (LiBr)

- Water absorbs readily into it
- High boiling point
- Non-toxic

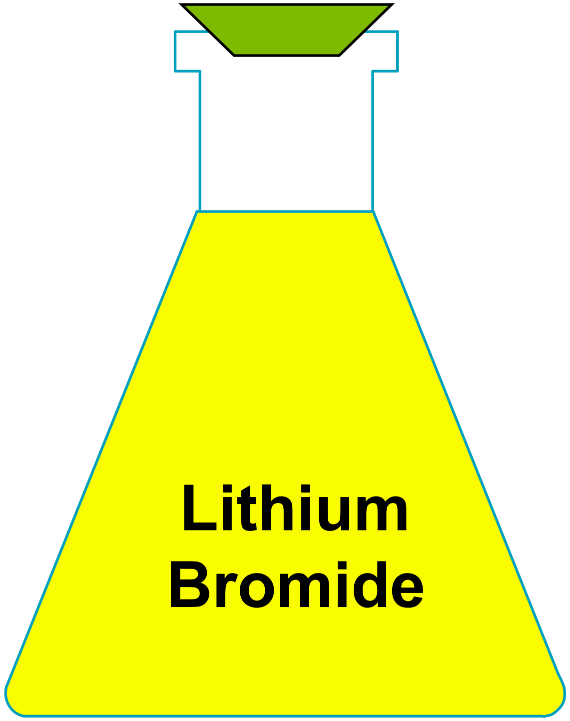


Properties of Lithium Bromide and Water



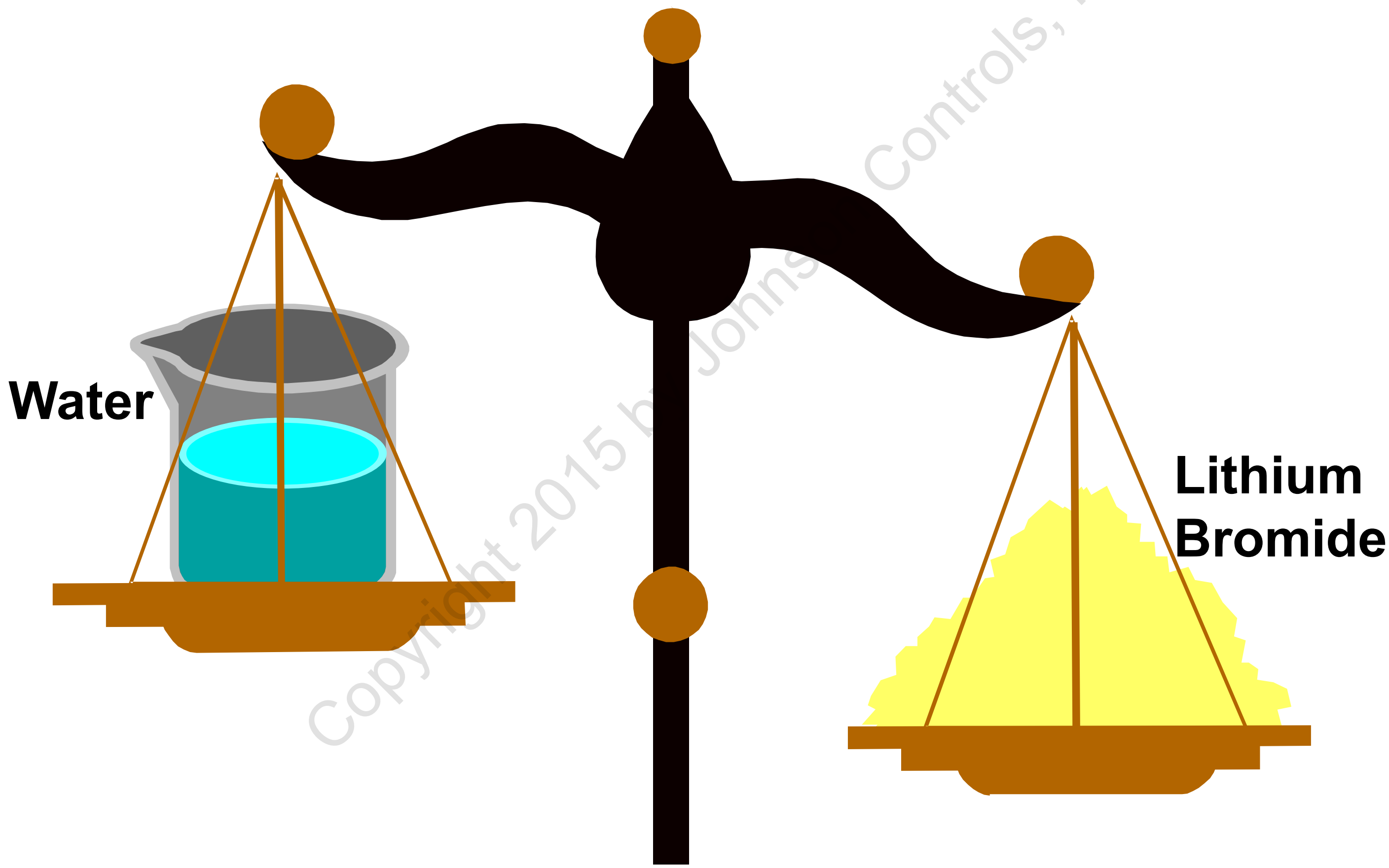
Lithium Bromide

- Lithium Bromide is referred to as “solution”
- This solution is expressed in “% concentration”
- Lithium Bromide is shipped at a concentration of 55%

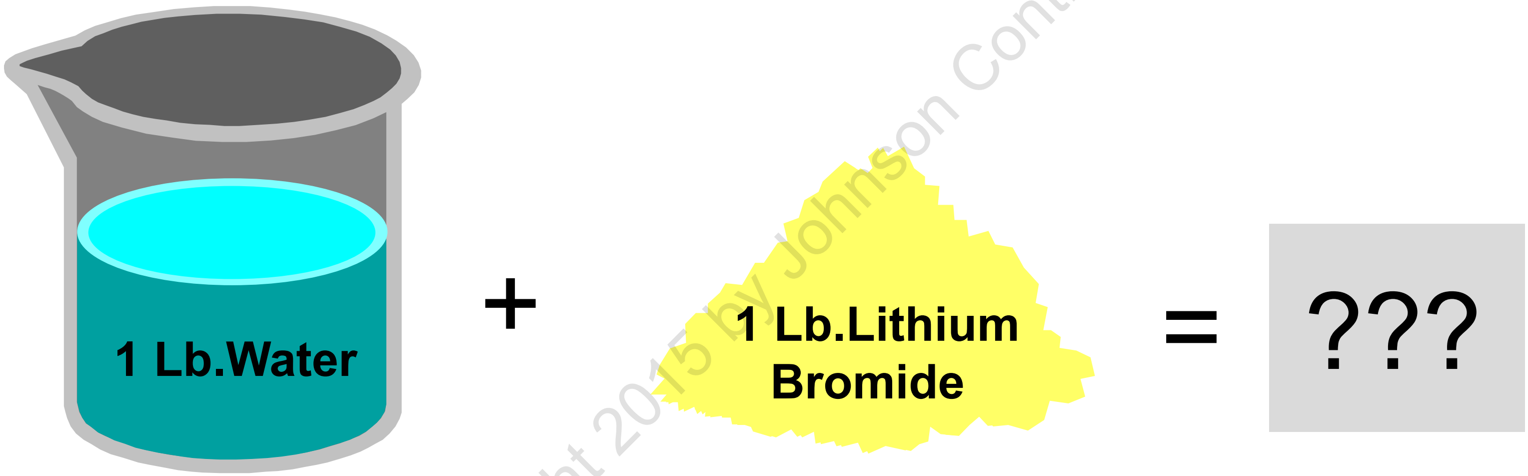


Concentrations

Solution concentrations are determined by weight

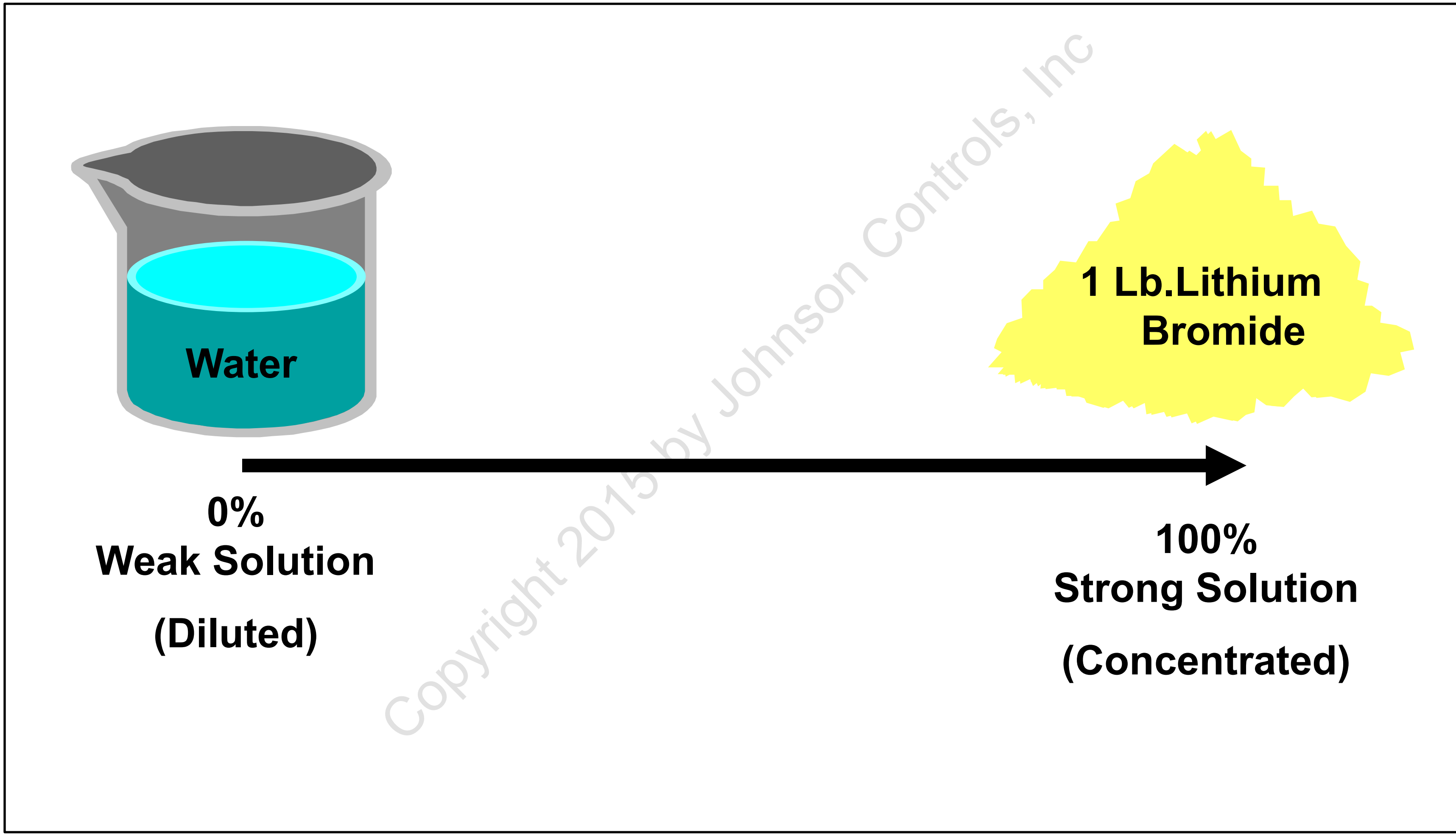


Concentrations



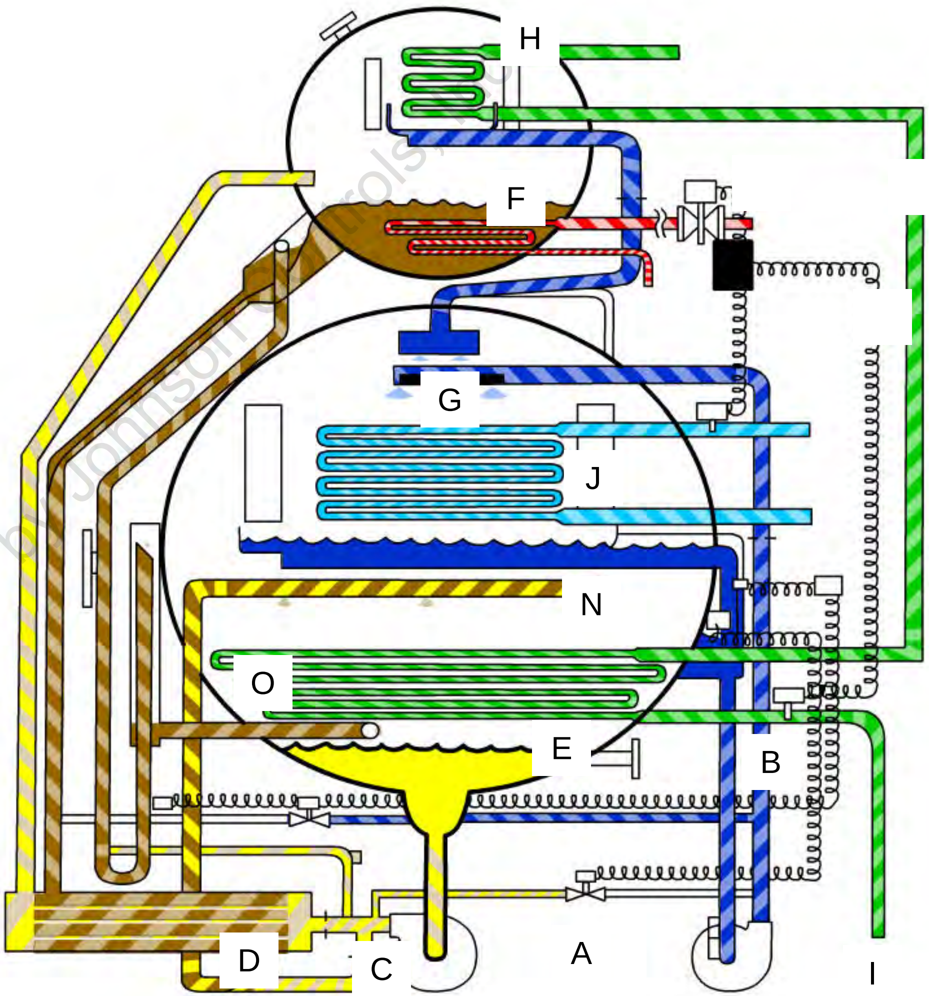
Concentrations

Concentrations



Exercise 1 – Label the Unit

A. Solution Pump
B. Refrigerant Pump
C. Eductor
D. Solution Heat Exchanger
E. Absorber
F. Generator
G. Evaporator
H. Condenser
I. Tower Water Circuit
J. Chilled Water Circuit
K. Micropanel
L. Sight Glass
M. Metering Device
N. Absorber Spray Heads
O. ADC Circuit



Exercise 1 – Answer

A. Solution Pump
B. Refrigerant Pump
C. Eductor
D. Solution Heat Exchanger
E. Absorber
F. Generator
G. Evaporator
H. Condenser
I. Tower Water Circuit
J. Chilled Water Circuit
K. Micropanel
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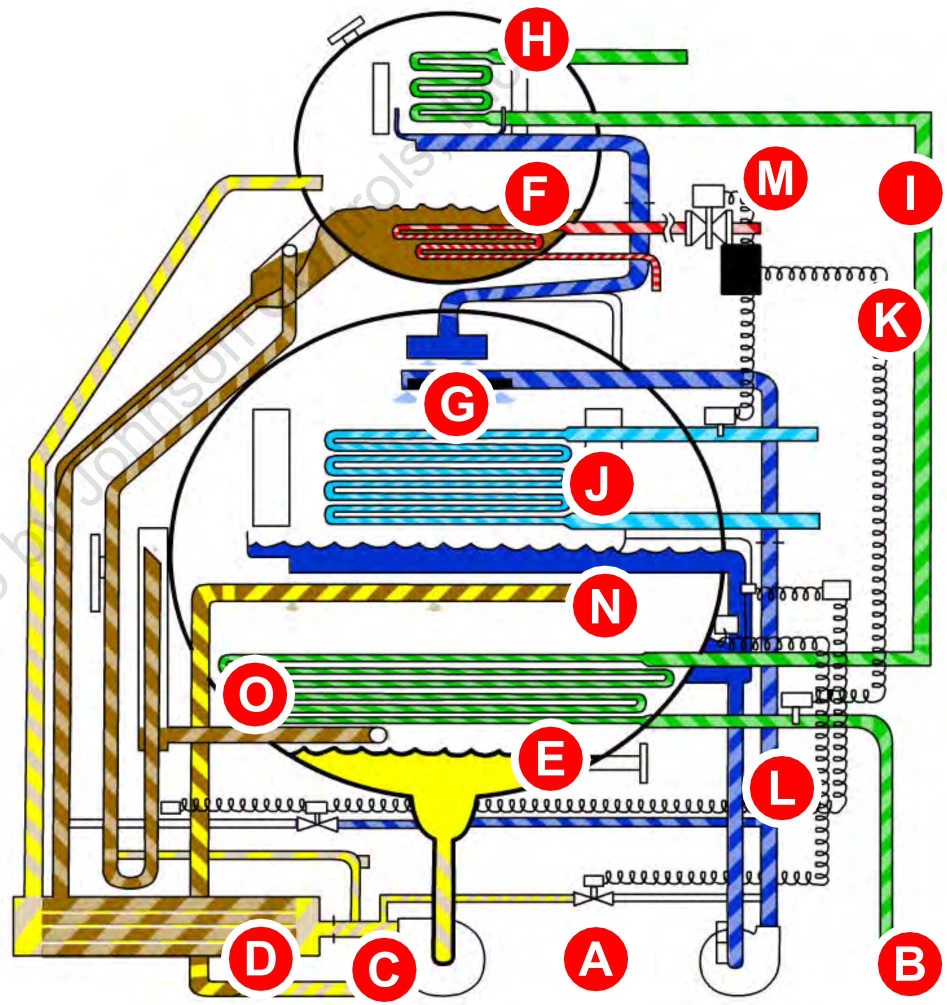
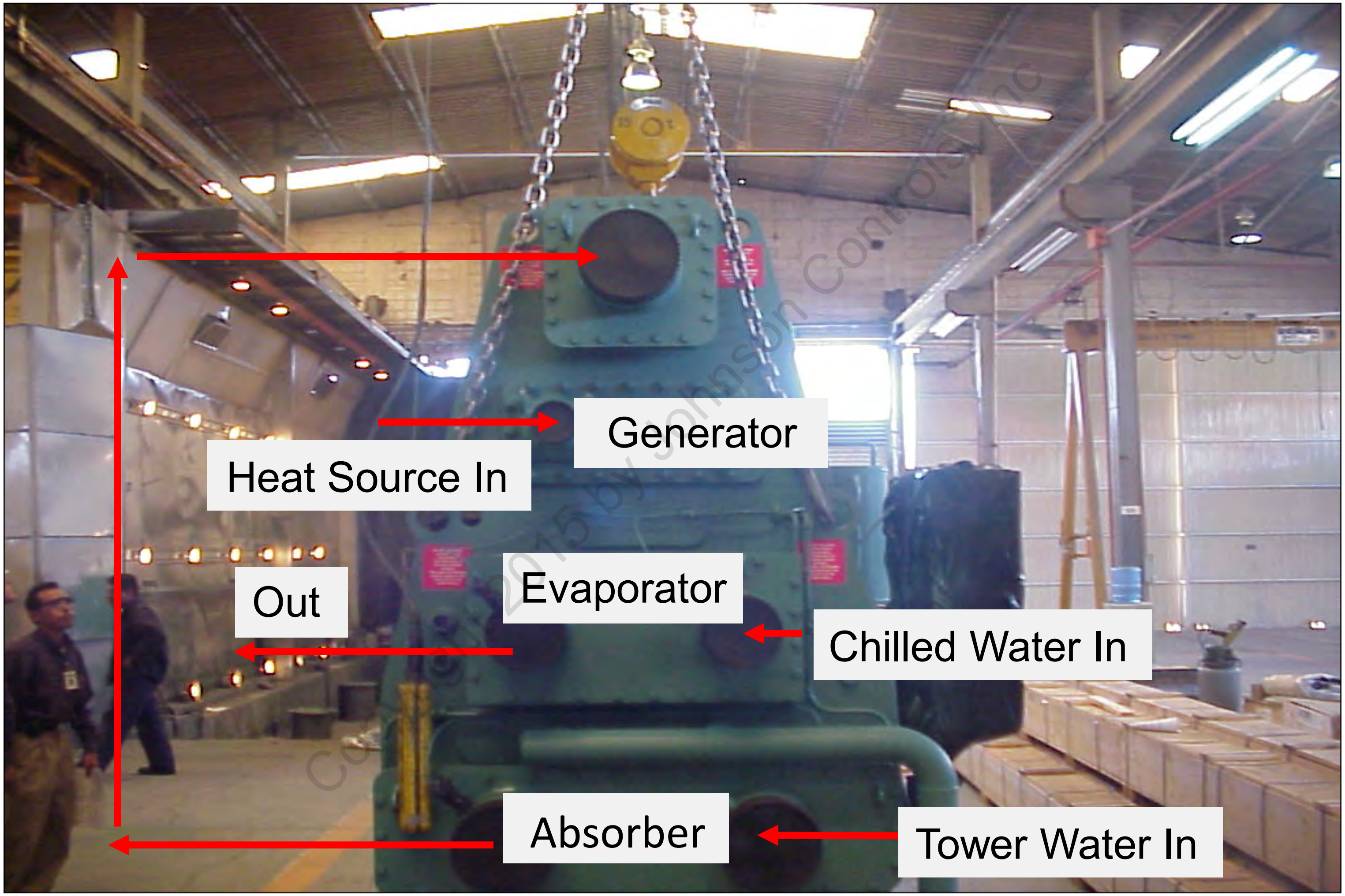
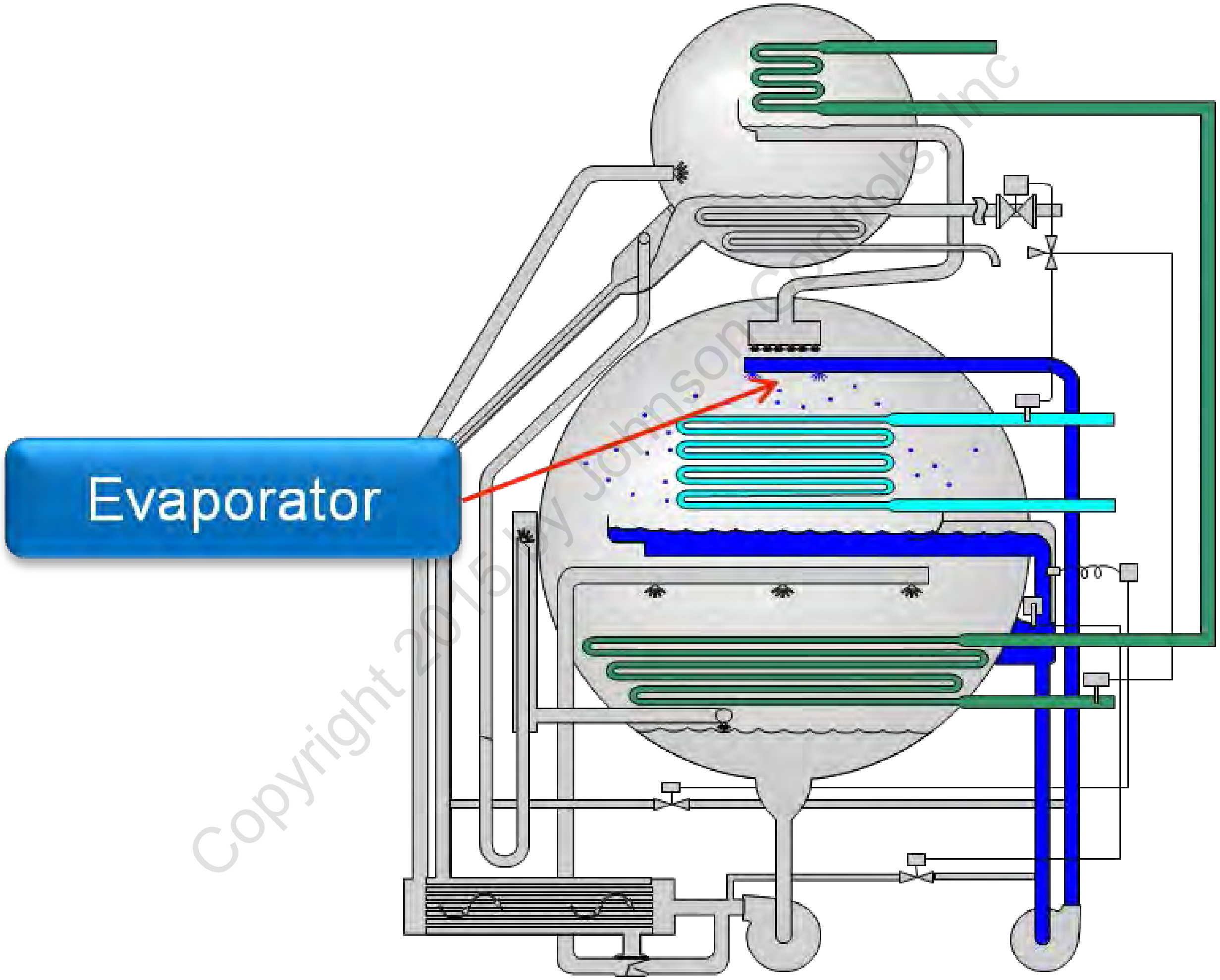


YIA Absorption Cycle (*animation*)


Generator
Heat Source In
Out
Evaporator
Chilled Water In
Absorber
Tower Water In

YIA: Evaporator




Hole for Spray header
Mist Eliminators
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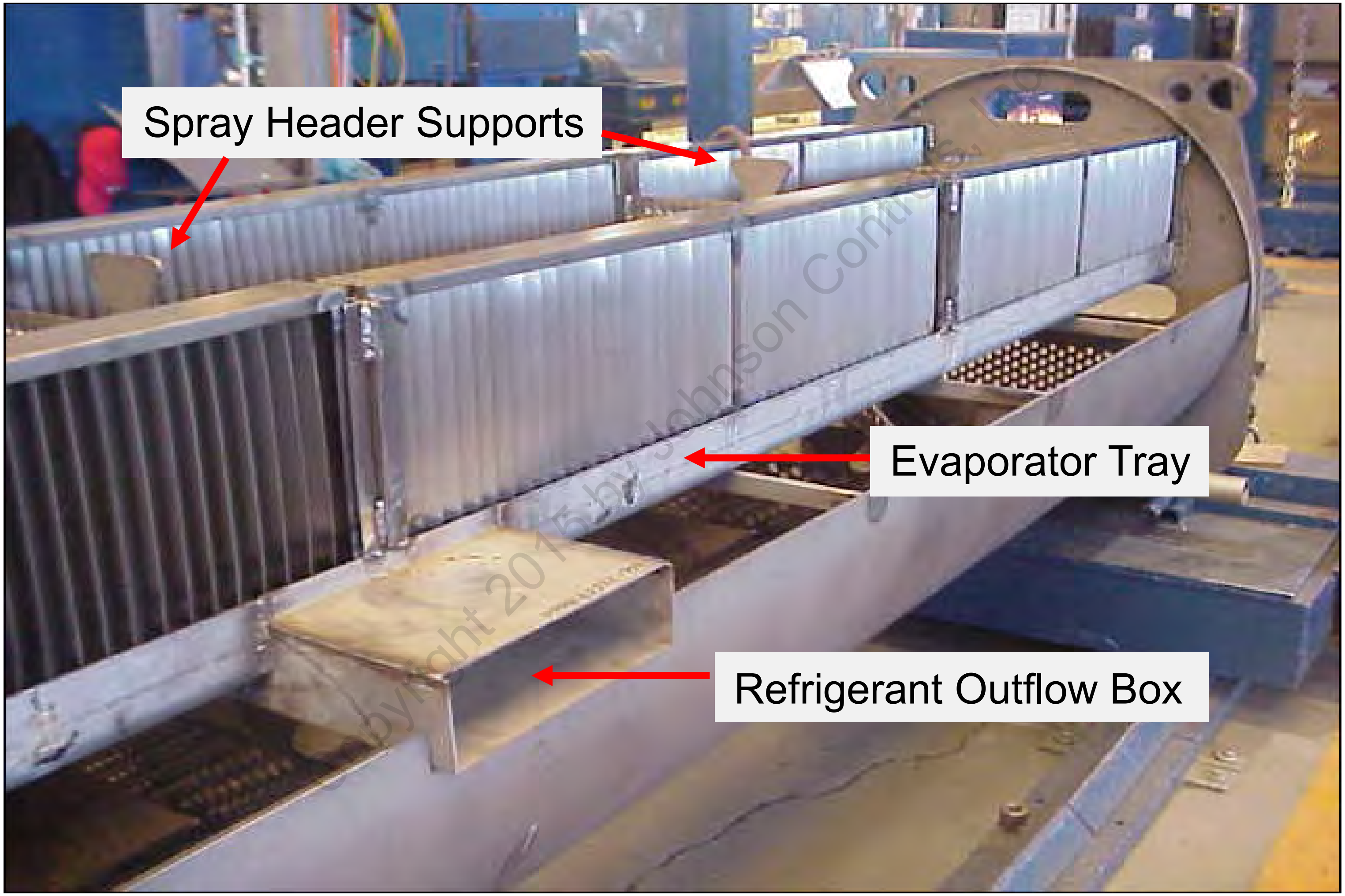
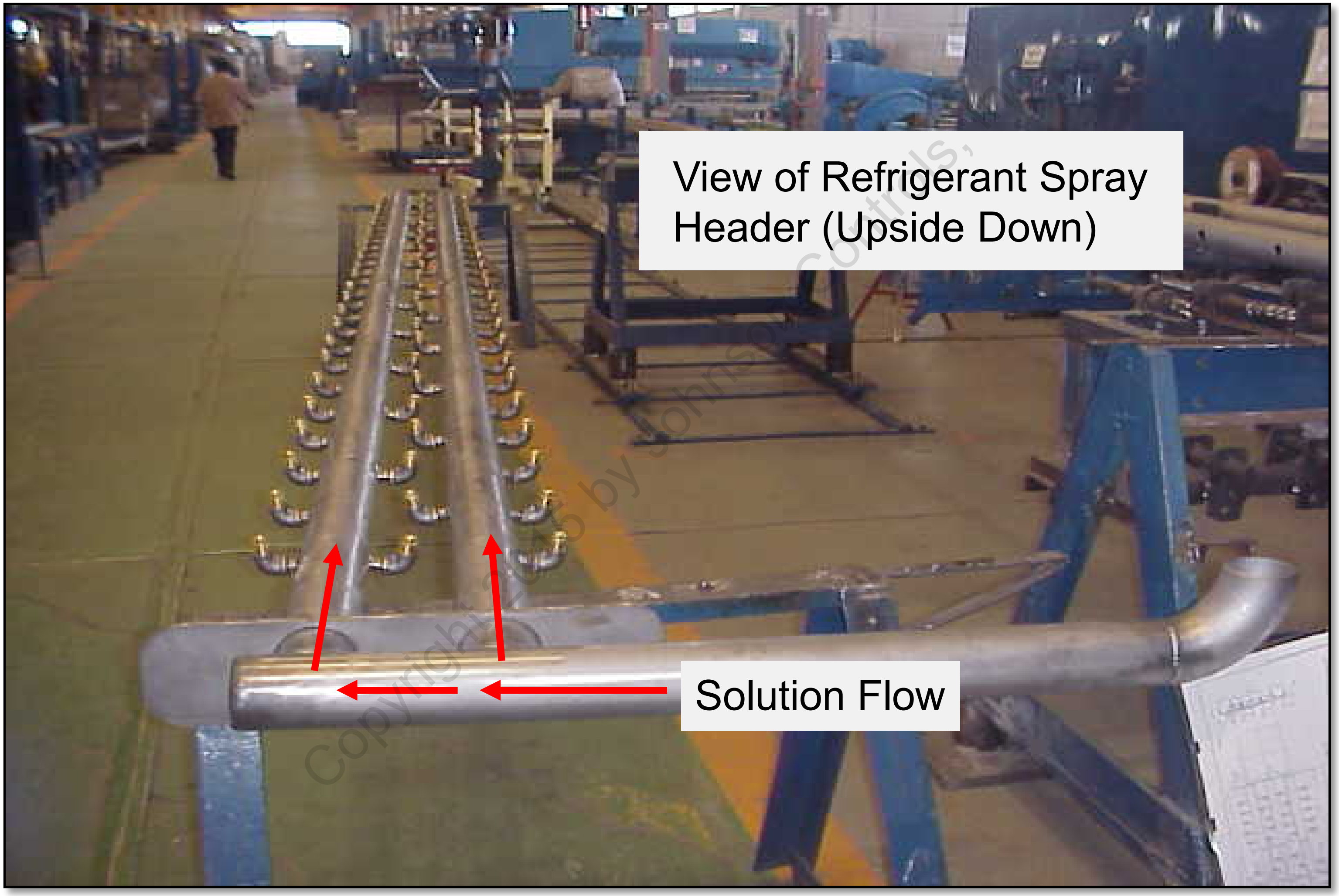
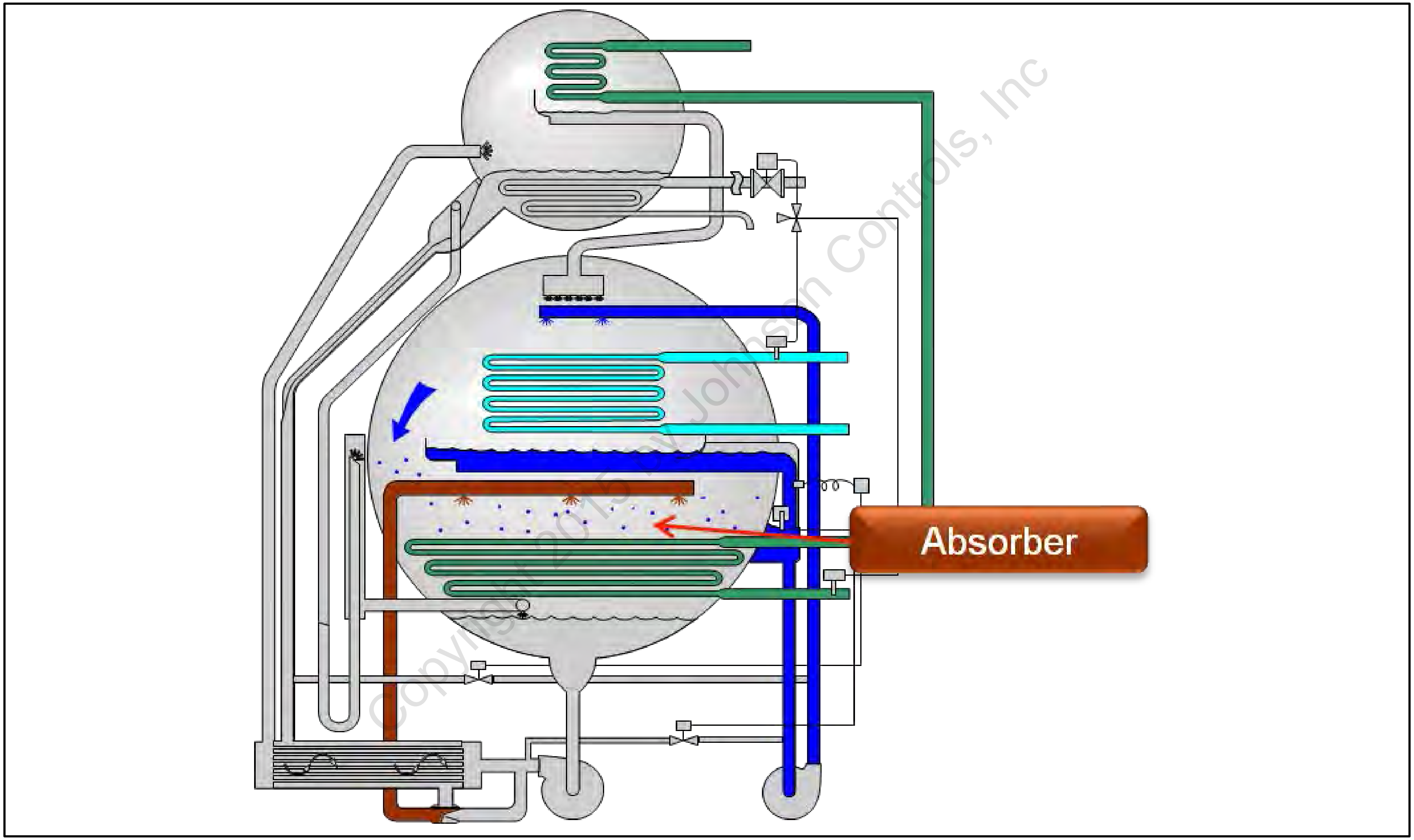

Spray Header Supports
Evaporator Tray
Refrigerant Outflow Box


6:27PM

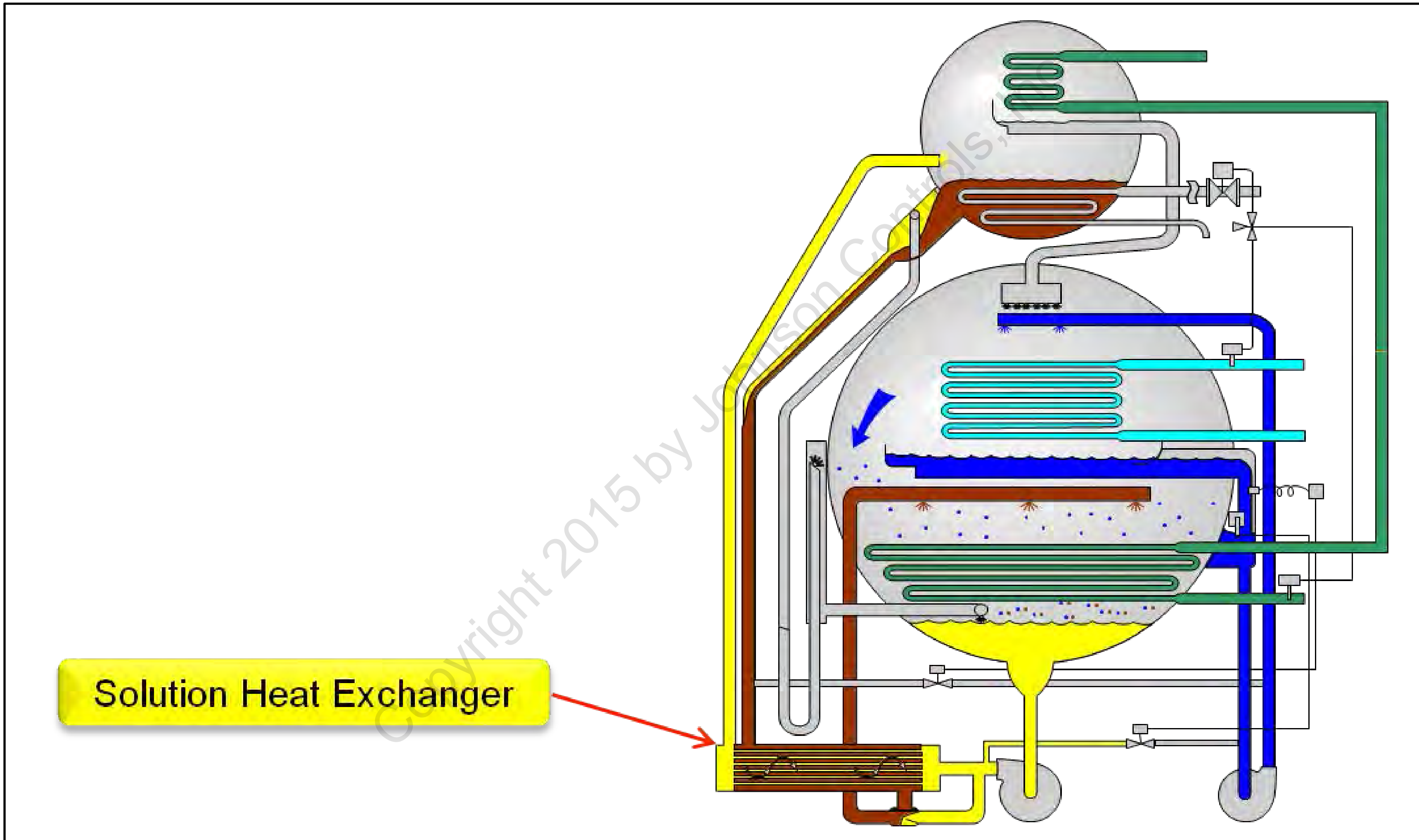

Evaporator Tray showing outflow
C-19

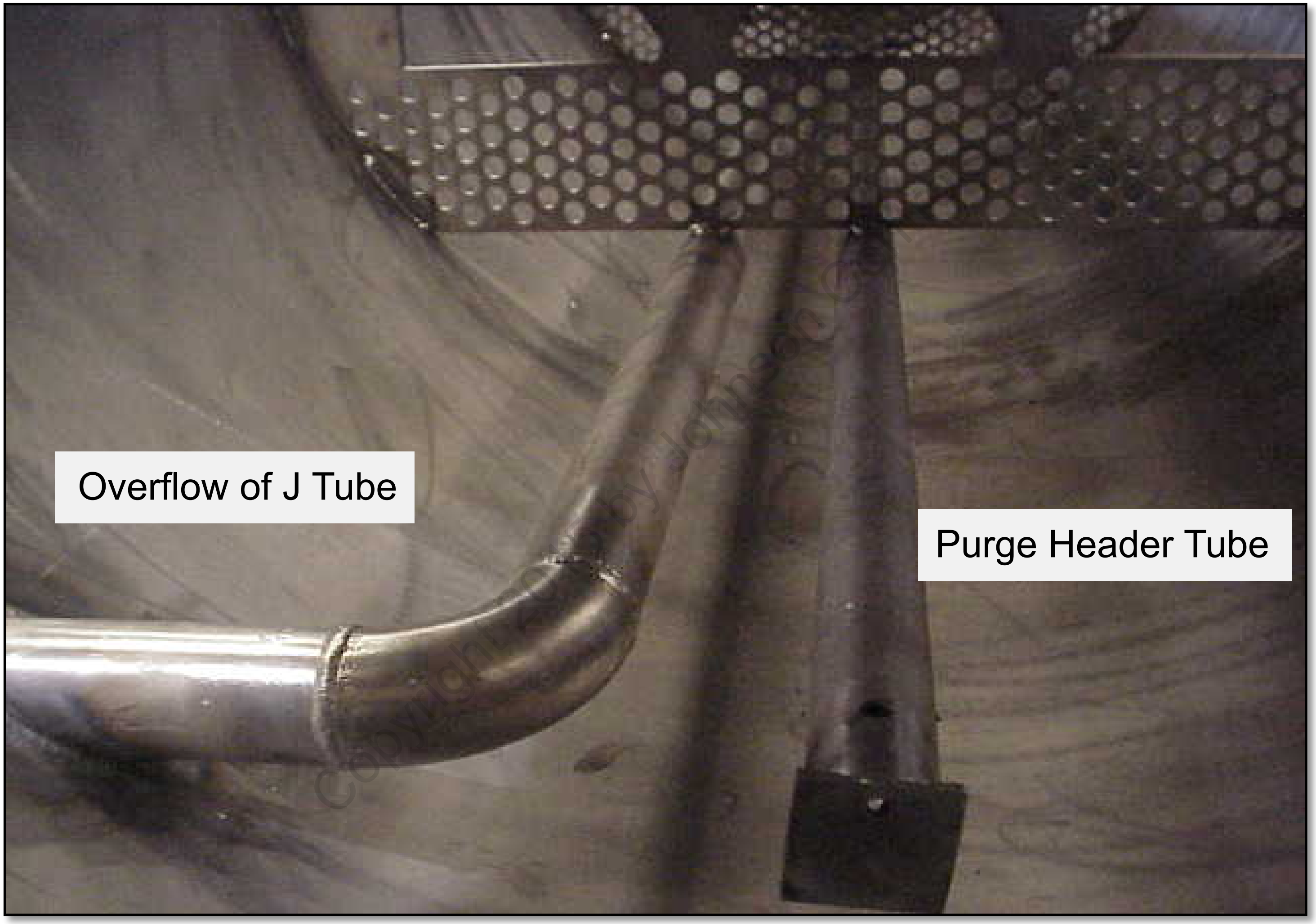

View of Refrigerant Spray Header (Upside Down)
Solution Flow

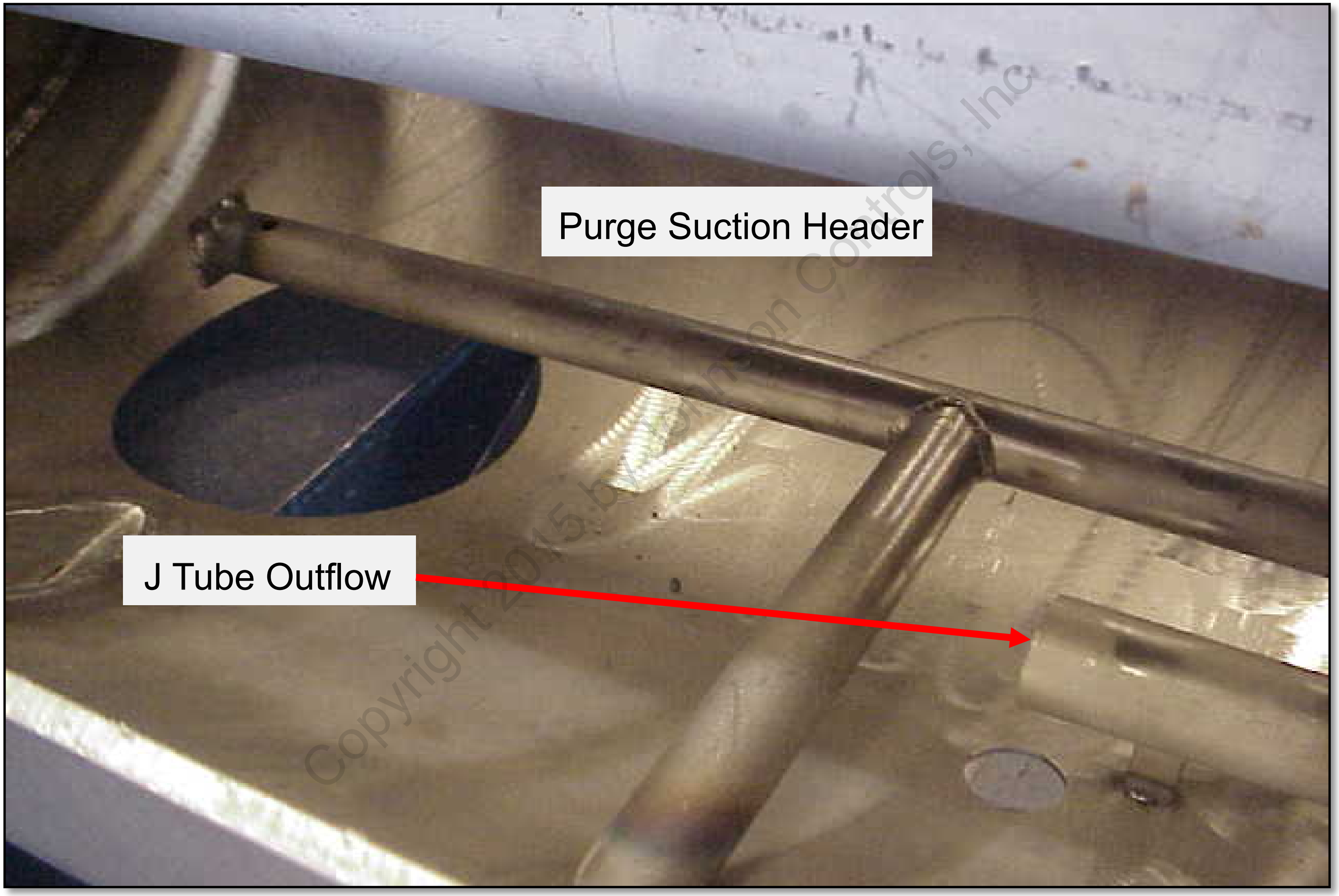
YIA: Absorber



YIA: Solution Heat Exchanger




Overflow of J Tube
Purge Header Tube


Purge Suction Header
J Tube Outflow
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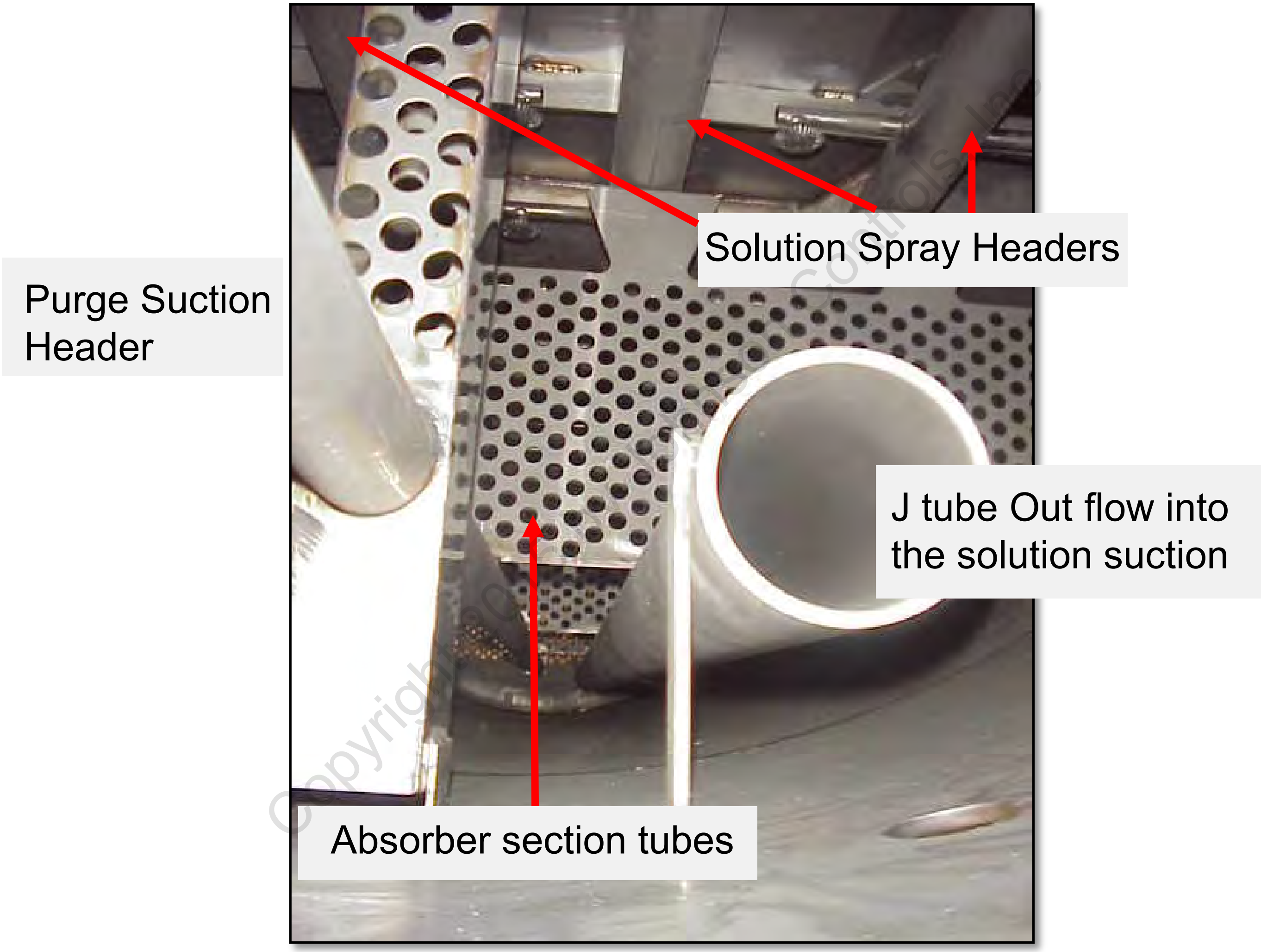
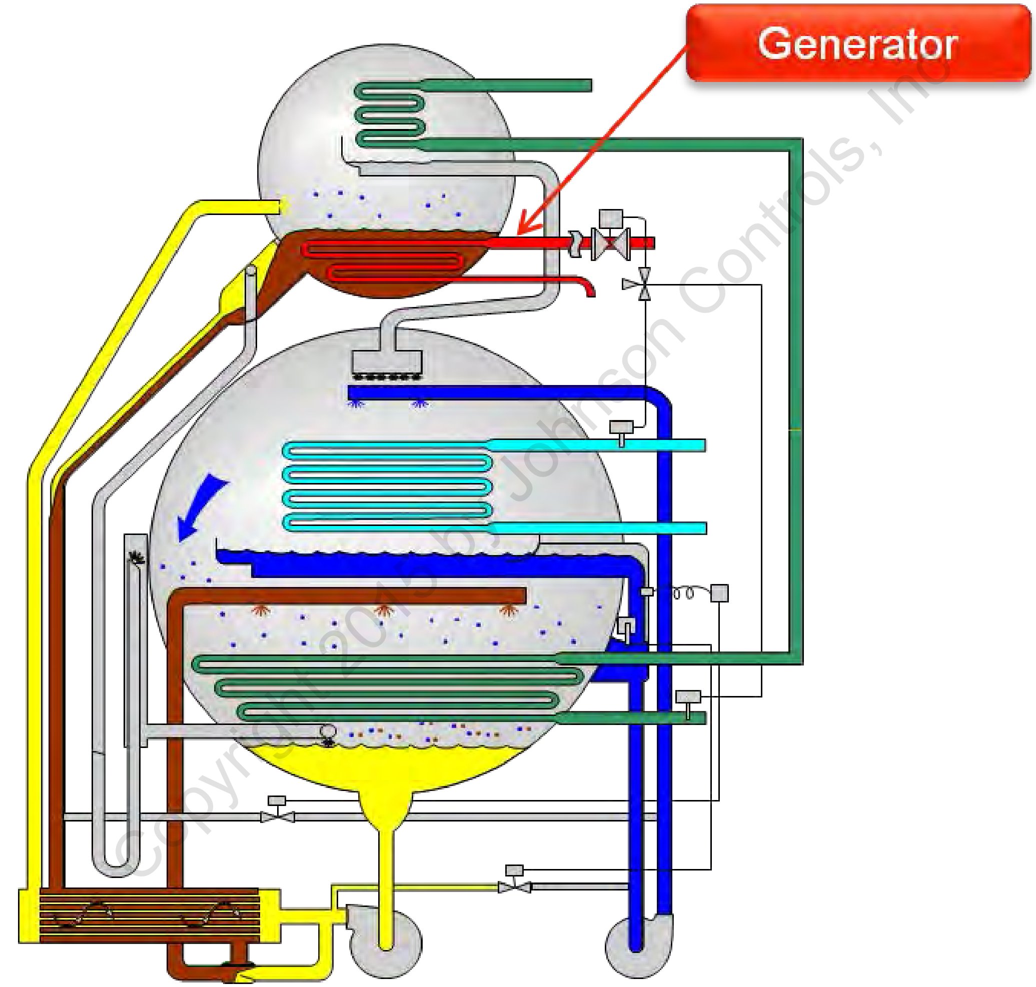
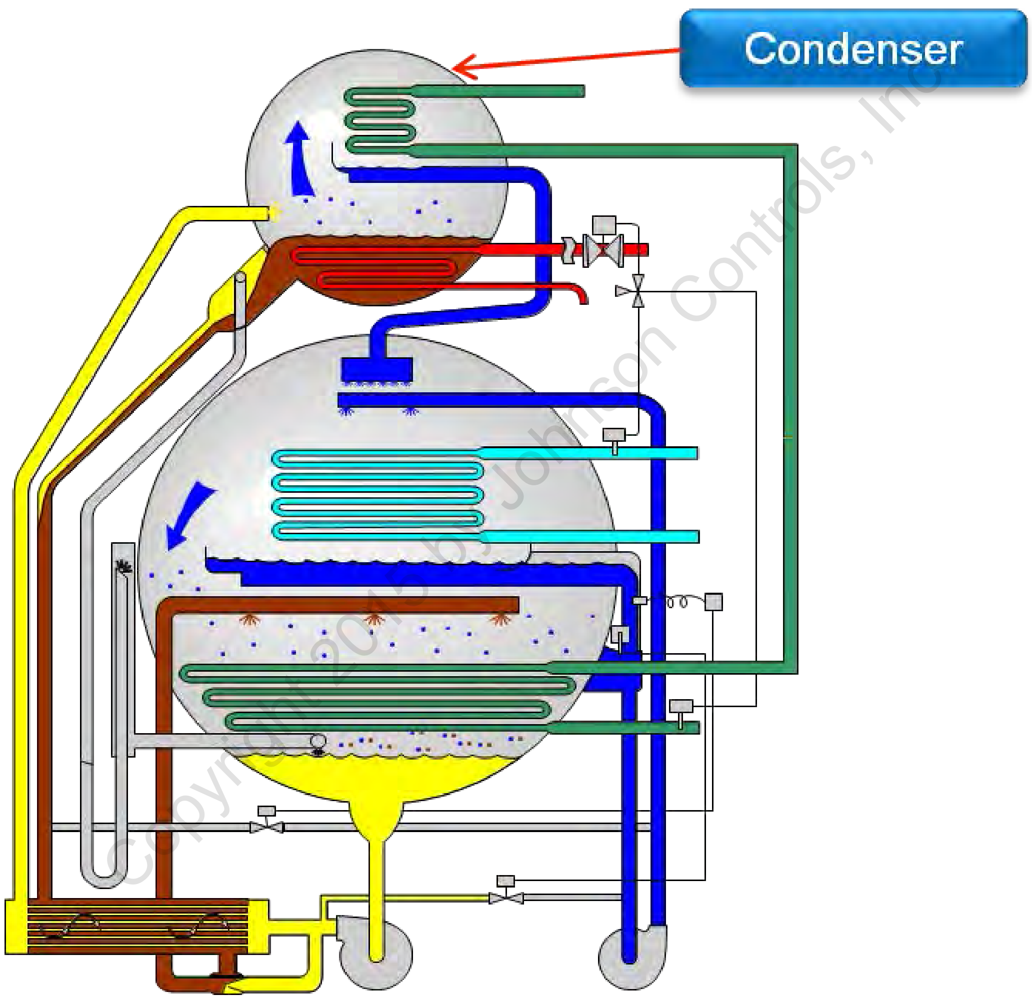
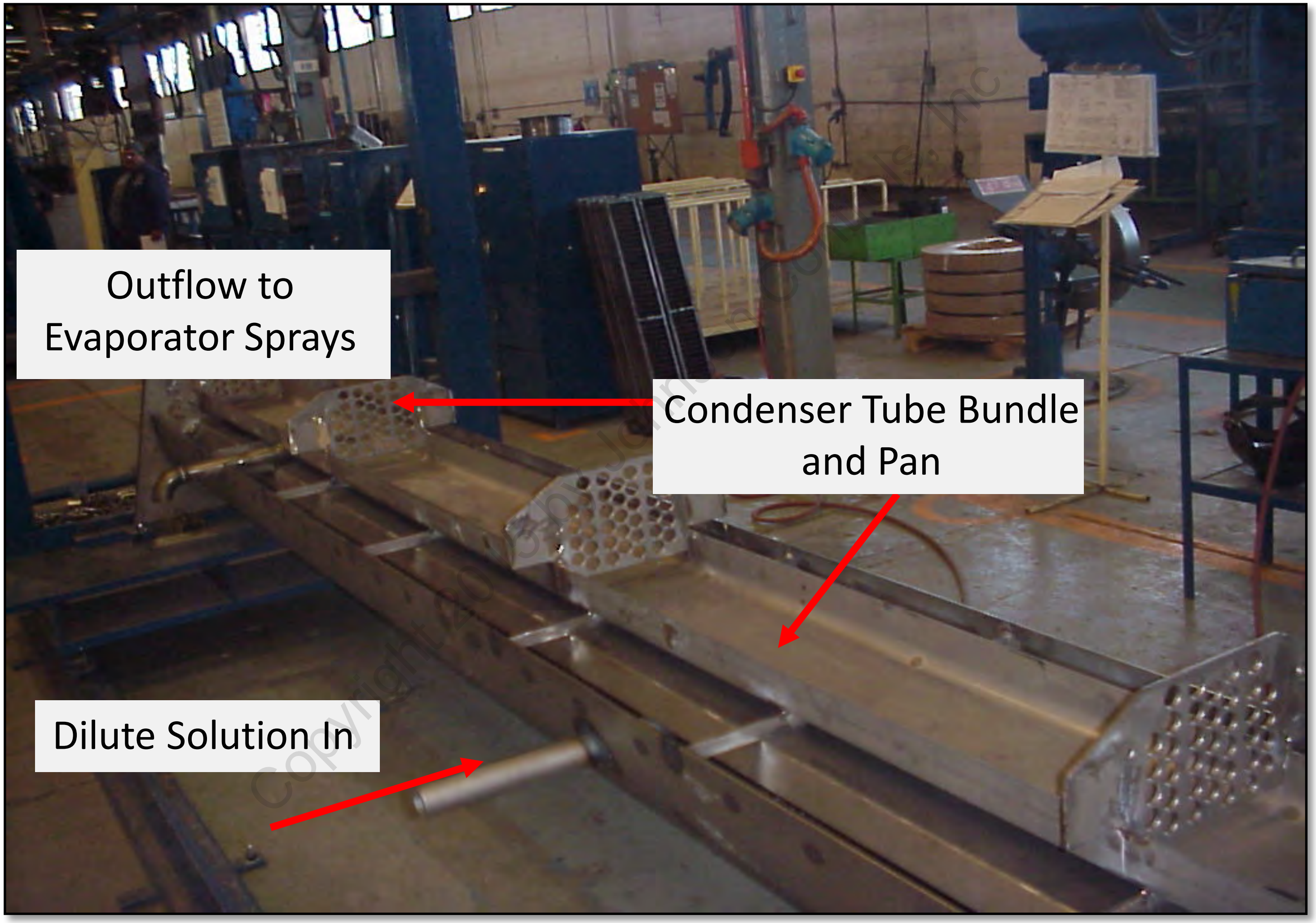

Purge Suction Header
Solution Spray Headers
J tube Out flow into the solution suction
Absorber section tubes

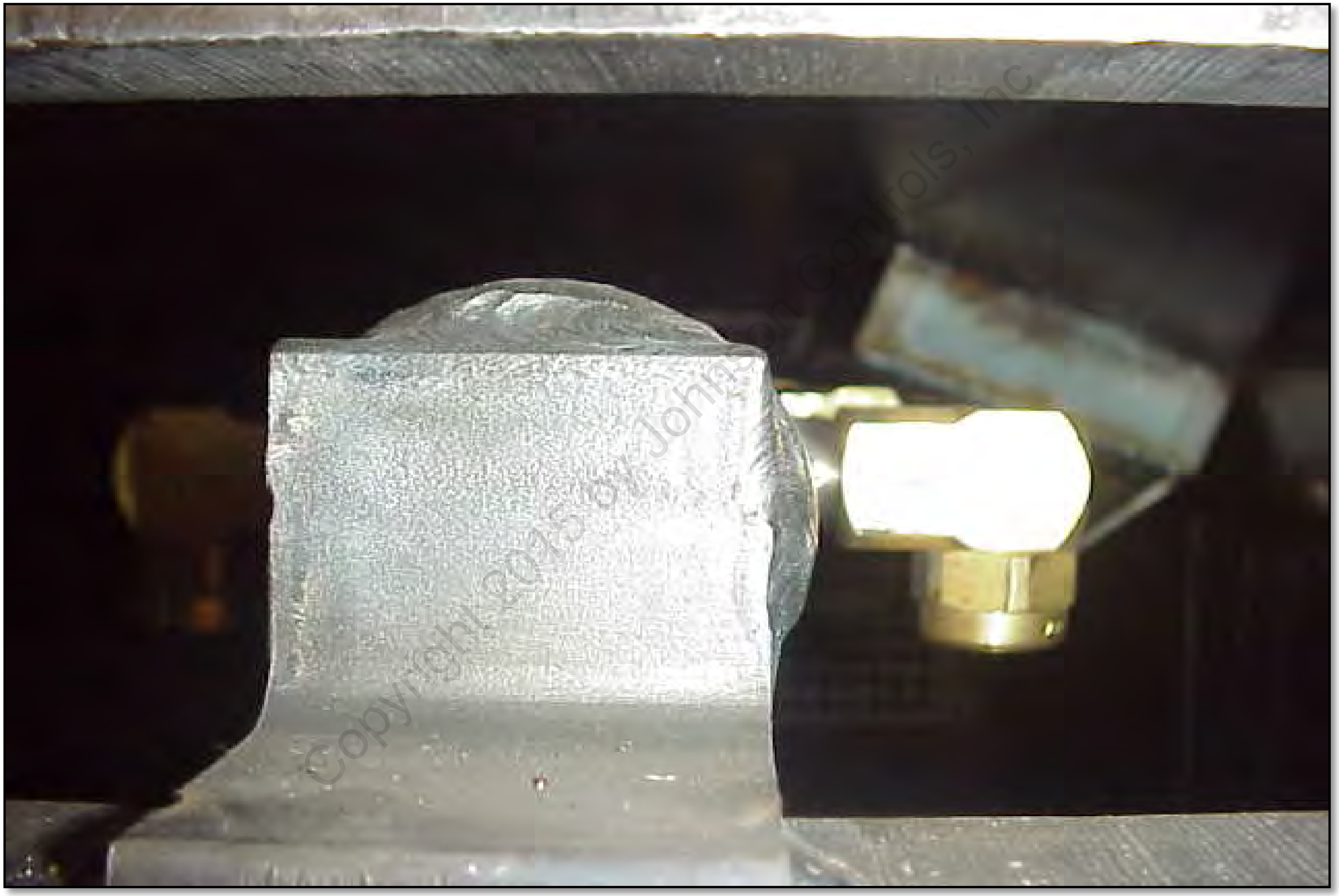
YIA: Generator



YIA: Condenser




Outflow to Evaporator Sprays
Condenser Tube Bundle and Pan
Dilute Solution In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Sections of Condenser

YIA Absorption Cycle (*animation*)


Millennium Absorption Chiller
Display
Entry
Setpoints
Service
1 2 3
4 5 6
7 8 9
0
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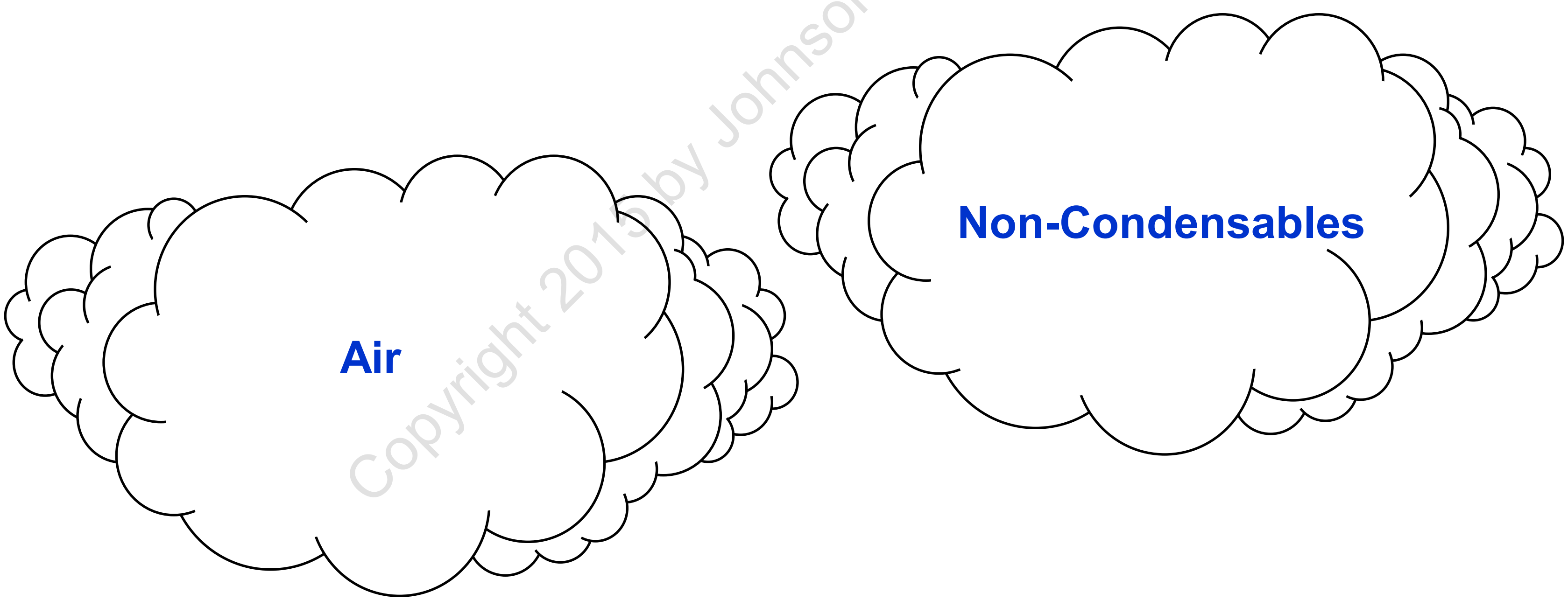
Why Purging is Necessary

- Air leakage into unit
- Internal generation of non-condensables



What are non-condensables

Internally Generated

- Hydrogen - H_2 - Product of Corrosion
- NOx Gases - Typically formed due to rapid depletion of inhibitor
- Ammonia - NH_3 - Indicative of an air leak in the system. Has been linked to corrosion stress cracking in copper

What are non-condensables

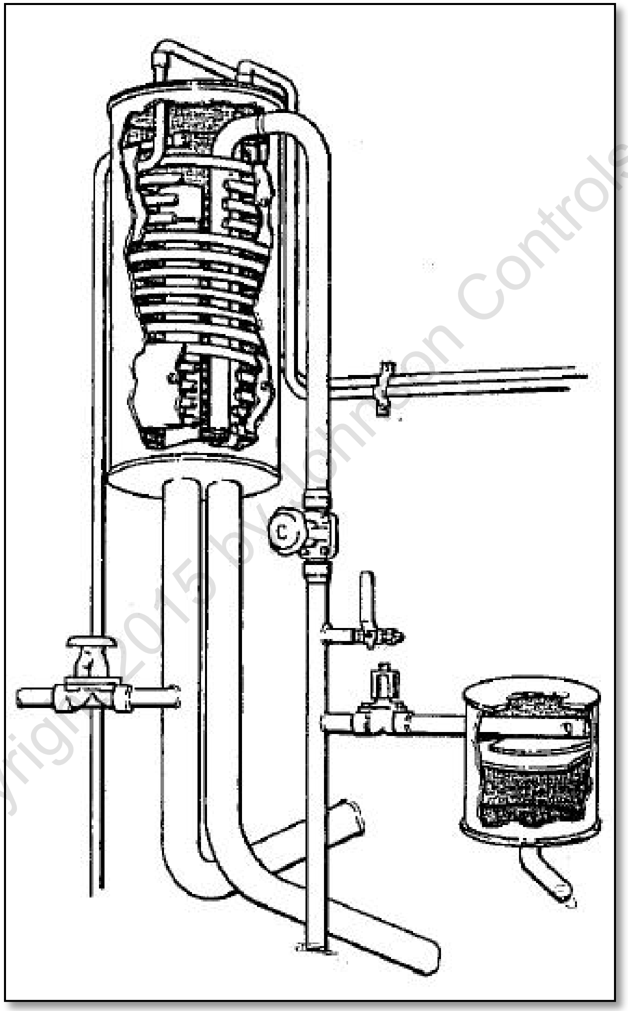
Generated by Air Leaks

- Nitrogen - Main constituent of air
- Oxygen - O_2 - Greatly increases internal corrosion rates, which in turn produce a greater number of internally generated non-condensables
- Any gas that may be present around the leak will also be drawn into the machine

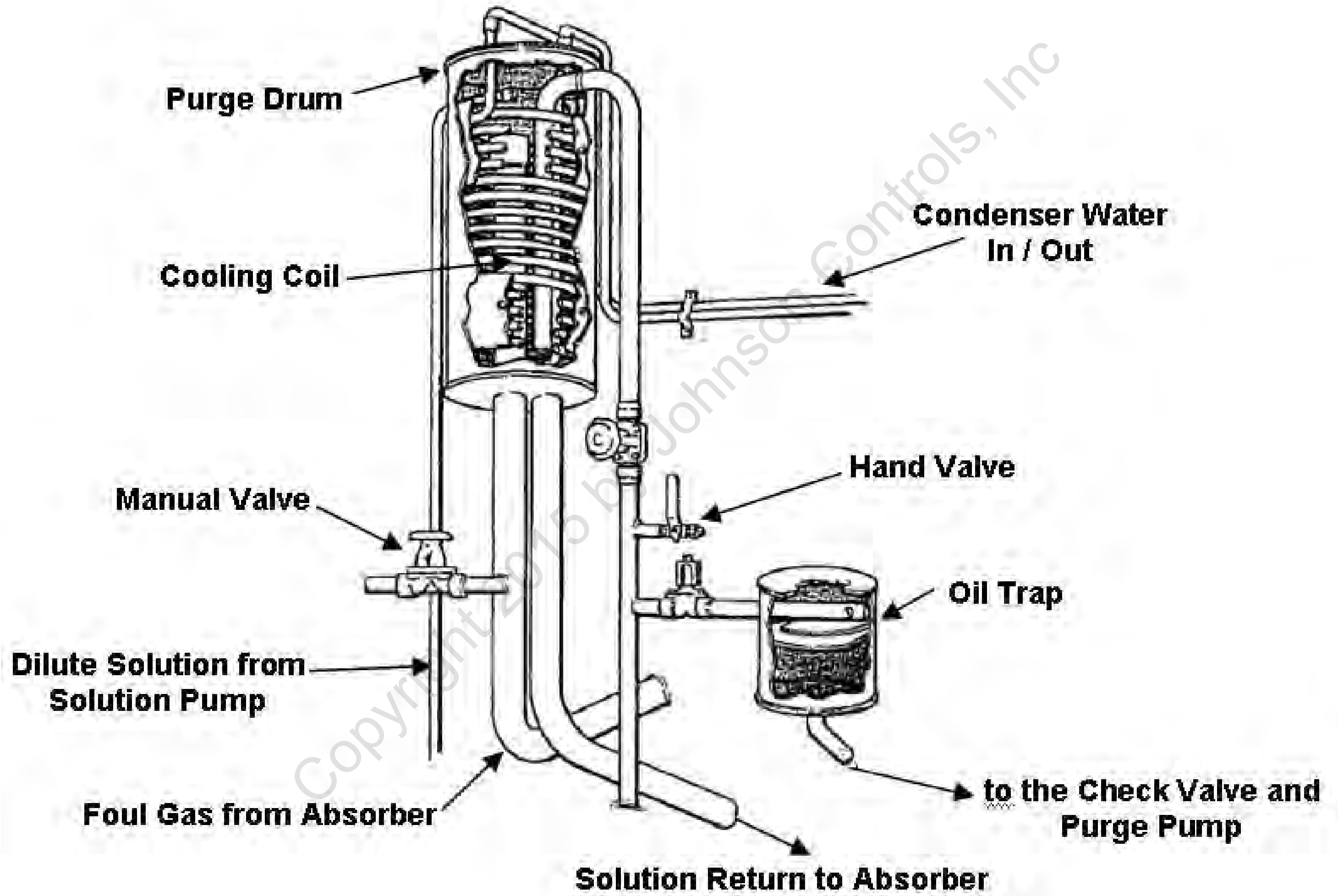
Effects of Non-condensables

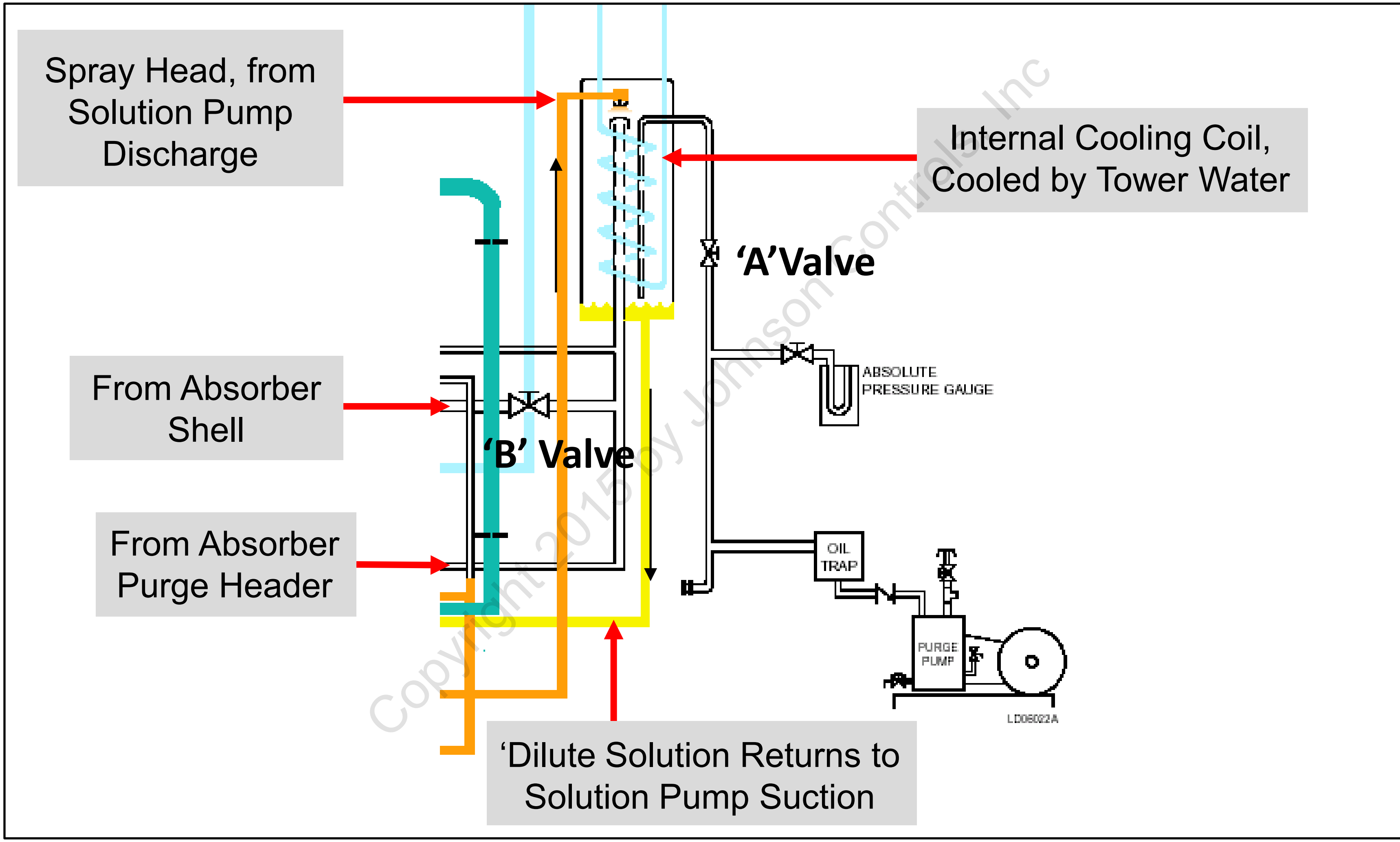
- Higher Operating Pressures and Temperatures
- Loss in Performance
- Rapid Breakdown of Corrosion Inhibitors
- Decreased Unit Life

YIA Purge Components

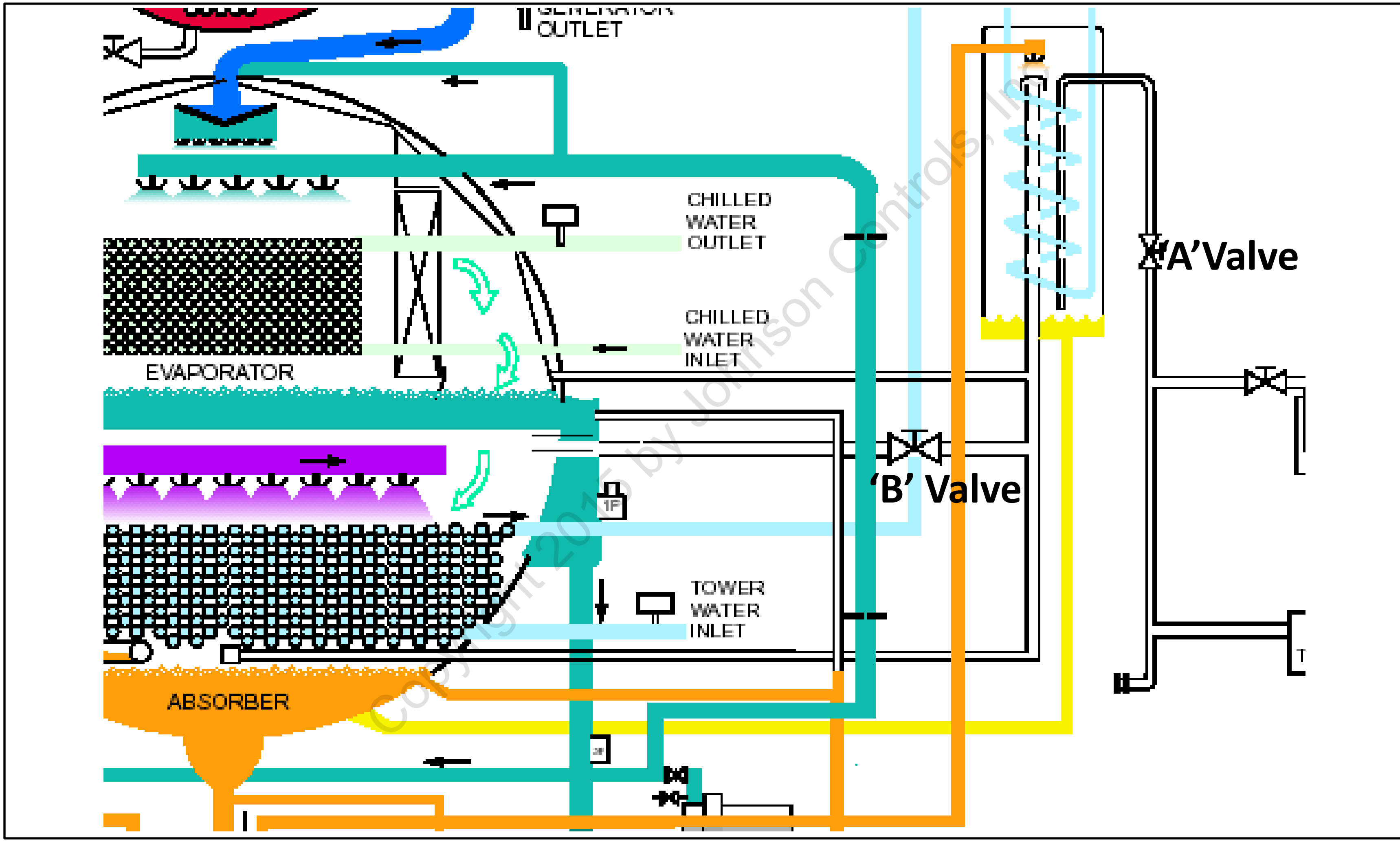


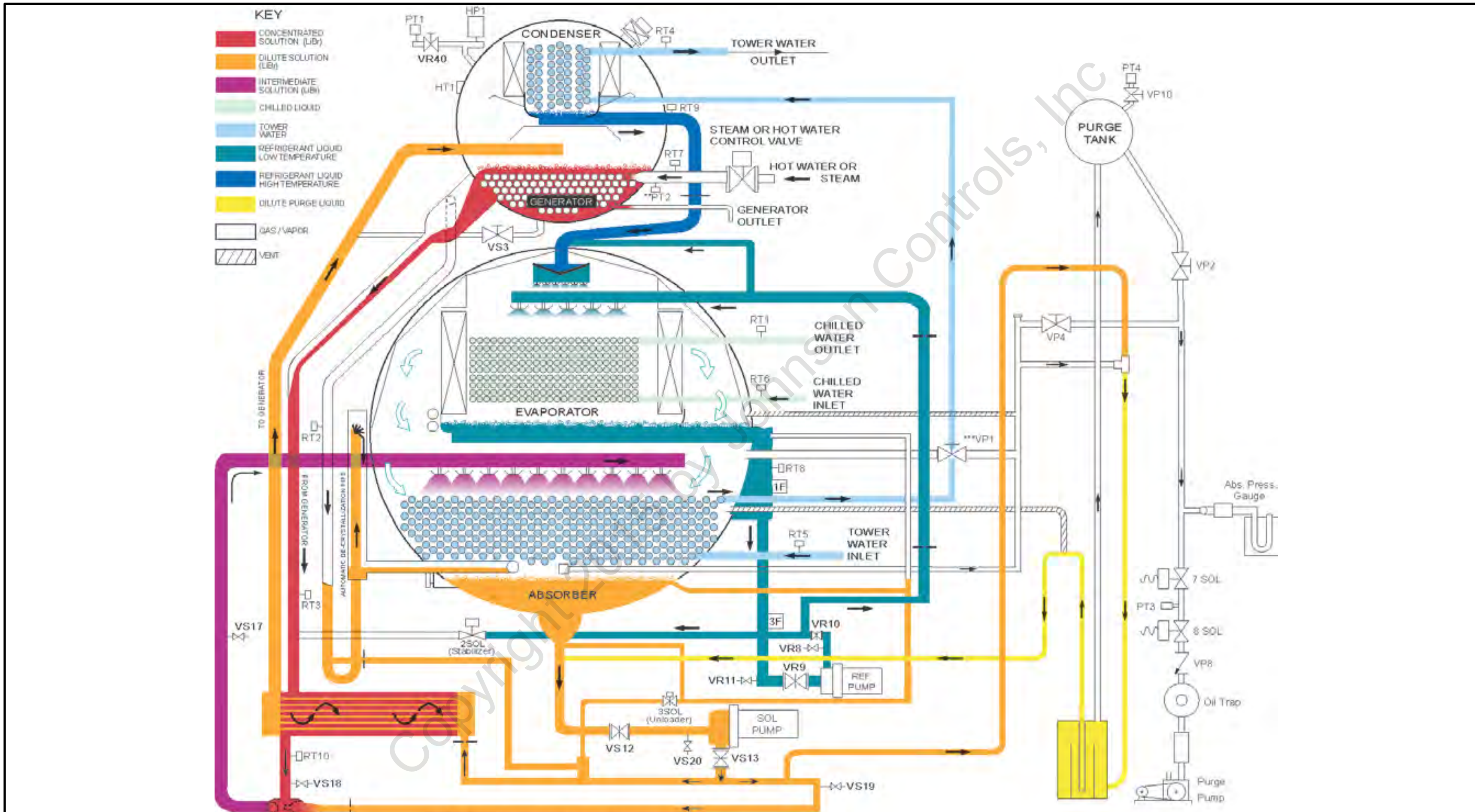
YIA Purge Components





Spray Head, from Solution Pump Discharge
Internal Cooling Coil, Cooled by Tower Water
'A' Valve
ABSOLUTE PRESSURE GAUGE
From Absorber Shell
'B' Valve
From Absorber Purge Header
OIL TRAP
PURGE PUMP
LD06022A
'Dilute Solution Returns to Solution Pump Suction


GENERATOR
OUTLET
CHILLED
WATER
OUTLET
CHILLED
WATER
INLET
EVAPORATOR
'A'Valve
'B' Valve
TOWER
WATER
INLET
ABSORBER



* Orifices may differ between various models.
** PT2 is for Steam units only.
*** May differ between various models.

Chiller Nomenclature

YPC - FN - 13S - 46 - H - S - C

Model
YPC = York ParaFlow Chiller
YIA = York IsoFlow Chiller

Heat Source
FN = Direct-fired (w/PowerFlame burner, natural gas)
FD = Direct-fired (w/natural gas/No. 2 oil)
FO = Direct-fired (w/No. 2 oil)
FX = Direct-fired (w/other fuels)
FL = Direct-fired (w/natural gas with low NOx FGR)
FP = Direct-fired (w/natural gas with low NOx FGR/No. 2 oil)
FE = Direct-fired (w/Weshaupt Burner, natural gas)
FZ = Direct-fired (w/natural gas/No. 2 oil)
FB = Direct-fired (w/No. 2 oil)
FA = Direct-fired (w/other fuels)
FR = Direct-fired (w/natural gas with low NOx FGR)
FC = Direct-fired (w/natural gas with low NOx FGR/No. 2 oil)
ST = Steam-fired

Size
12SC through 19S
19G through 22 GL

Electrical
17 = 208-3-60
28 = 230-3-60
46 = 460-3-60
50 = 380-3-50

Hot Water Heater
S = Standard Heater
H = High Temperature Heater
C = Cooling Only

Tube Type
S = Standard tubes
A = Tube Option "A"
B = Tube Option "B"
C = Tube Option "C"
X = Special Tubesx

Modification Level
A = Inhibitor
B = 122 Alloy InAbs. Cond.
C = SmartPurge

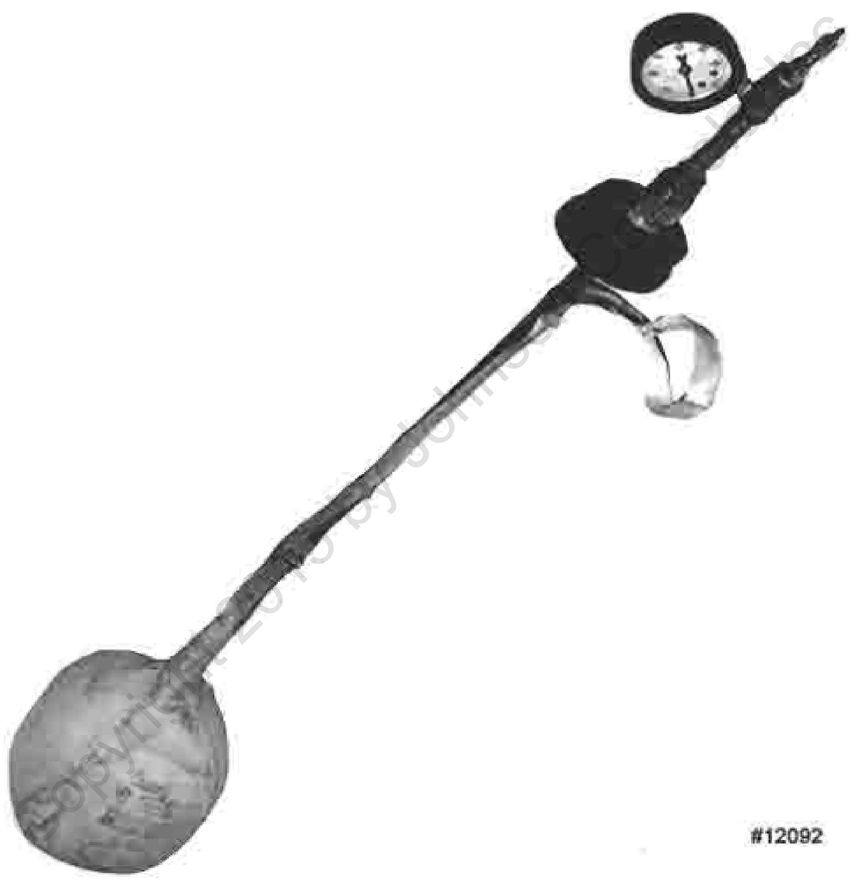
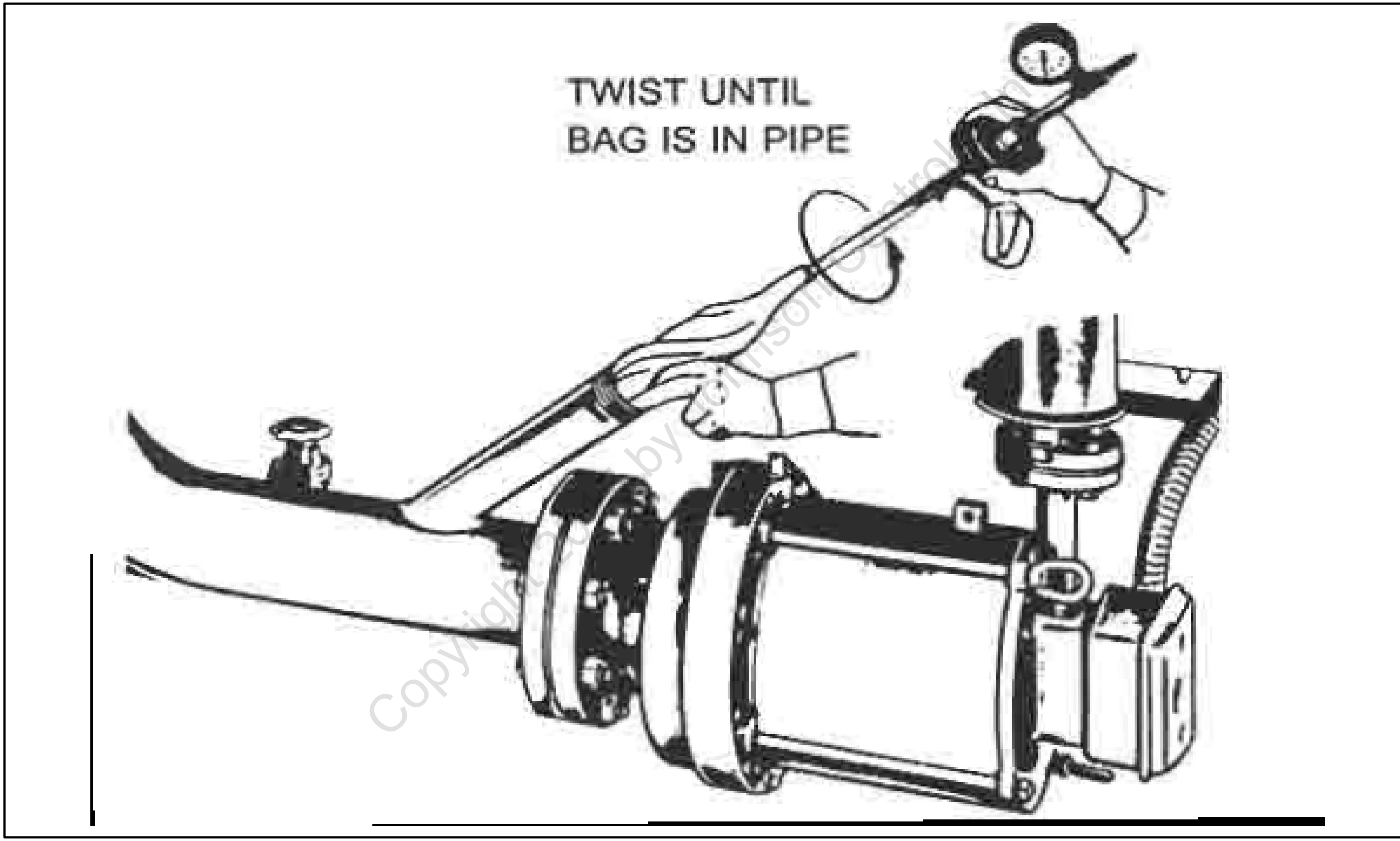


FIG. 10 – ISOLATION BAG


TWIST UNTIL
BAG IS IN PIPE

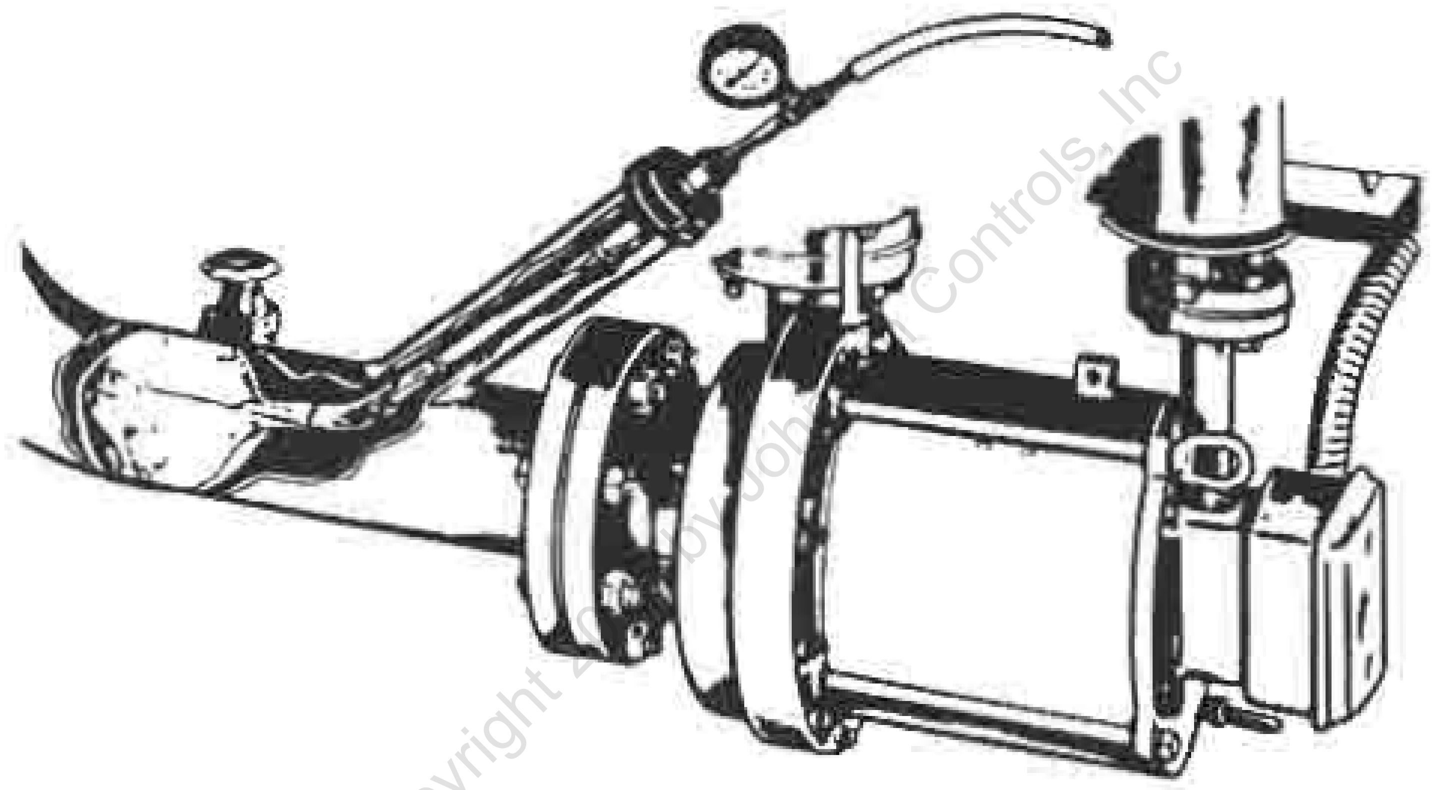
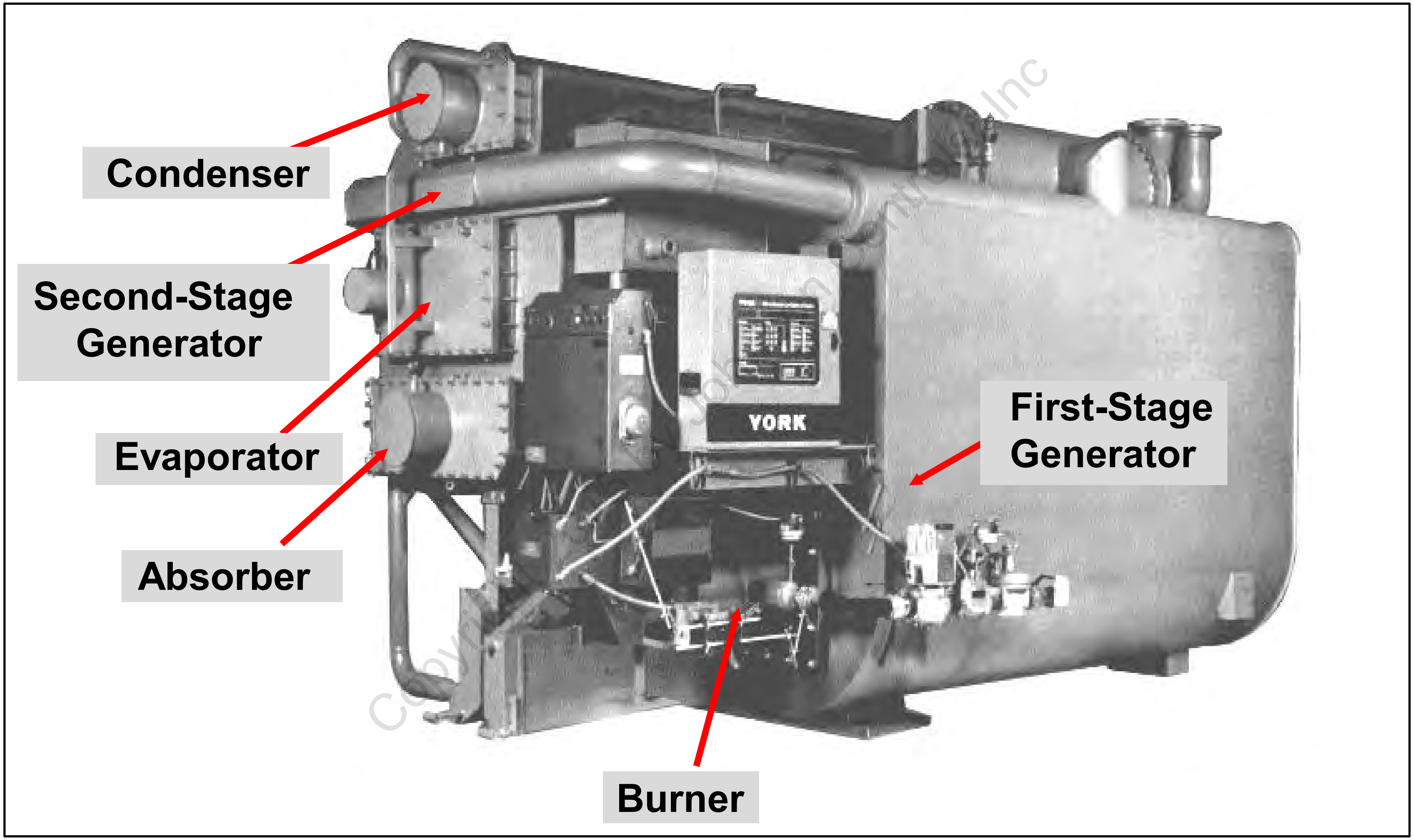


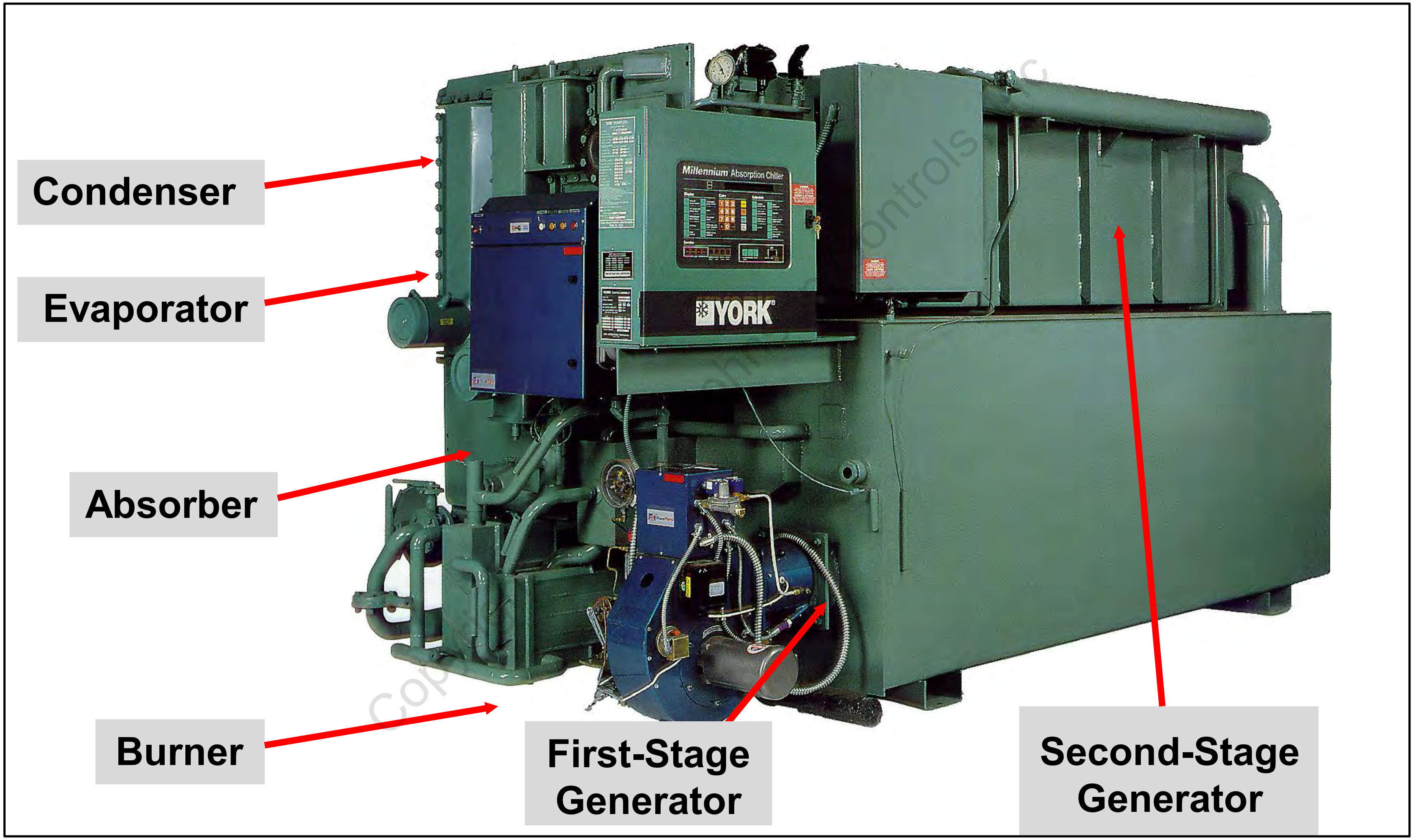
FIG. 12 – ISOLATION BAG LOCATED IN PIPE

Section 2:
System Components

Two-Stage, Direct-Fired G-Series



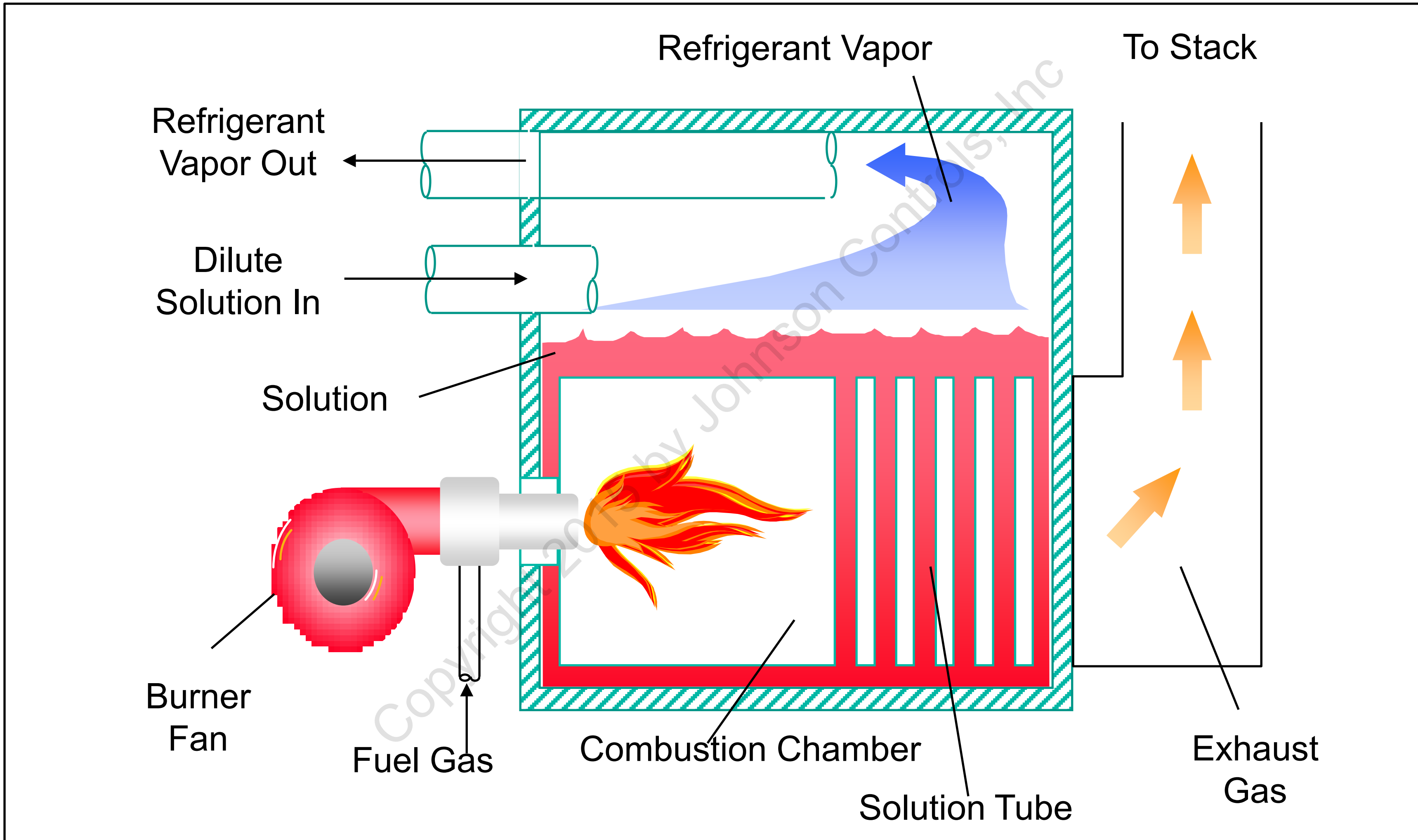
Two-Stage, Direct-Fired S-Series



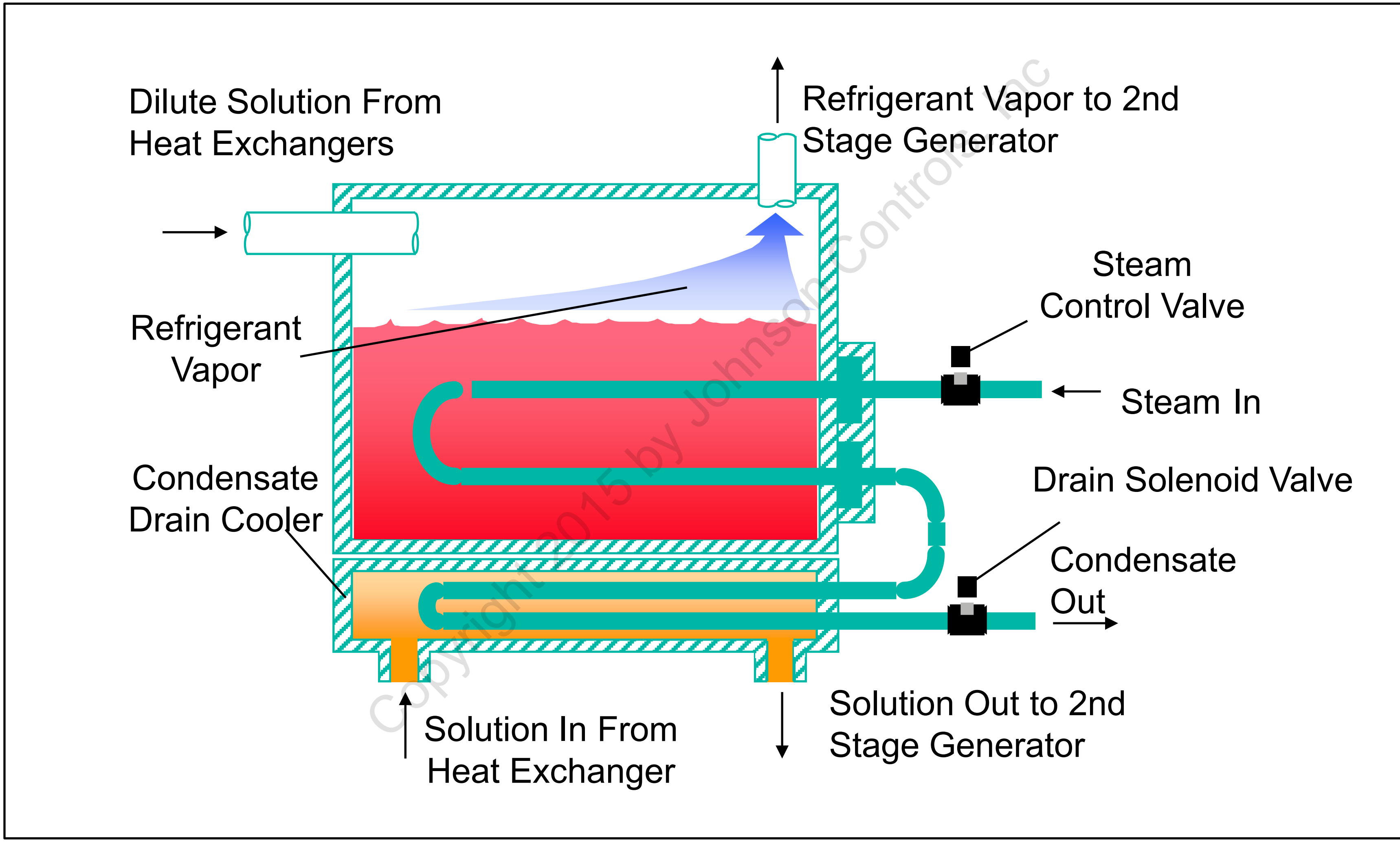
COP (Coefficient of Performance)

- Single Effect (Steam Fired) = 0.7
- Double Effect (Steam Fired) = 1.12
- Double Effect (Direct Fired) = 1.0
- Triple Effect (Direct Fired) = 1.4

Two-Stage, Direct-Fired



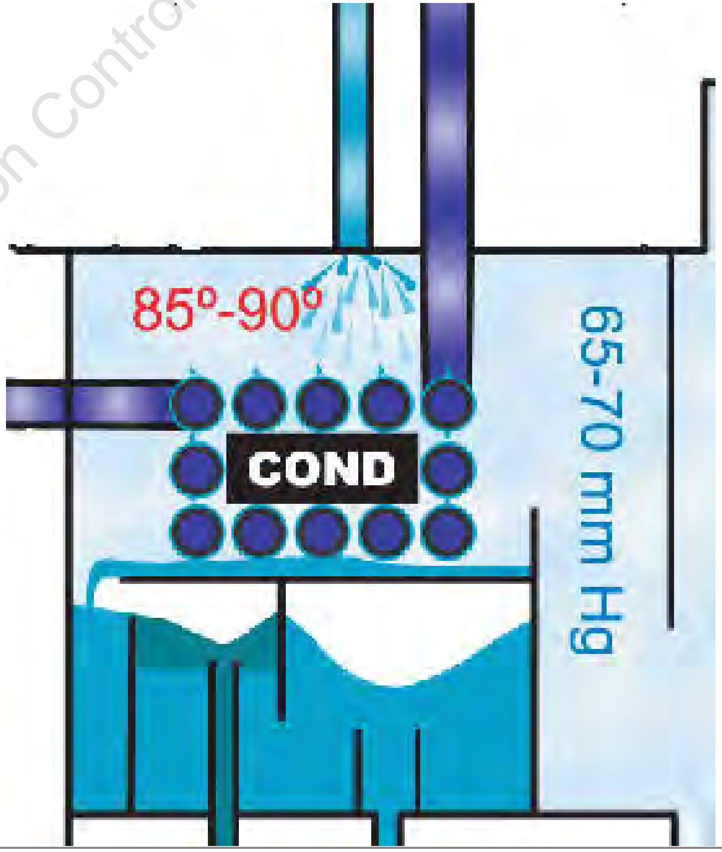
Two-Stage, Steam Fired



YPC Flow Animation

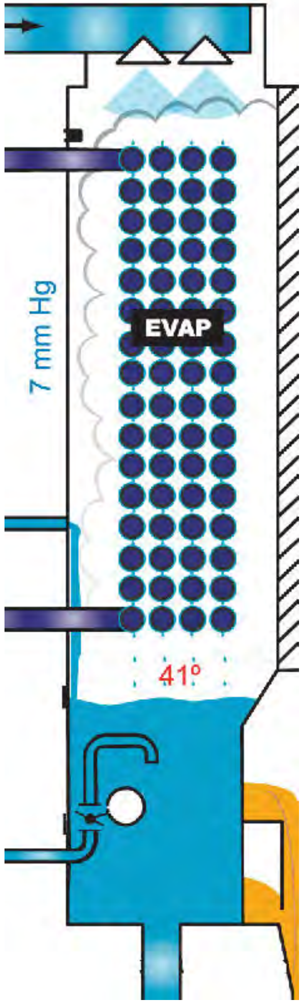
YPC Condenser

- Tower water inlet/outlet
- Condensed refrigerant from low temperature generator
- Evaporator outlet
- Purge system outlet
- Alcohol trap



YPC Evaporator

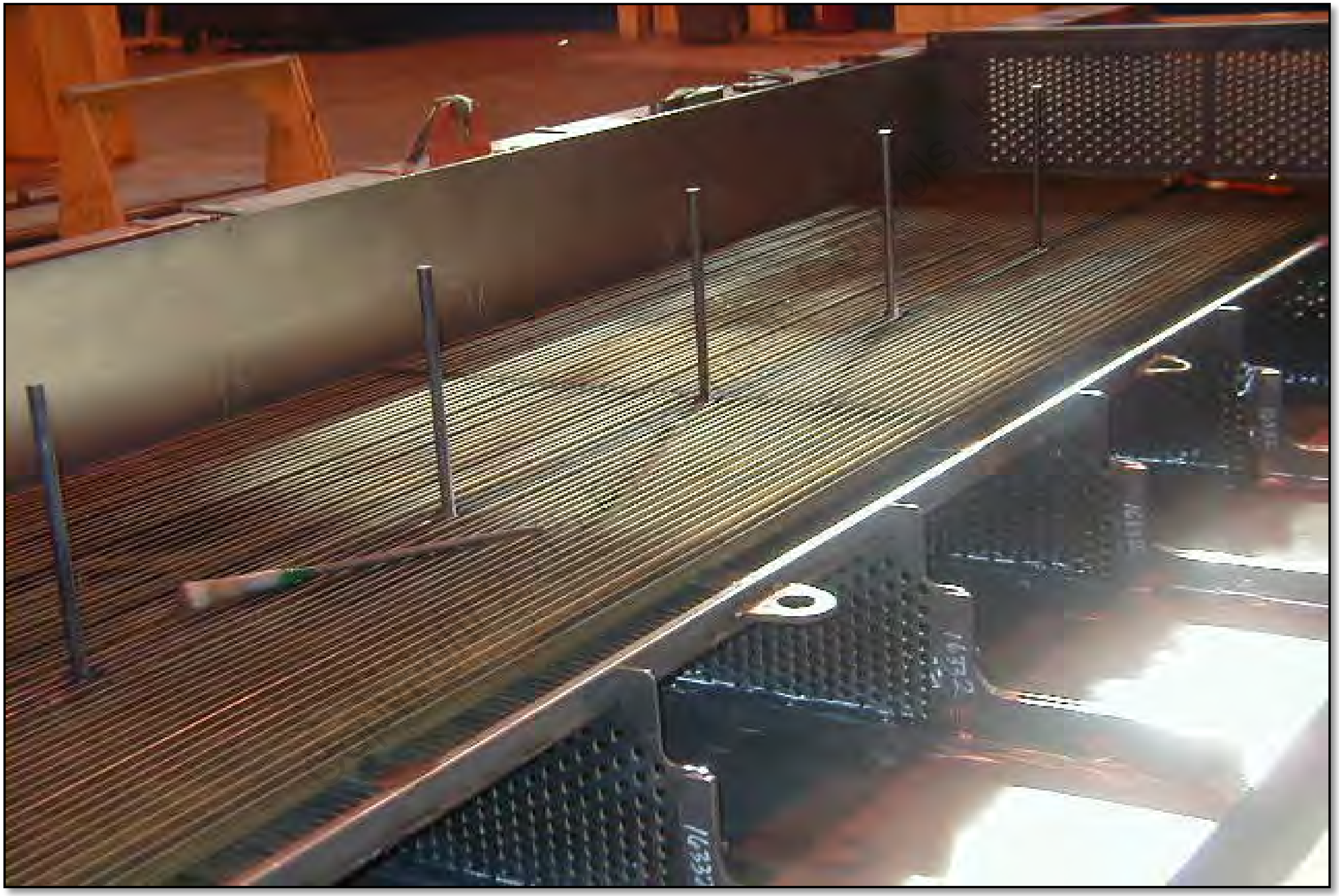
- Evaporator tube bundle
- Refrigerant pan
- Refrigerant spray header
- Evaporator chilled water inlet/outlet
- Refrigerant tank
- Refrigerant pump
- Float valve/box
- Eliminators



Float Valve/Box

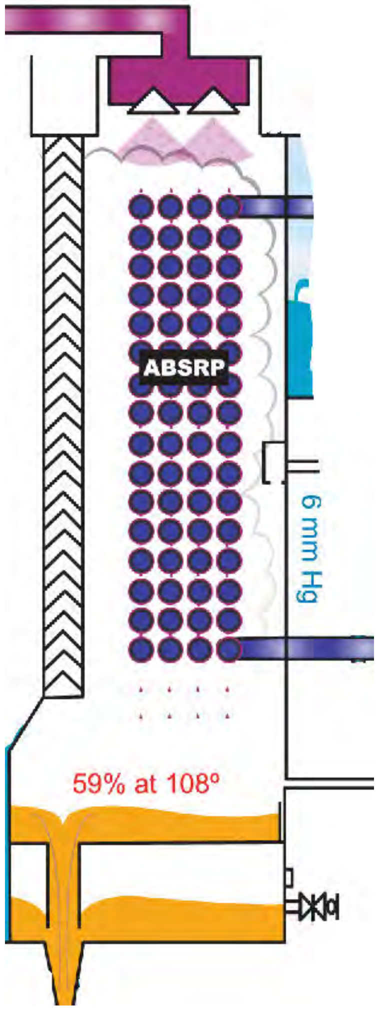
Steam Fired S Unit

Eliminators



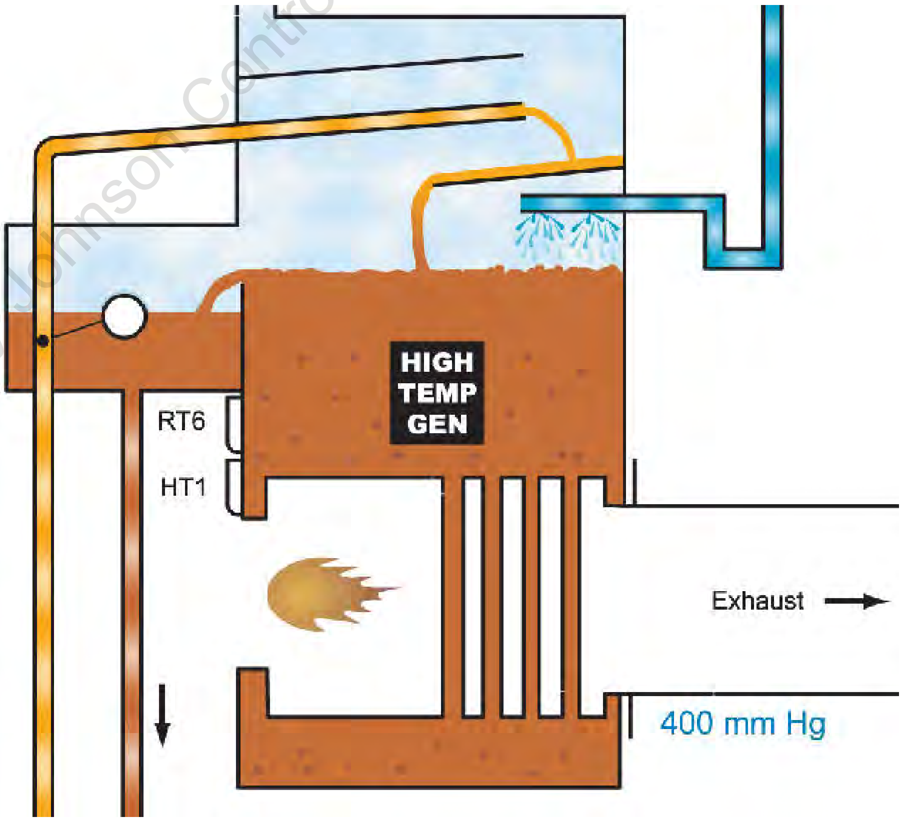
YPC Absorber

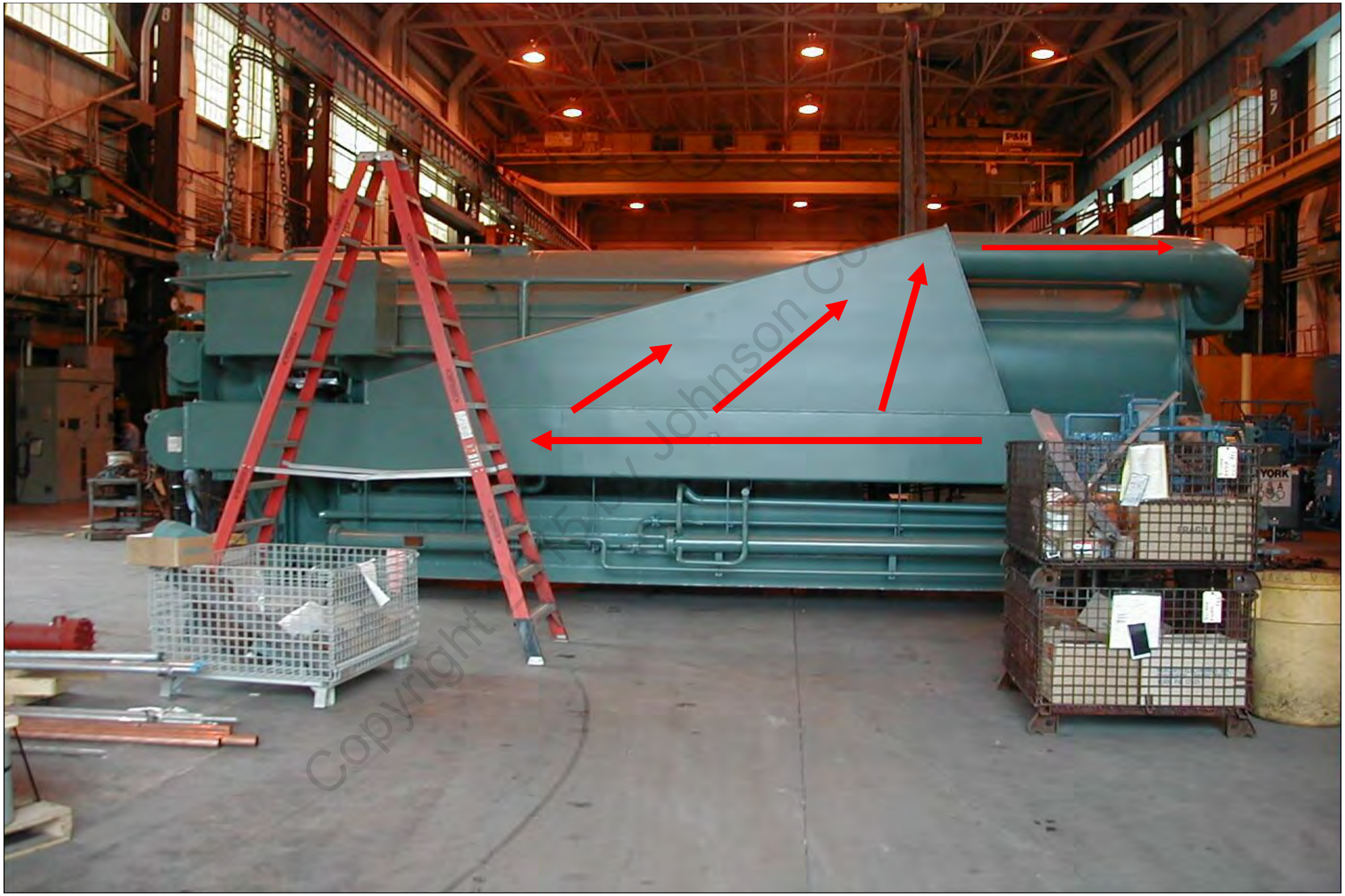
- Absorber tube bundle
- Absorber spray heads
- Tower water inlet
- Tower water outlet to Condenser
- Refrigerant blowdown pipe
- Solution sump
- Solution vortex



High Temperature Generator

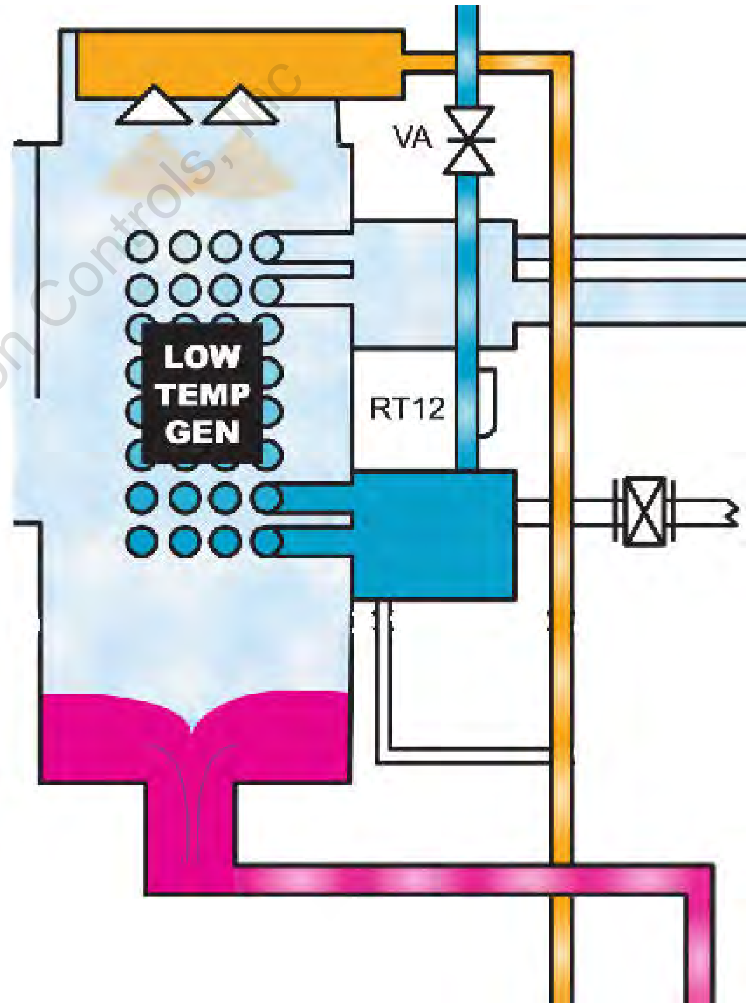
- Dilute solution inlet (from high temp heat exchanger)
- Concentrated solution outlet(to high temp heat exchanger)
- Refrigerant vapor outlet
- Float valve/box
- Hot water heat exchanger





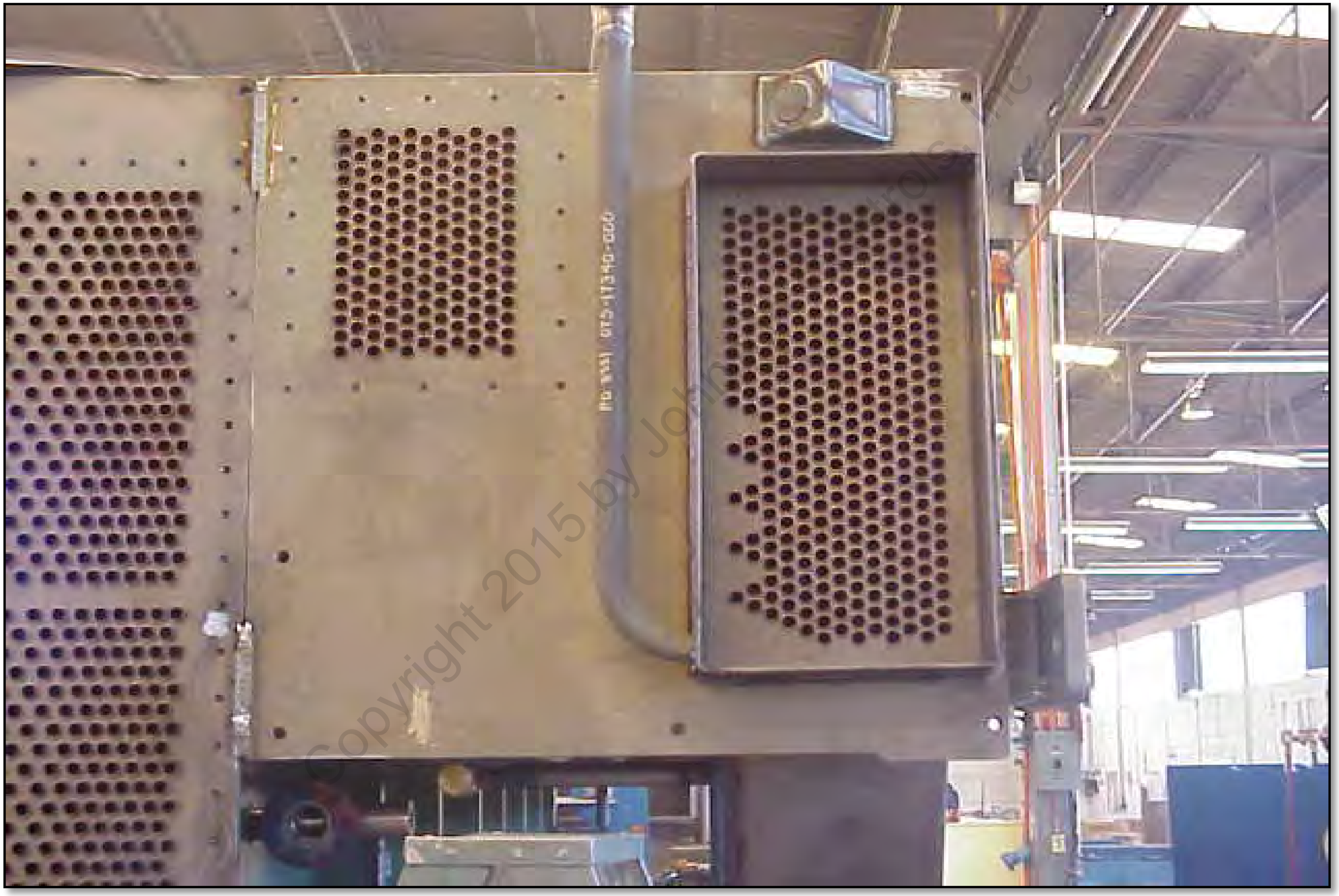
Low Temperature Generator

- Refrigerant vapor outlet



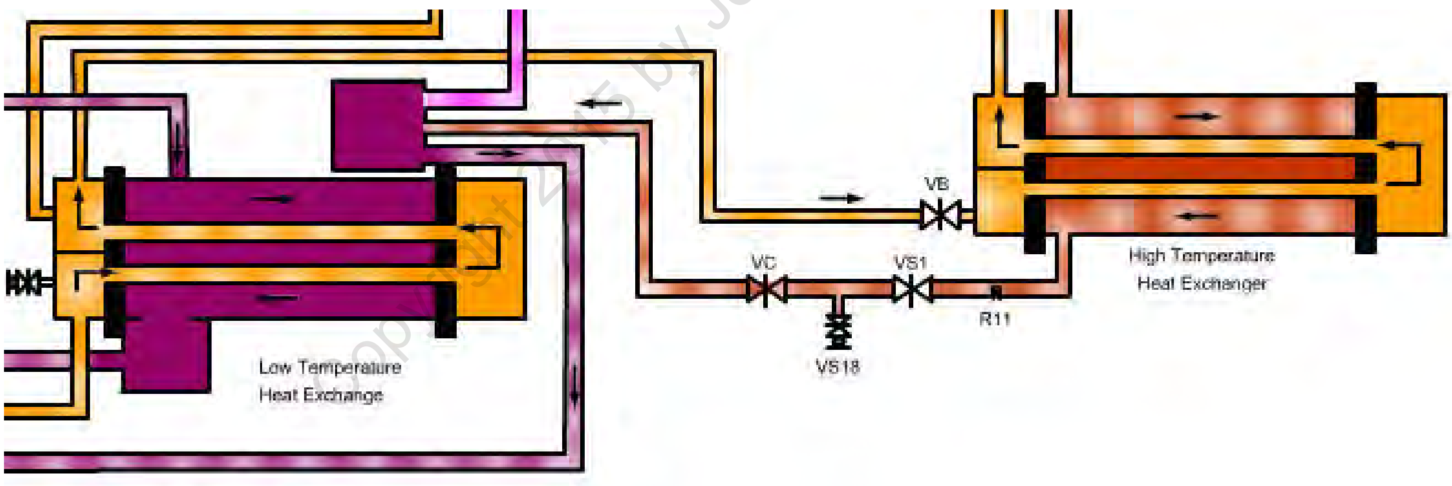
2nd Stg Gen location

2nd Stage Generator / Steam Condensate Box

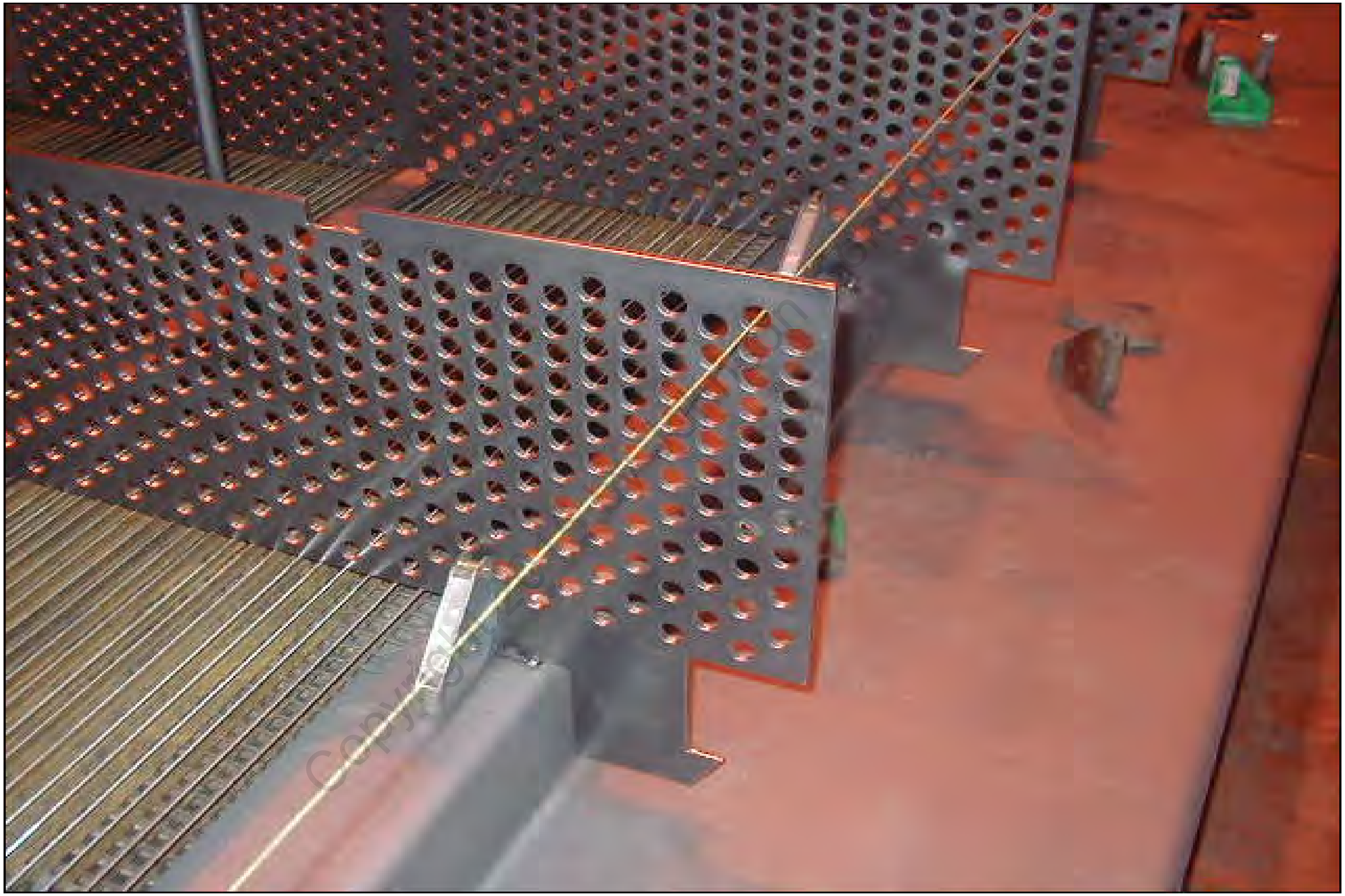


Heat Exchangers

- Pre-heating solution
- Purging
- Drain Cooler
- Mixing box



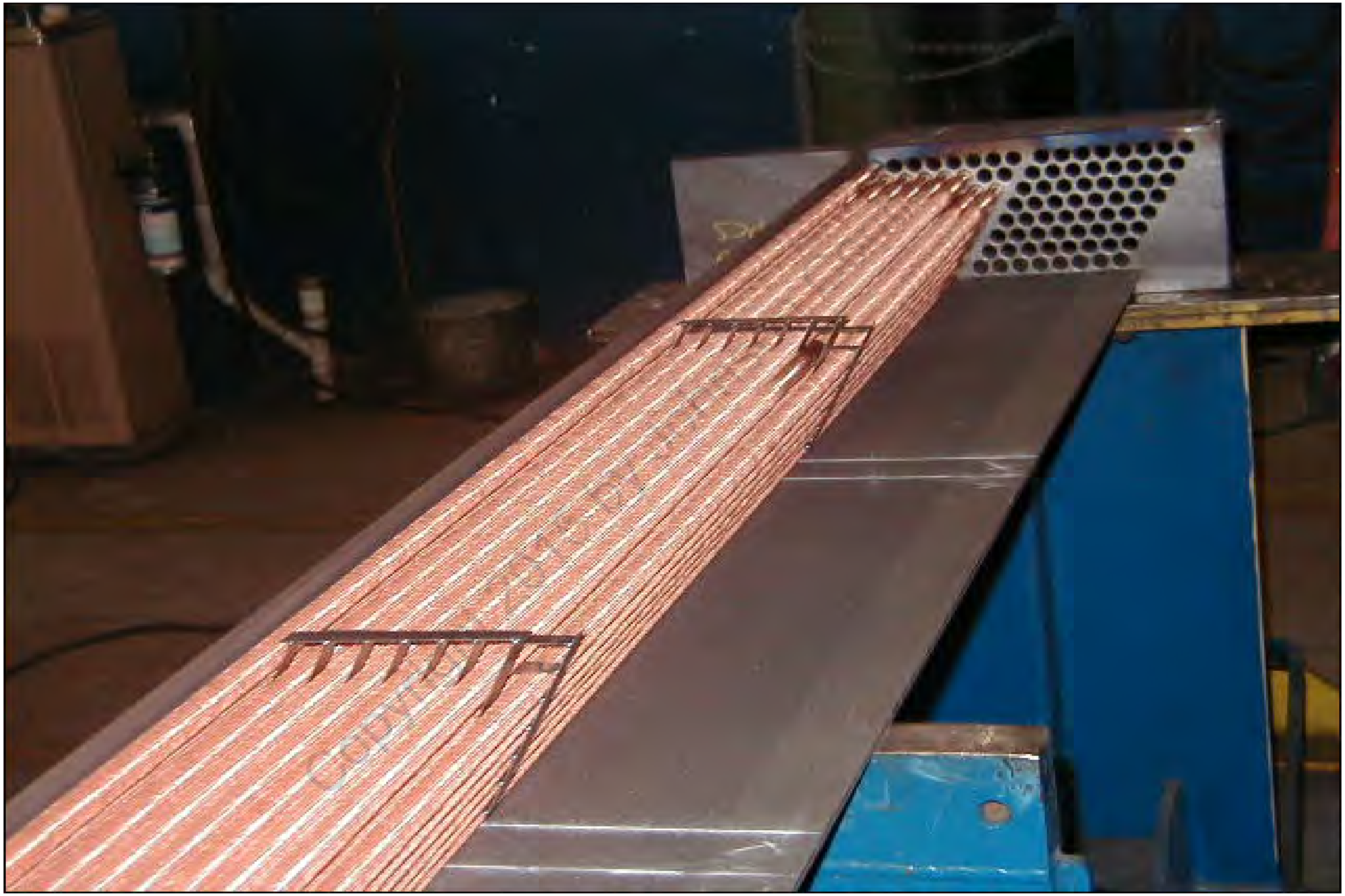
Tube Support sheets



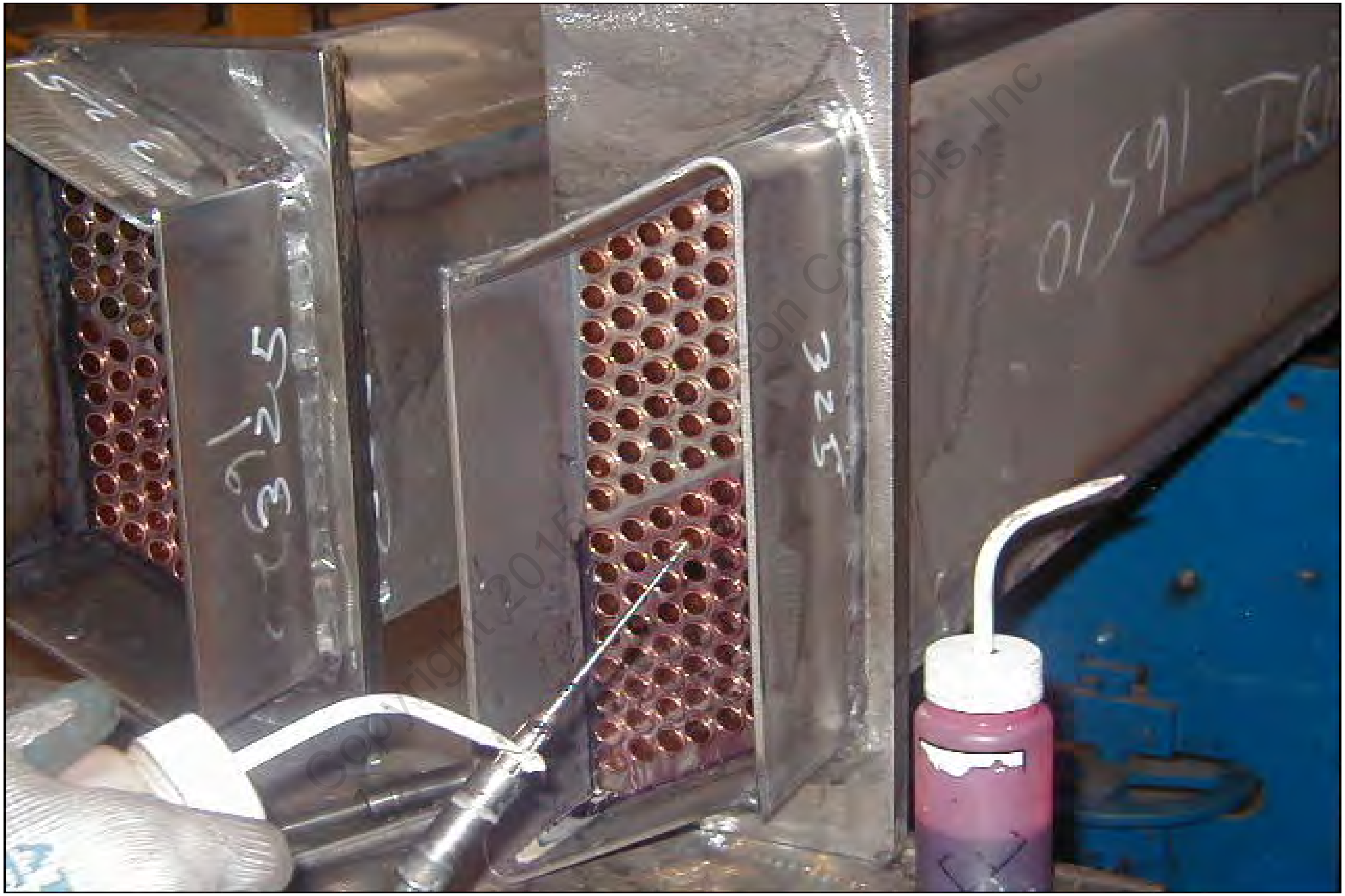
Tube Support sheets

Heat Exchanger Tubes

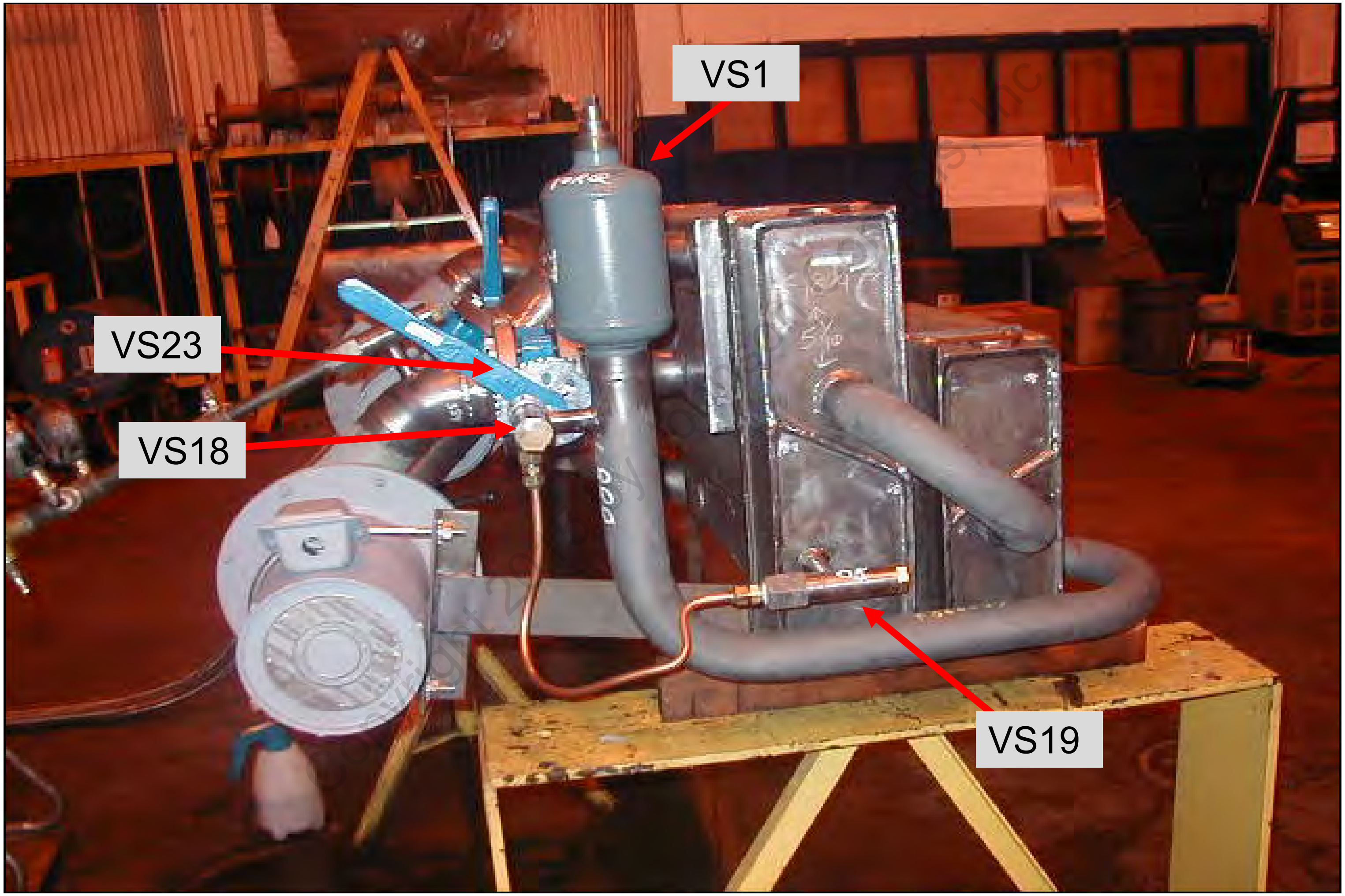
HX Tubes



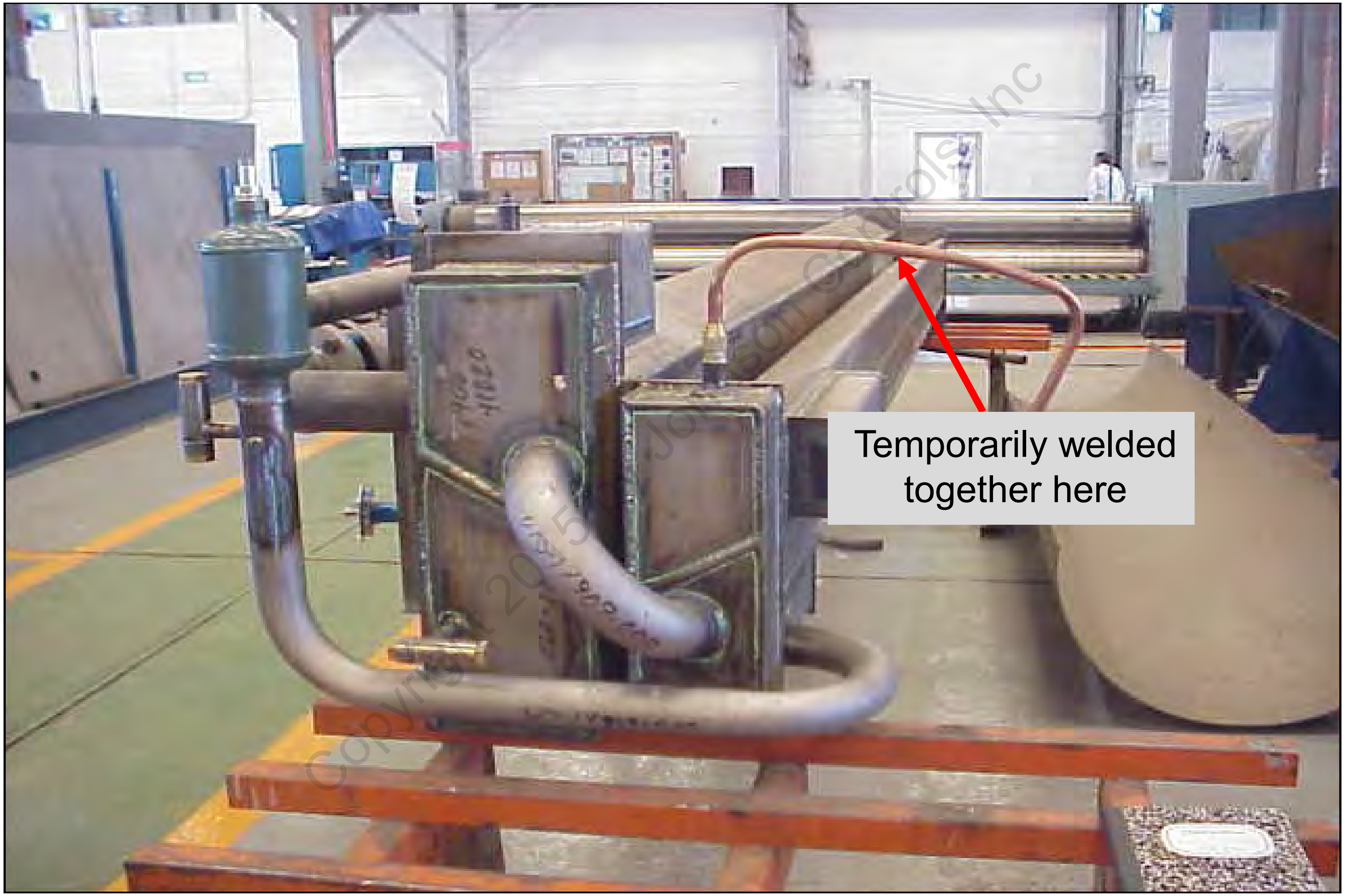
Heat Exchanger End Sheet



HX Assembly

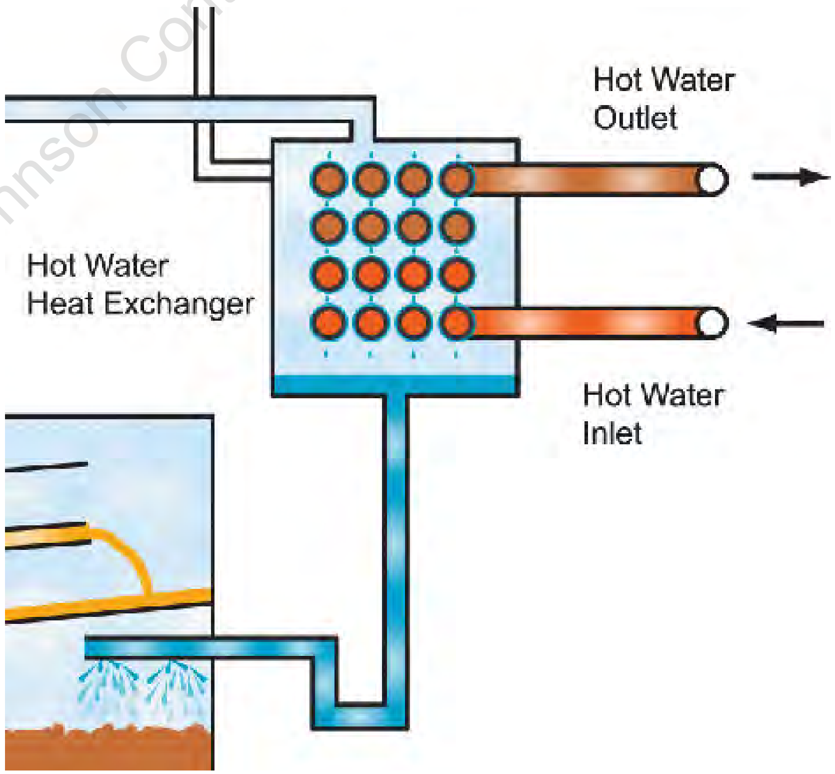


Heat Exchanger Subassembly



Hot Water Heat Exchanger

- Optional feature for heating only



Pumps

Valves

- Startup valves
- Steam control valves
- Isolation valves

Thermometer & Sight Glasses

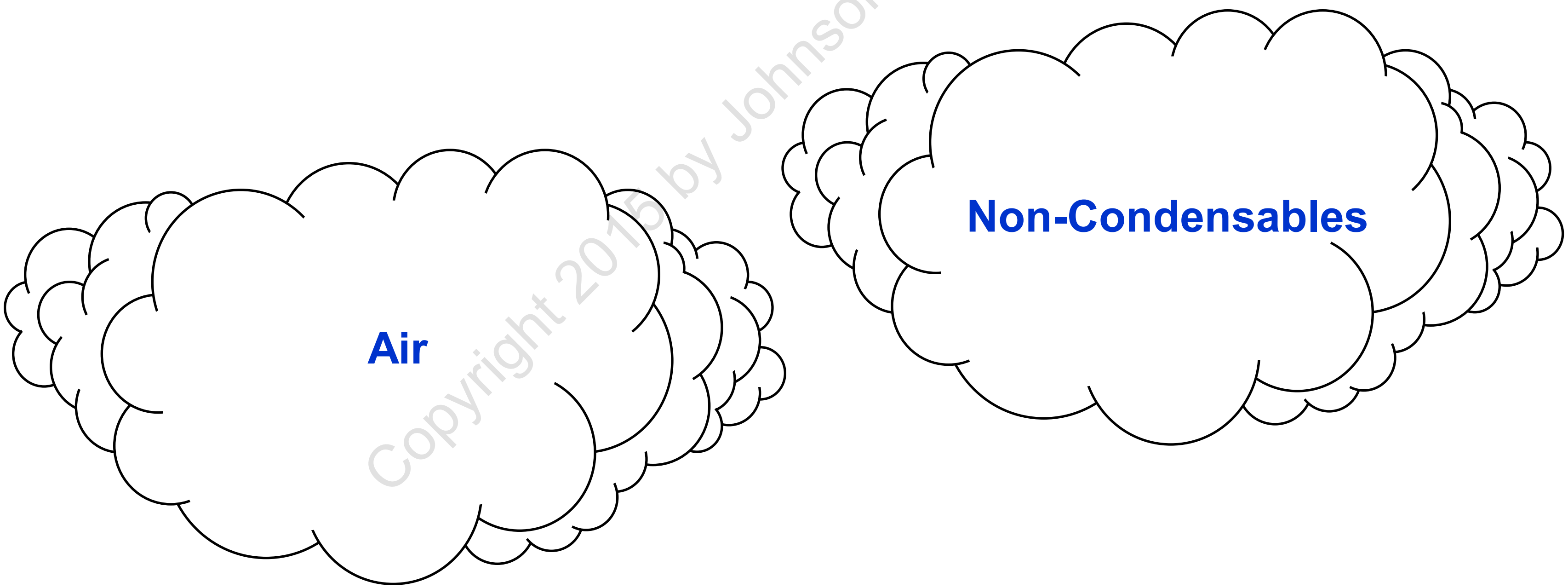
MicroPanel

ISN™ ParaFlow™ Control Center
STATUS
Display
CHILLED WATER TEMPS
CONDENSER WATER TEMPS
1ST STAGE GEN PRESS/TEMP
PRINT
REFRIGERANT/ SOL'N TEMPS
HOT WATER TEMPS
OPTIONS
OPERATING HRS/ START COUNTER
PUMP STATUS
PURGE CYCLE COUNTER
Entry
1 2 3
4 5 6
7 8 9
* 0 AM/PM
ENTER
CANCEL
DISPLAY HOLD
ADVANCE DAY/ SCROLL
Setpoints
LEAVING WATER TEMP
DAILY SCHEDULE
COOL/HEAT CHANGEOVER
HOLIDAY
SPRAY SOL'N PUMP DELAY
REMOTE RESET TEMP RANGE
CLOCK
DATA LOGGER
PULL DOWN DEMAND
Service
LOAD
UNLOAD
HOLD
AUTO
UNIT
WARNING RESET
MANUAL PUMP
DISPLAY DATA
HISTORY PRINT
ACCESS CODE
PROGRAM
MODE
UNIT
START
RUN
STOP/ RESET

Burner

Why Purging is Necessary

- Air leakage into unit
- Internal generation of non-condensables



What are non-condensables

Internally Generated

- Hydrogen - H_2 - Product of Corrosion
- NOx Gases - Typically formed due to rapid depletion of inhibitor
- Ammonia - NH_3 - Indicative of an air leak in the system. Has been linked to corrosion stress cracking in copper

What are non-condensables

Generated by Air Leaks

- Nitrogen - Main constituent of air
- Oxygen - O_2 - Greatly increases internal corrosion rates, which in turn produce a greater number of internally generated non-condensables
- Any gas that may be present around the leak will also be drawn into the machine

Effects of Non-condensables

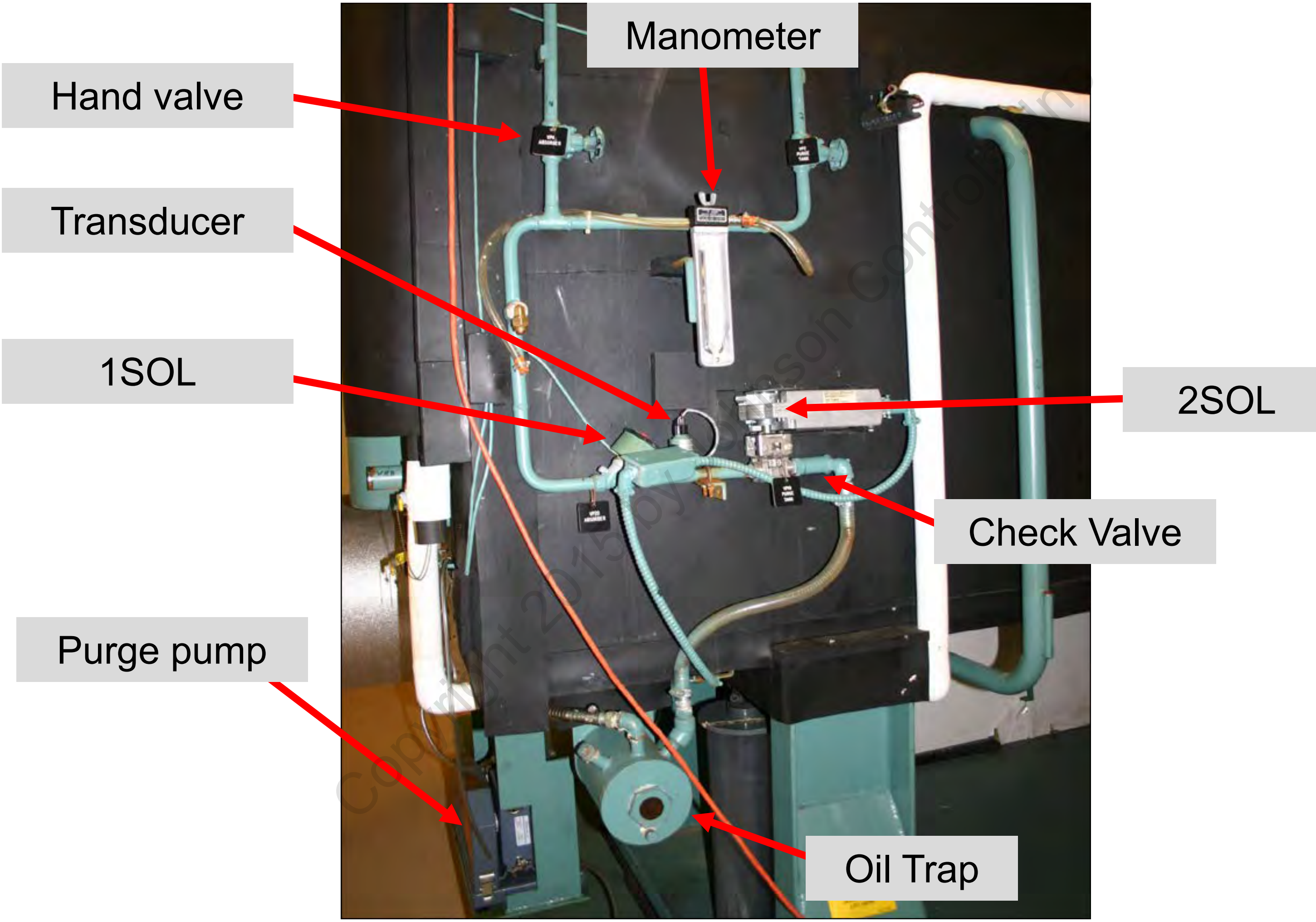
- Higher Operating Pressures and Temperatures
- Loss in Performance
- Rapid Breakdown of Corrosion Inhibitors
- Decreased Unit Life

YPC Flow Animation

Purging

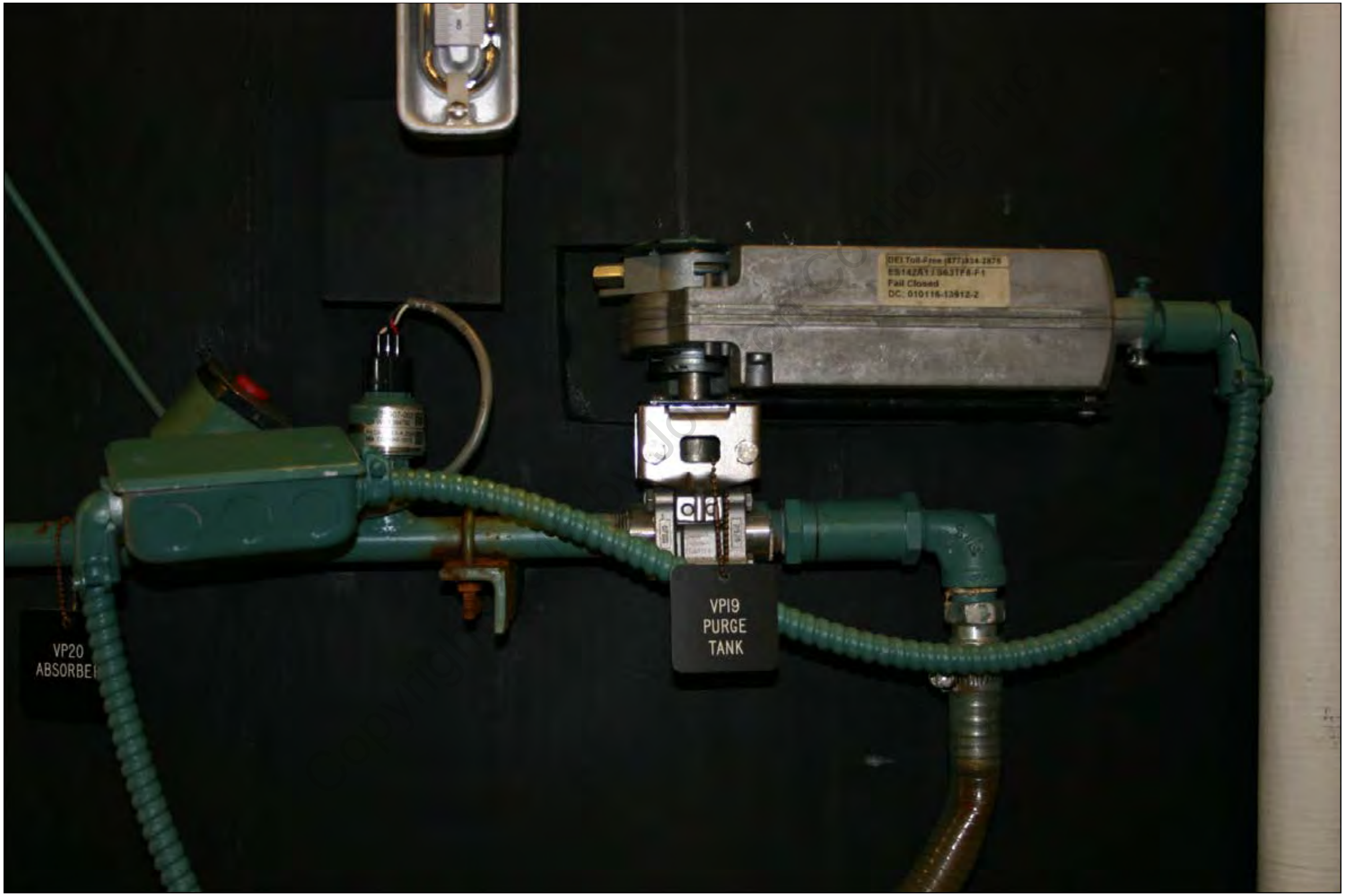

Condenser
Evaporator
Absorber
Purge Tree
Refrigerant Pump

Purge Tree



Manometer
Hand valve
Transducer
1SOL
2SOL
Check Valve
Purge pump
Oil Trap

Auto purge (Smart purge)

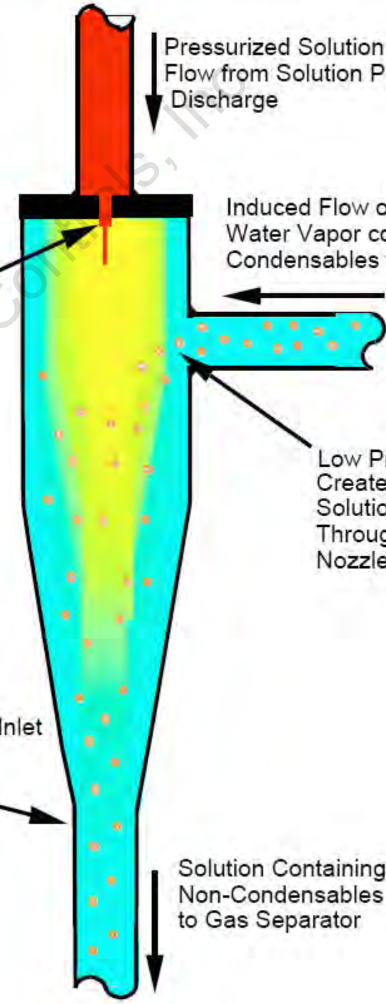


Purge Tank

Purge Tank on a Direct Fired S Unit

Purge Pump

Purge Eductor



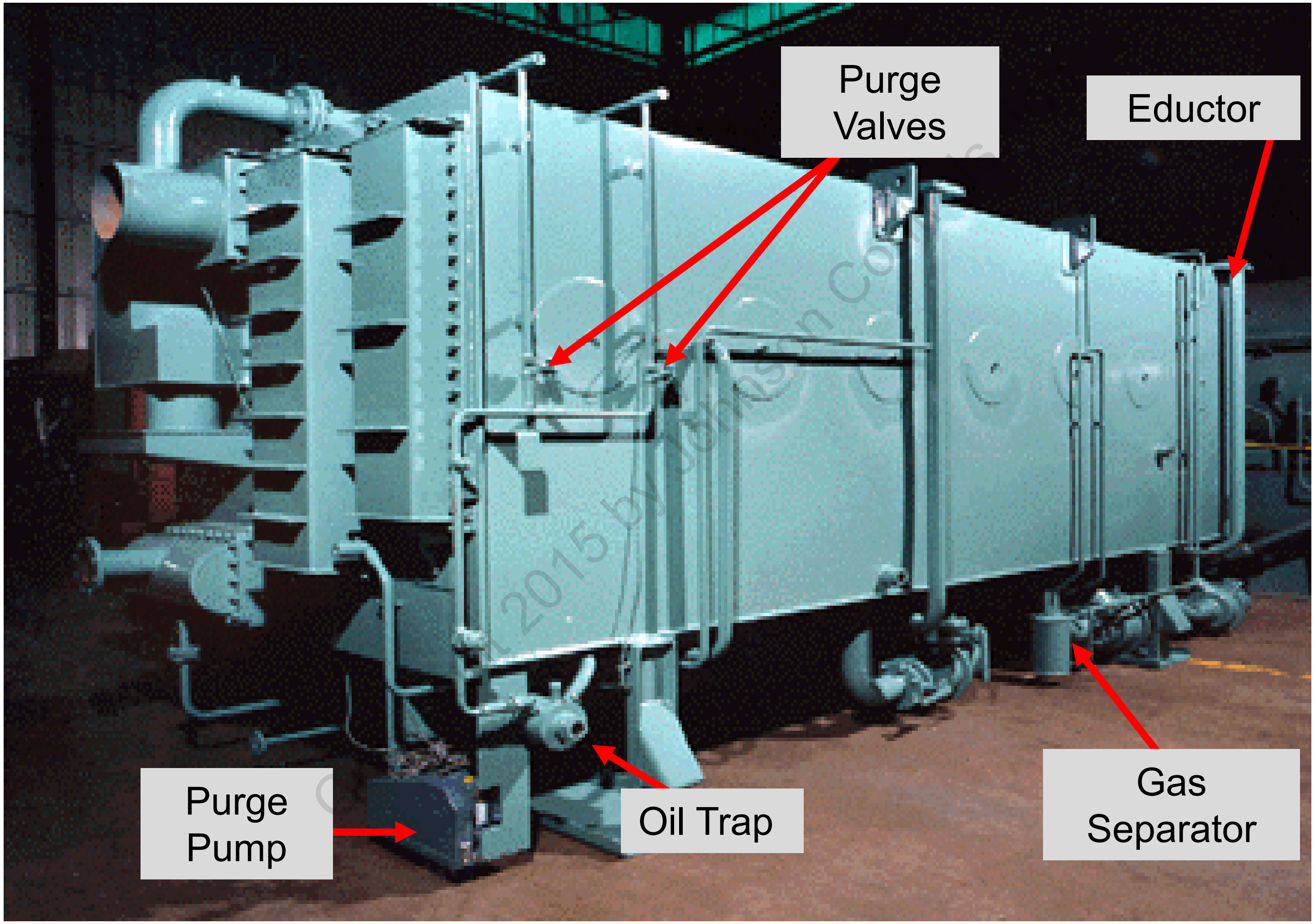
Purge System

Gas Separator

Isoflow and Paraflow

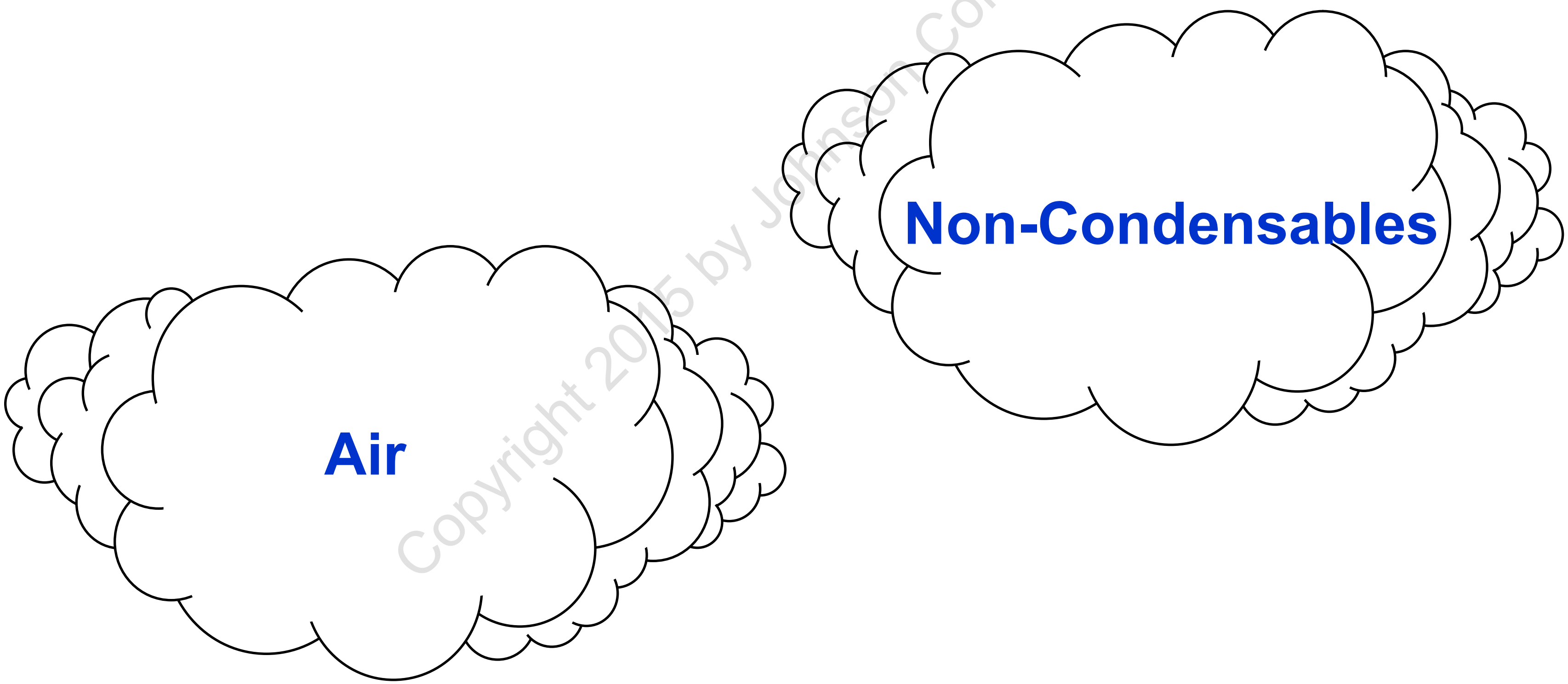
Purge System

Purge System



Why Purging is Necessary

- Air leakage into unit
- Internal Generation of Non-Condensables



Effects of Non-Condensables

- Higher Operating Pressures and Temperatures
- Loss in Performance
- Rapid Breakdown of Corrosion Inhibitors
- Decreased Unit Life

Non-Condensable Types

Internally Generated

- Hydrogen - H_2 - Product of Corrosion
- NOx Gases - Typically formed due to rapid depletion of inhibitor
- Ammonia - NH_3 - Indicative of an air leak in the system. Has been linked to corrosion stress cracking in copper

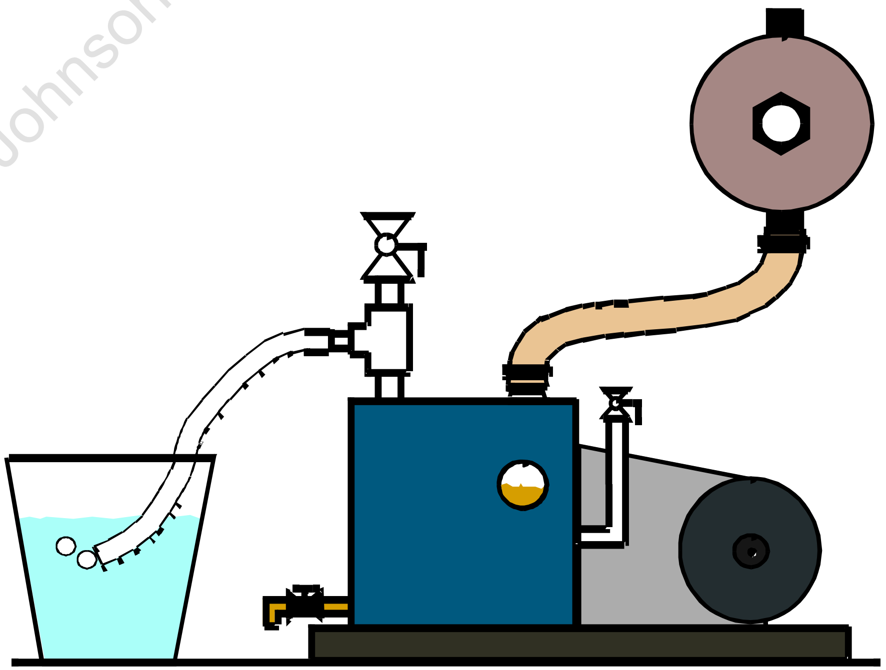
Non-Condensable Types

Gases drawn into machine due to a leak.

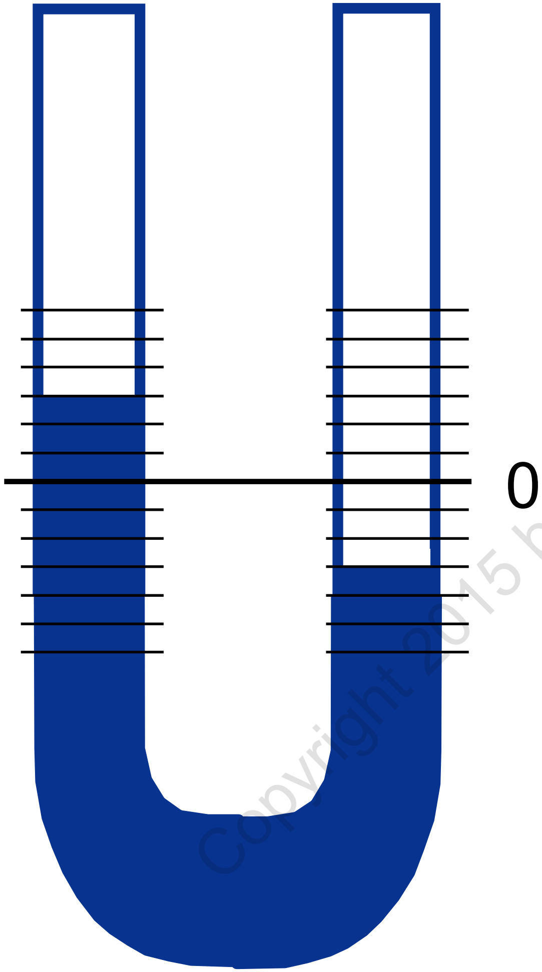
- Nitrogen - Main constituent of air
- Oxygen - O_2 - Greatly increases internal corrosion rates, which in turn produce a greater number of internally generated non-condensables
- Any gas that may be present around the leak will also be drawn into the machine

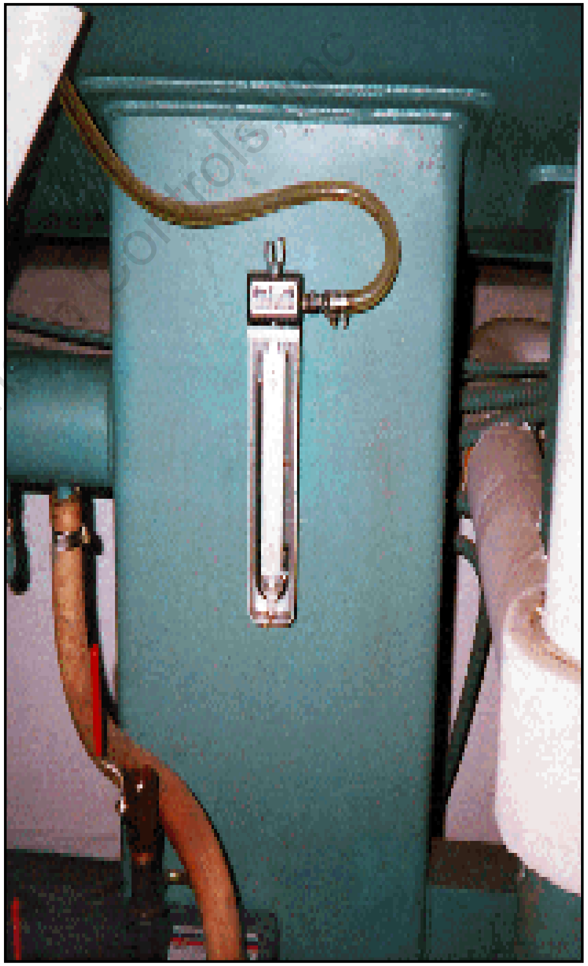
Purge System Components

- Absolute Pressure Gauge (Manometer)
- Vacuum Pump
- Eductor
- Solution Pump
- Gas Separator
- Oil Trap
- Various Hand Valves
- Automatic Valves
- Check Valve
- Purge Tank
- Purge Tree/Piping



Manometer





Purge Pump

- Removes accumulated non-condensables from purge tank, absorber, condenser and hot water heat exchanger (where applicable)
- 5.6 CFM Welsh Pump can also be used to evacuate the machine on initial start-up

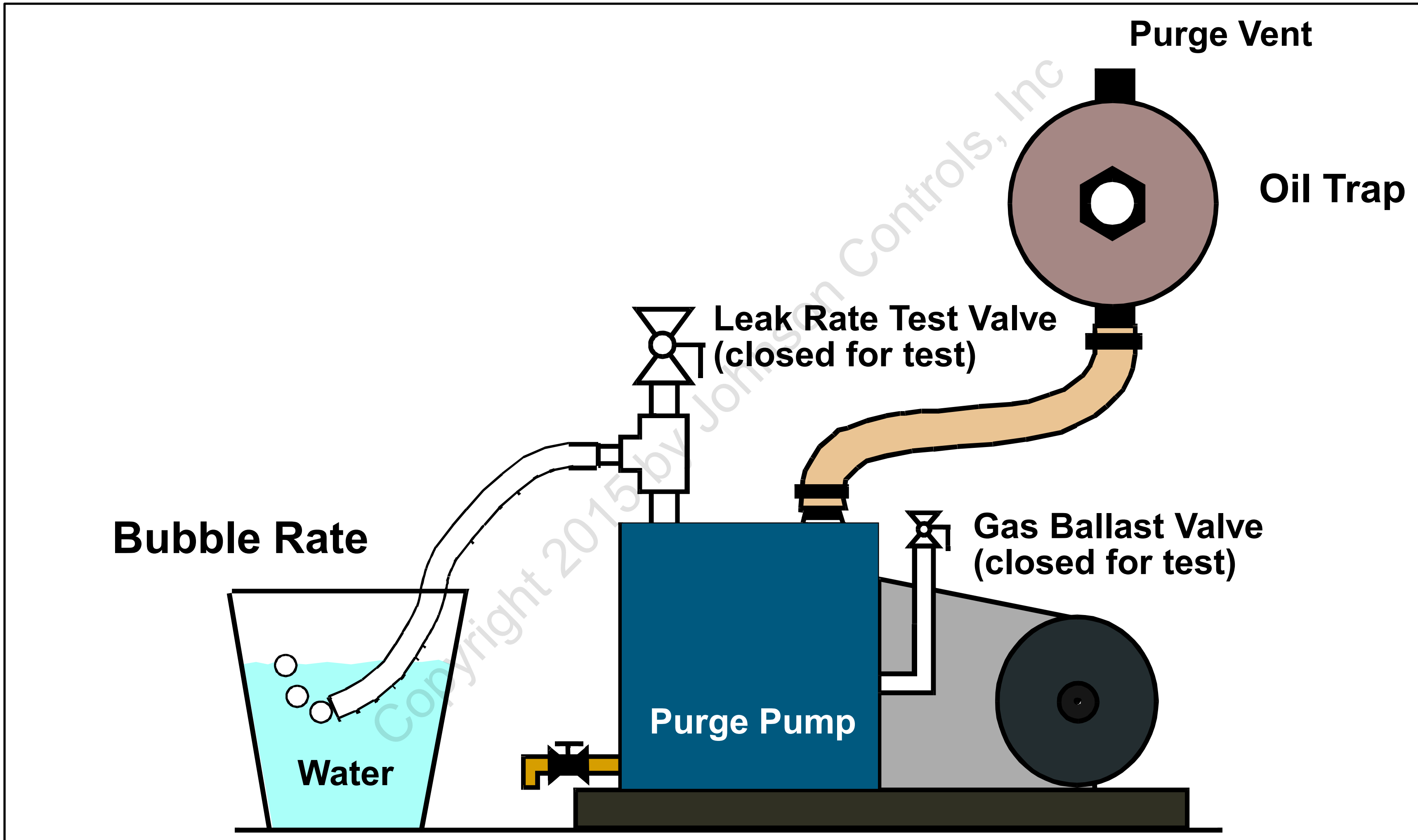
Purge Pump Specifications

- “G” Series units use a 5.6 cfm 2-stage Welch Pump
- “S” Series units use a .7 cfm Welch Pump

General Purge Pump Maintenance

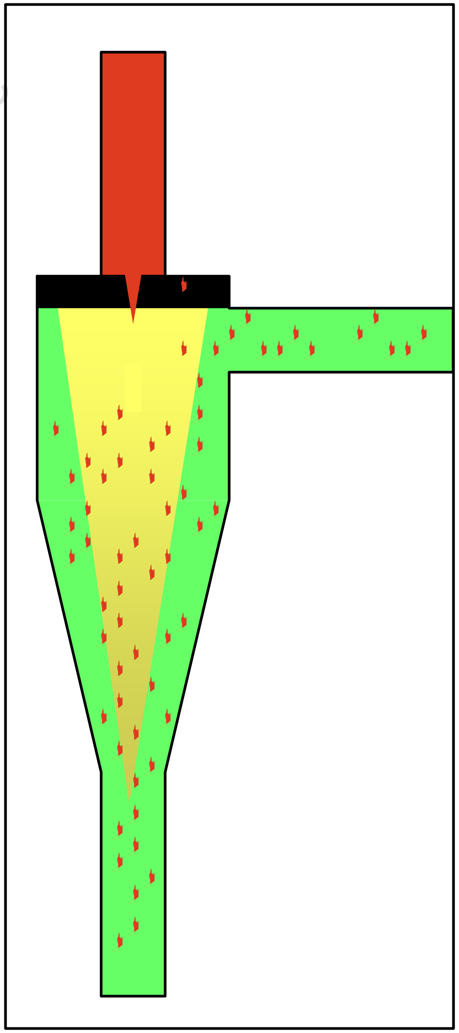
- Check belt condition. Belt deflection should be approximately 1/2”
- Check hose condition and clamps for tightness
- Oil should be changed regularly

Purge Pump Set-Up

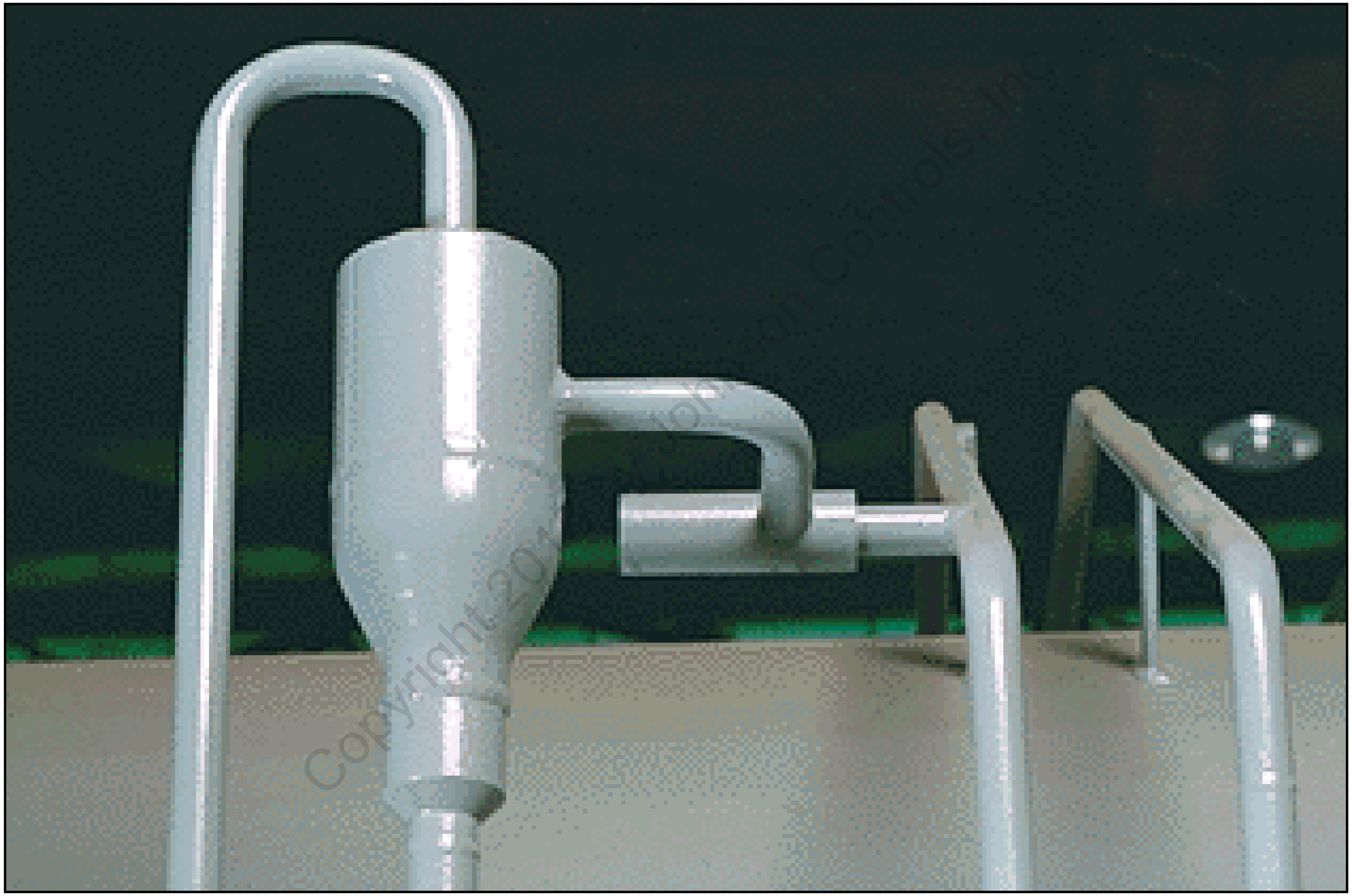


Purge Eductor

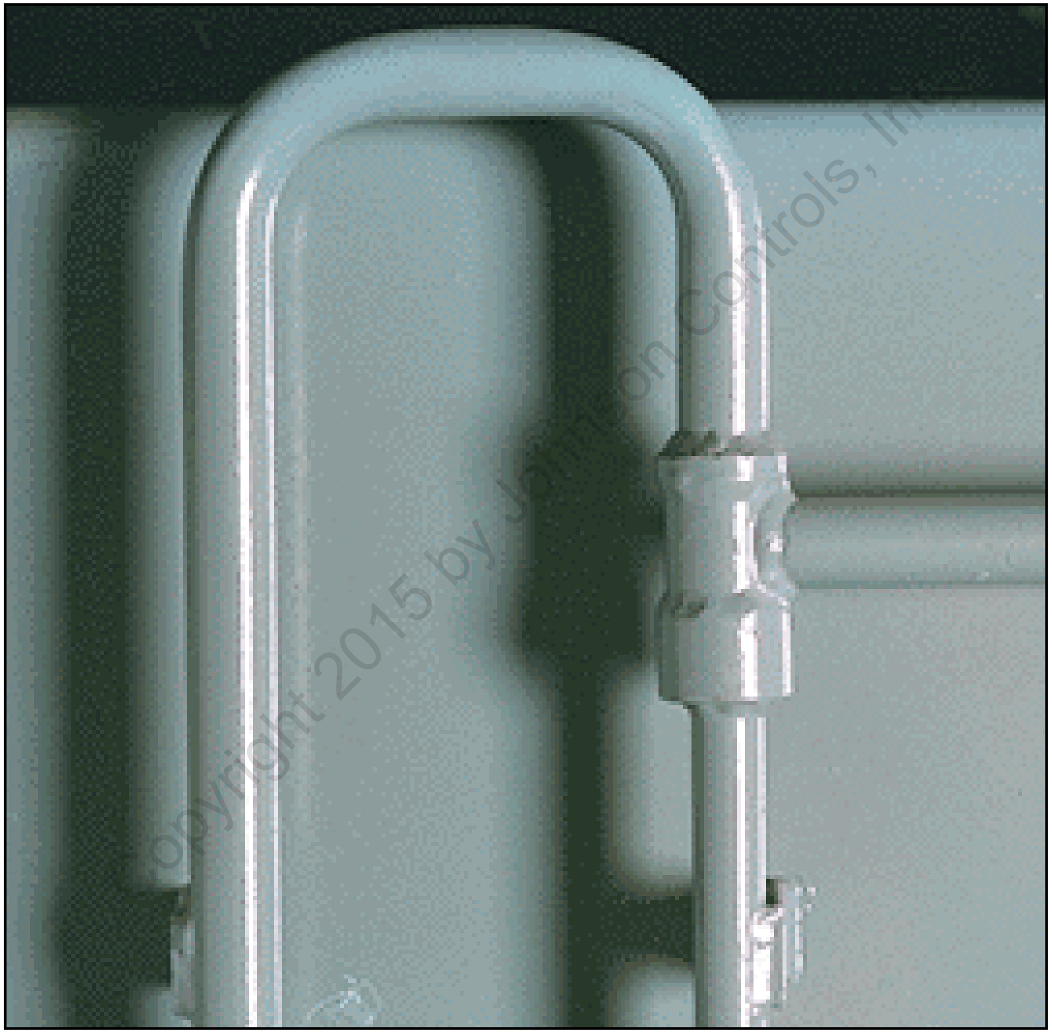
- Solution flows through orifice creating a low pressure area
- Induces flow of non-condensable entrained refrigerant vapor from the condenser
- Solution pump must be operating for this component to function
- Solution temperature out of eductor will be higher due to the heat of dilution (Typically around 5 - 10 deg. F)



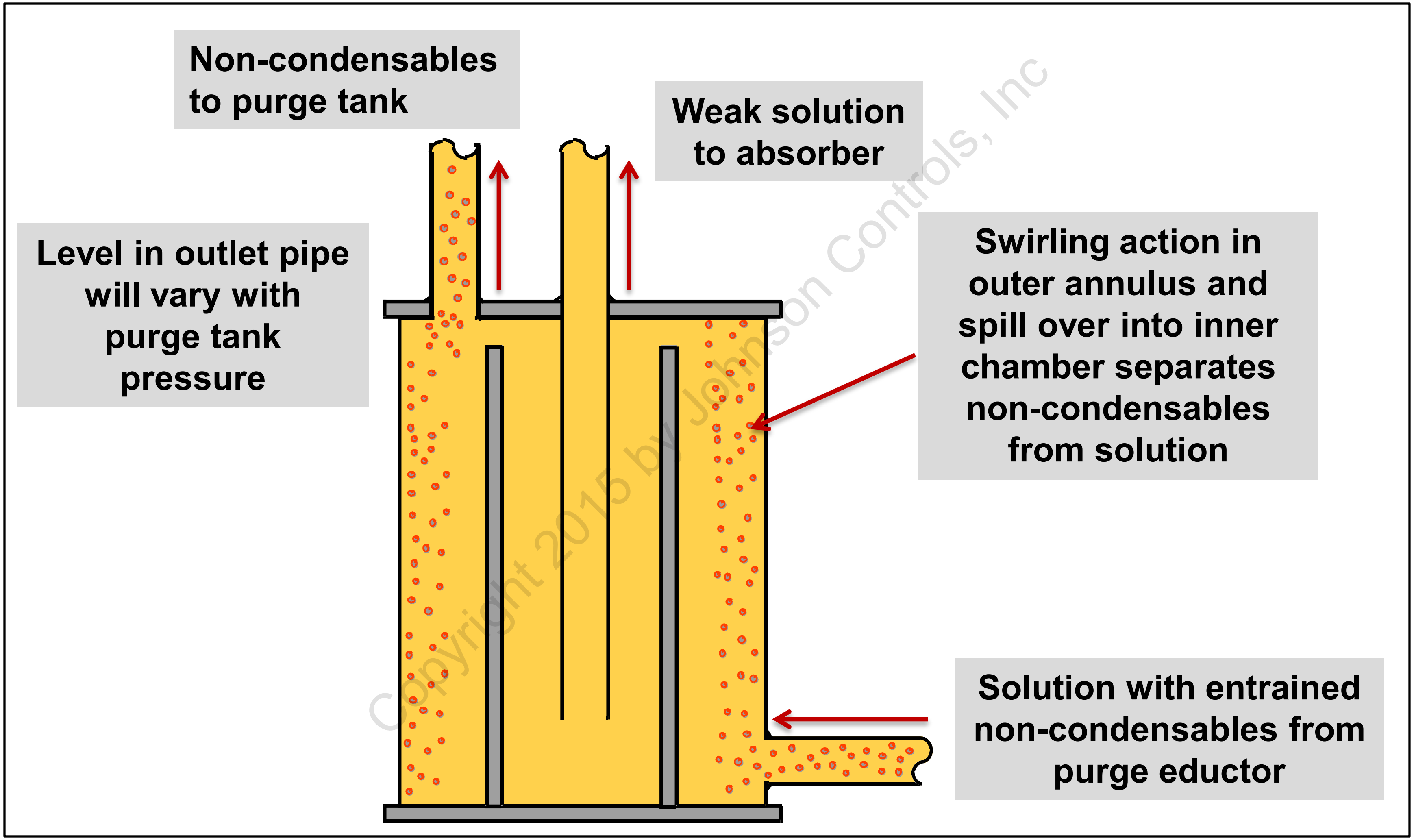
Purge Eductor "G" Unit



Purge Eductor "S" Unit



Gas Separator



Check Valve

- Prevents the back-flow of air into the machine during a power failure

Oil Trap

- Prevents the back-flow of oil into the machine during a power failure. Trap is sized to hold the entire pump oil charge

Hand Valves

- Diaphram type valves used to isolate or establish a connection between the purge pump and various sections of the unit.

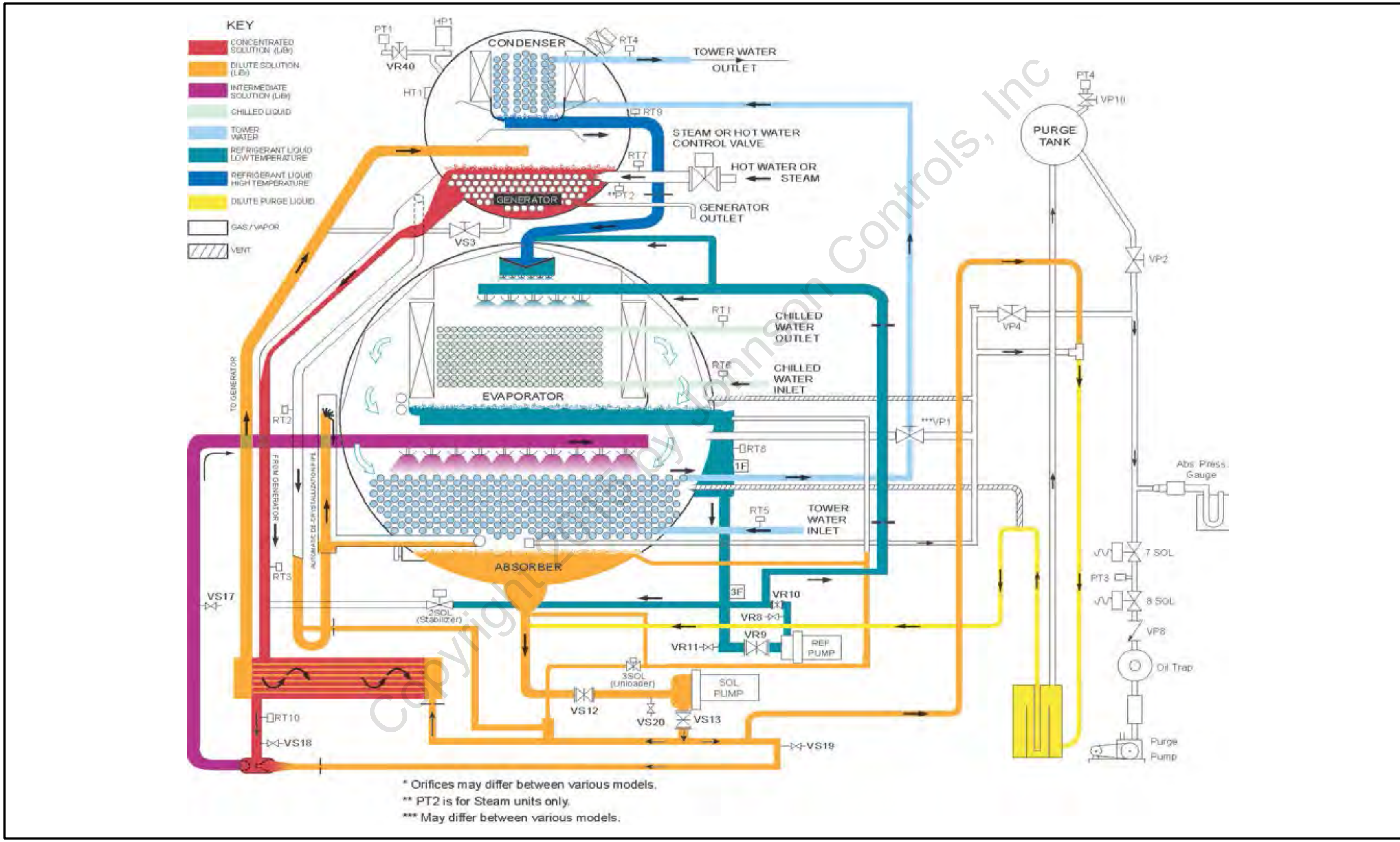
Automatic Valves

- Used to automatically purge the purge tank. Present only when the Smart-Purge option is installed

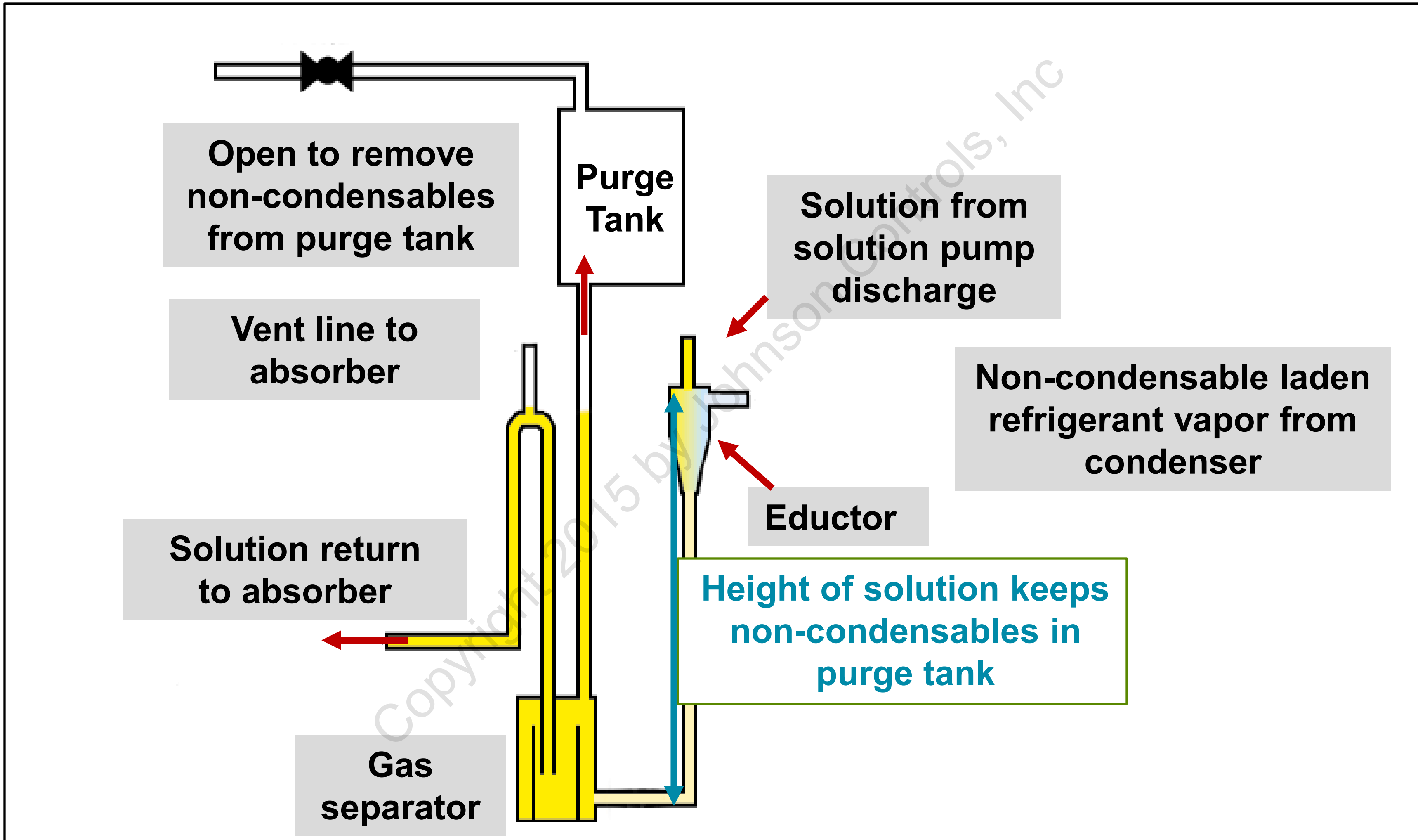
Purge Tree "G" Unit

Purge Tree "S" Unit

Purge Operation

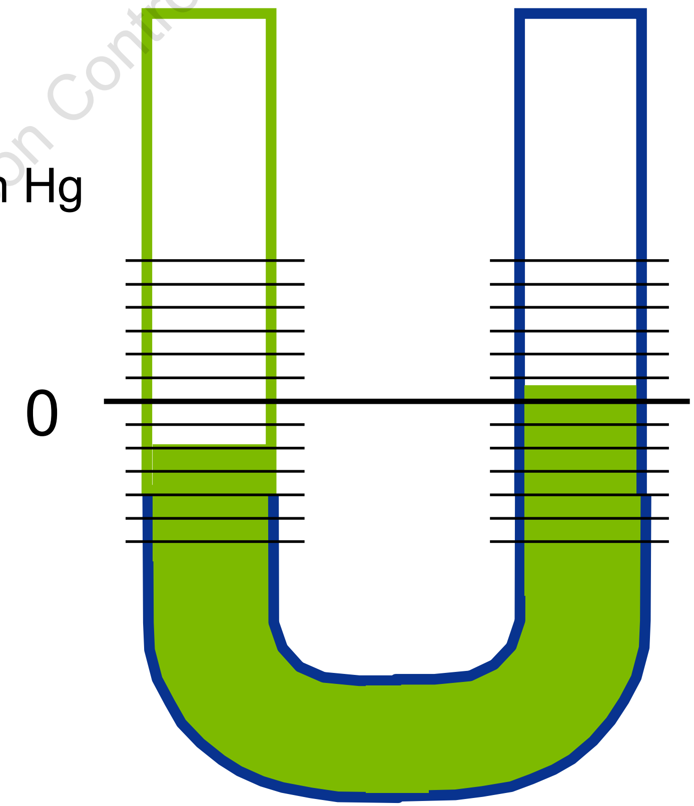

KEY
CONCENTRATED SOLUTION (LiBr)
DILUTE SOLUTION (LiBr)
INTERMEDIATE SOLUTION (LiBr)
CHILLED LIQUID
TOWER WATER
REFRIGERANT LIQUID LOW TEMPERATURE
REFRIGERANT LIQUID HIGH TEMPERATURE
DILUTE PURGE LIQUID
GAS / VAPOR
VENT
CONDENSER
GENERATOR
EVAPORATOR
ABSORBER
TOWER WATER OUTLET
STEAM OR HOT WATER CONTROL VALVE
HOT WATER OR STEAM
GENERATOR OUTLET
CHILLED WATER OUTLET
CHILLED WATER INLET
TOWER WATER INLET
PURGE TANK
Abs Press. Gauge
REF PUMP
SOL PUMP
Oil Trap
Purge Pump
* Orifices may differ between various models.
** PT2 is for Steam units only.
*** May differ between various models.

Purge Piping

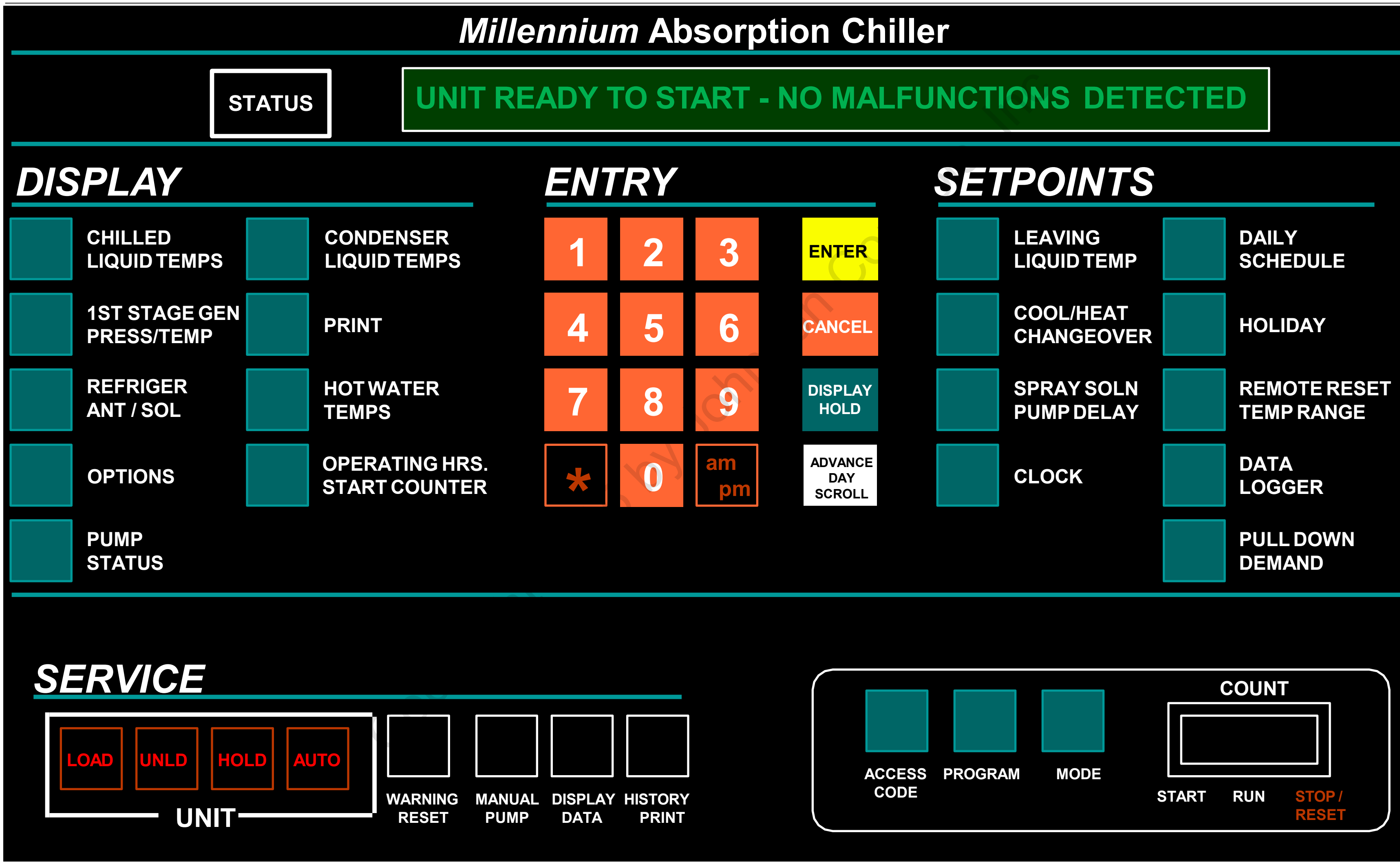


Starting the Vacuum Pump - Manually

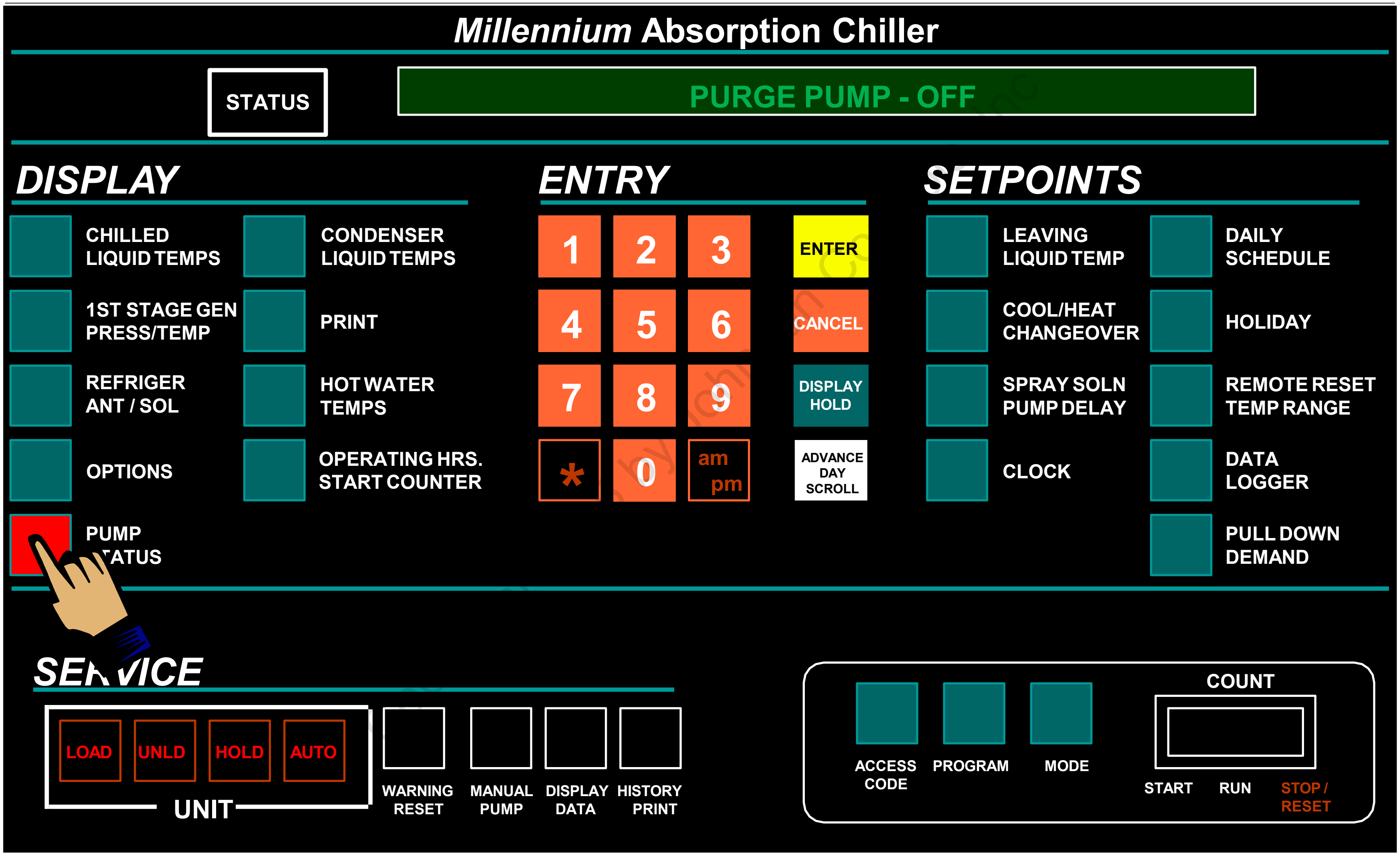
- Start pump with gas ballast closed (prevent oil spatter)
- Open gas ballast fully
- Warm up pump for 20 minutes
- Open VP5
- Confirm pump is capable of pulling to 3mm Hg absolute



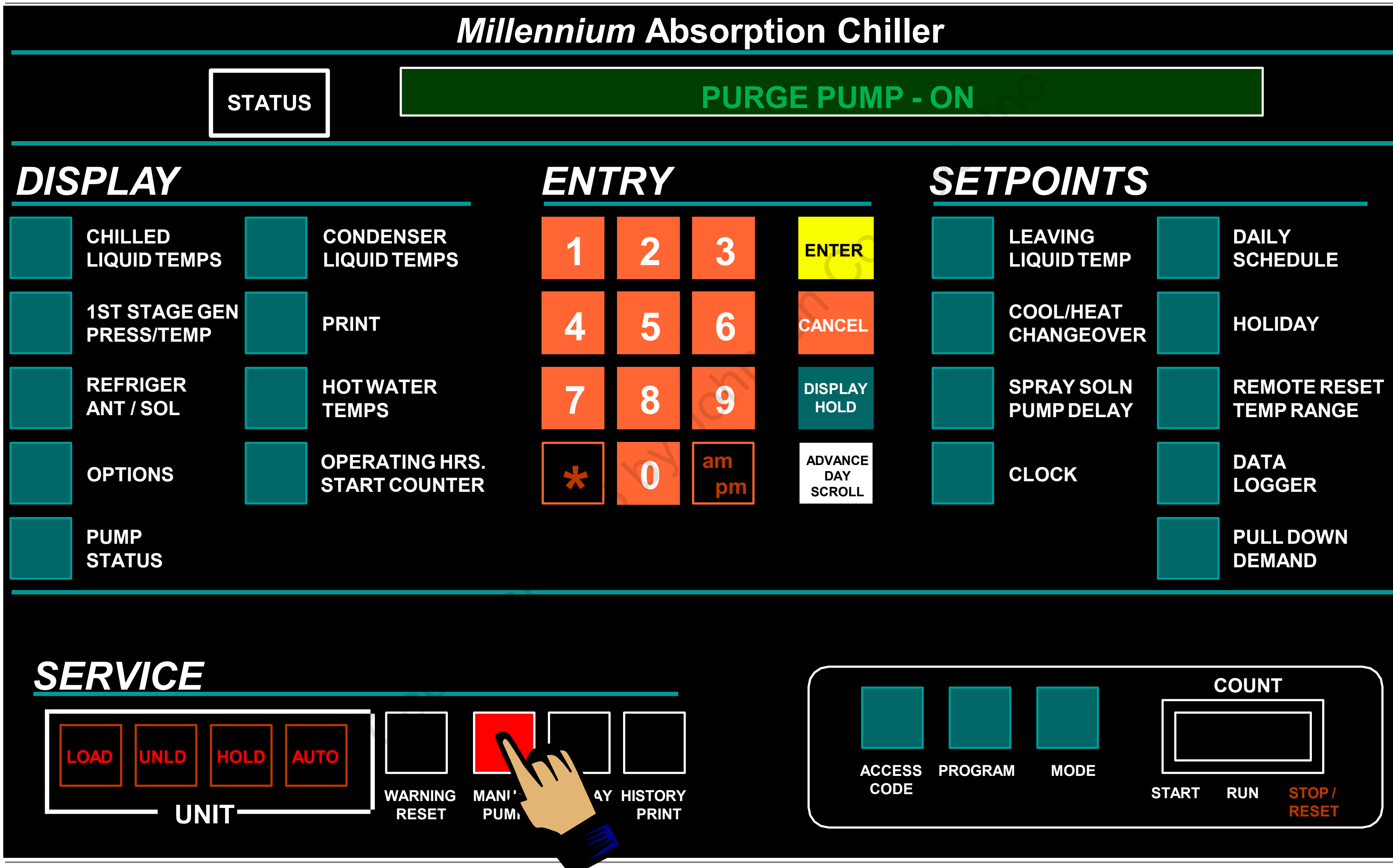
Millennium Absorption Chiller



Millennium Absorption Chiller (Contd.)



Millennium Absorption Chiller (Contd.)



Manually Purging the Purge Tank

- Purge when the purge tank pressure is > 60 mmHg
- Purge down to 30 mmHg

Absorber Purging

- Normally not required
- Indicative of an air leak
- Should only be performed to keep unit operating until repair or service is performed or during the initial evacuation of the machine

Absorber Purging

Caution (G-series only):

Solution level in absorber shell must not be above the upper sight glass. If the level is too high, solution may be sucked into vacuum pump.

Purging During Heating Cycle
(Units equipped with high temperature hot water heat exchanger)

- The unit doesn’t automatically purge during heating operation. If the high temperature generator’s pressure increases over time, purging may be necessary
- Purge only when necessary
- Open VP6 for no more than 3 minutes per month

Purging the Condenser

- The condenser should never be purged while the unit is hot
- Typically purged only during initial start-up or after a repair
- The handle of the condenser purge valve is typically locked, so it is not accidentally opened during operation

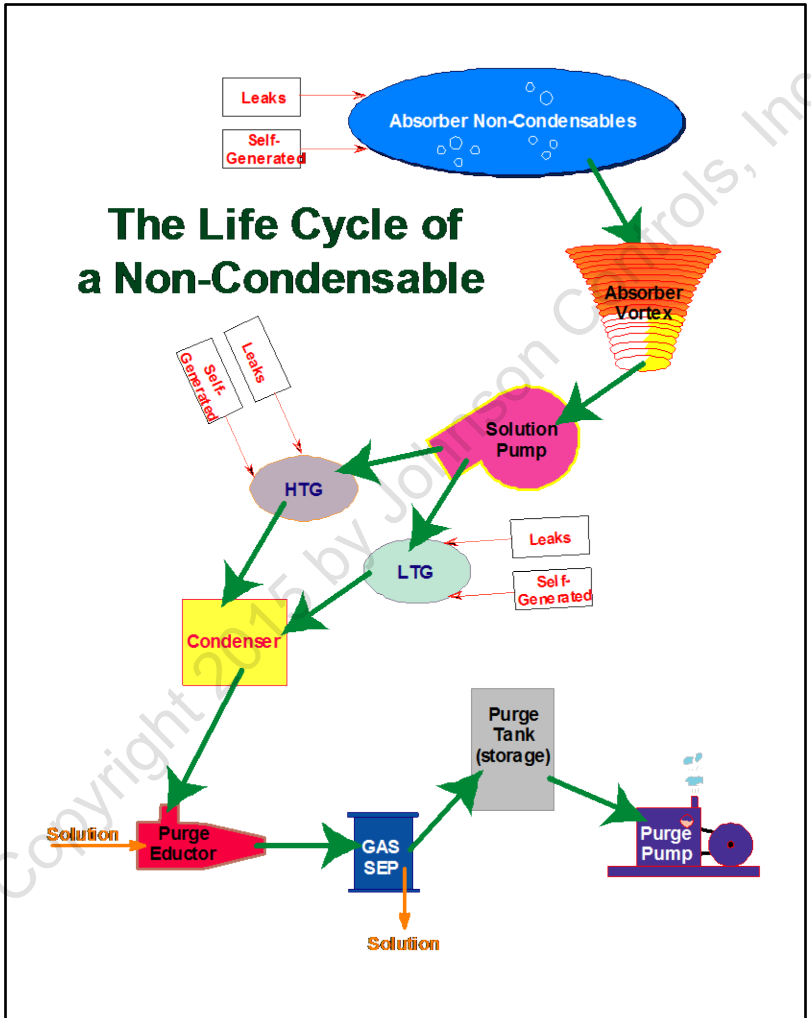
Absorber Self-Purging

- Absorber section is automatically purged during full load operation (low solution level)
- A vortex is formed which pumps the non-condensables from the absorber purge header to the generators

Condenser Self-Purging

- Condenser is purged automatically by the purge eductor
- The solution pump must be running for the purge eductor to function
- Efficiency of purging is increased at low load conditions

Paraflow



Leaks
Self-Generated
Absorber Non-Condensables
The Life Cycle of
a Non-Condensable
Absorber Vortex
Self-Generated
Leaks
Solution Pump
HTG
Leaks
Self-Generated
LTG
Condenser
Purge Tank (storage)
Solution
Purge Eductor
GAS SEP
Purge Pump
Solution

Smart-Purge System

- Automatically purges purge tank
- VP2 and VP5 (if present) must always remain open
- Monitors the frequency of purges
- If the frequency becomes excessive, a warning will be displayed on the micro-panel
- All units should be equipped with a Smart-Purge system
- A retrofit kit is available

Smart-Purge System

System consists of the following components:

- Purge Tank Pressure Transducer (PT-4)
- Purge Pump Pressure Transducer (PT-3)
- Purge Pump Motorized Ball Valve (2SOL)
- Purge Tank Solenoid Valve (1SOL)

Smart-Purge System Operation

- Cycle begins when the purge tank pressure reaches 60 mmHg
- Vacuum pump is started and allowed to warm up
- The purge pump motorized ball valve is energized
- When the purge pump pressure decreases to 15 mmHg, the purge tank solenoid valve is energized
- When the purge tank pressure reaches 30 mmHg, the cycle ends
- The automatic valves are de-energized
- After a clean-up period, the purge pump is shut off

Non-Condensable Monitoring

- An estimated 90% of all absorption problems can be directly attributed to non-condensables
- Monitoring the non-condensable production gives the operator an early warning that problems are about to develop in the machine
- An increase in the non-condensable production is indicative of a solution chemistry imbalance, an air leak, or a combination of the two
- Simply put, monitoring the non-condensable production and if necessary taking prompt corrective action, will extend the life of an absorption unit

Non-Condensable Monitoring

- A ParaFlow Purge Log Form should be filled out by the operator on a daily basis unless the unit is equipped with a Smart-Purge System
- A Baseline should be determined for every unit
- The Purge Tank Pressure Difference should be trended over time

Determining the Baseline Pressure Difference

- Inhibitor levels must be in there specified ranges
- Unit must be “leak free”
- Unit must operate for several days at full load conditions
- Trend as normal on the ParaFlow Purge Log Form

Typical Baseline Pressure Differences

■ S-Units -	Molybdate Inhibited	= 1 - 2 mmHg / 24Hrs
	Nitrate Inhibited	= 2 - 5 mmHg / 24Hrs
■ G - Units -	Molybdate Inhibited	= 1 - 4 mmHg / 24Hrs
	Nitrate Inhibited	= 3 - 8 mmHg / 24Hrs

Note: All values are at full load operating conditions.

Solution Chemistry Problem or Air Leak?

- Take a solution sample and send to lab for analysis
- Make chemical adjustments as required
- Monitor non-condensable production
  - If production drops to baseline and remains there, the problem was simply related to solution chemistry
  - If the production drops and then increases again, a leak is present. Leak test the unit according to factory recommendations

Leak Test Methods

Leak Test Methods

- The following methods may be used to leak test an absorption unit. The best method depends on several factors
  - Size of Leak
  - Does the leak get worse when the machine heats up?
  - Will the customer allow the unit to be shut down?

Leak Location Techniques

Detector-Probe Method

- Tracer gas is charged into the vessel to be tested. The leak is then searched for using an external sensing device
  - Soap Bubble Test
  - Refrigerant Leak Test
  - Helium Leak Detection - Sniff Test

Leak Location Techniques

Tracer-Probe Method

- The tracer gas is sprayed externally on the unit. A detector then samples the purge gas
  - Helium Leak Detection - While unit is operating

Leak Location Techniques

Soap Bubble Test

Unit can be charged with dry nitrogen or argon to the following maximum pressures:

- 5 PSIG - With carbon rupture disk installed
- 8 PSIG - With metal rupture disk installed
- 12 PSIG - With rupture disk blanked off or equalized.

- Will have to remove solution if testing under the solution level

Leak Location Techniques

Refrigerant Leak Test

Unit can be charged with dry nitrogen or argon to the following maximum pressures:

- 5 PSIG - With carbon rupture disk installed
- 8 PSIG - With metal rupture disk installed
- 12 PSIG - With rupture disk blanked off or equalized

- Will have to remove solution if testing under the solution level
- Unit can be charged with no more than 5% R-22
- Use halide leak detector to sniff joints

Leak Location Techniques

Helium Leak Test - Sniffer

Unit can be charged with dry nitrogen or argon to the following maximum pressures:

- 5 PSIG - With carbon rupture disk installed
- 8 PSIG - With metal rupture disk installed
- 12 PSIG - With rupture disk blanked off or equalized

- Will have to remove solution if testing under the solution level
- Charge unit with approximately 25% helium
- Use helium mass spectrometer to sniff joints

Leak Location Techniques

Helium Leak Test

- Performed while unit is operating
- Finds leaks under the solution level
- Finds hot leaks
- Finds one way leaks
- Finds leaks under the insulation
- Helium is sprayed on components. If helium is sensed (with a helium mass spectrometer) coming out of the purge tank, a leak is present

Picture Gallery

Helium Testing of Completed Single Stage Chiller

Picture Gallery

Section 3: Micropanel

Section 3: Micropanel

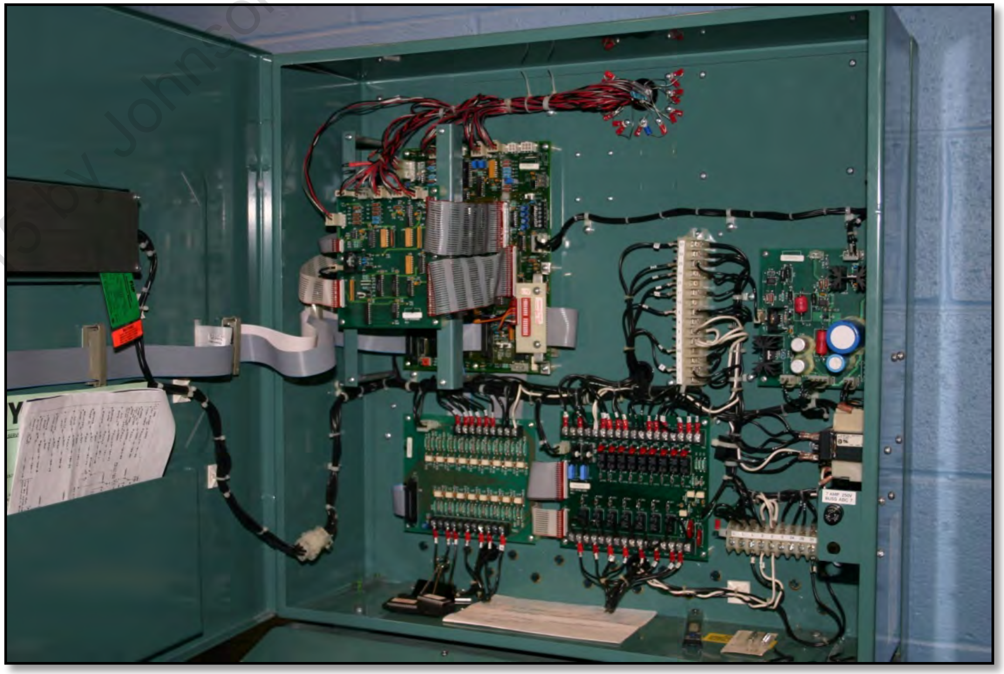
- Keypad Operation
- System Commissioning Procedure
- Special Setpoints & Programming
- Warning Messages
- Steam Valve Calibration
- Gas/Oil Burner Calibration
- System Safety & Cycling Controls
- Troubleshooting

Keypad Operation

System Commissioning Procedure

Reference:
Form 155.17-O2

- Factory Test Report
- Jumper positions set properly



Special Setpoints & Programming

Reference:

Form 155.17-O2 (pg 124)

Form 155.17-M2 (pg 52, 58)

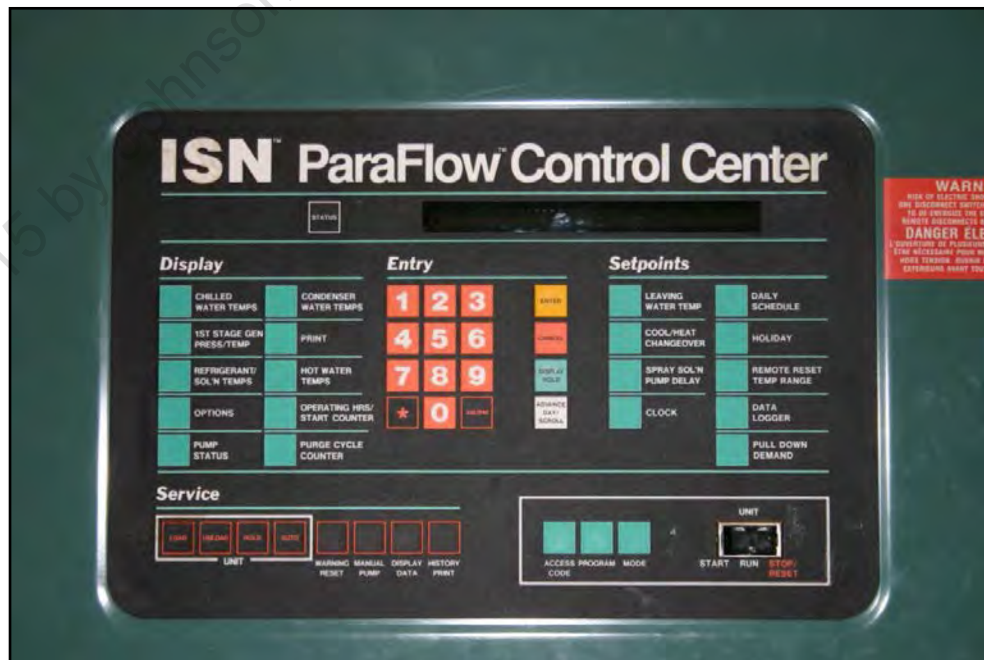
Special Setpoints & Programming

- Jumper Positions
- Programming System Setpoints: LCHW & LHW
- Solution Pump Delay
- Auto-temp Control Reset Time
- Auto-temp Control Delay
- Enable Auto Purge System
- Max Allowed Entering Condenser Water Temp
- Solution Concentration Display
- Max Allowed Loading
- Other setpoints:
  - Steam Valve Control Calibration (steam units only)
  - Alcohol Separation Procedure
  - Burner Calibration (gas/oil units only)

Warning Messages

Reference:

Form 155.17-O2 (pg 134,141)
Form 155.17-M2 (pg 64)



Warning Messages

- Interpreting Messages
- Override Procedure
- Functions that can be overridden
- WARNING – Low Refrigerant Temperature
- WARNING – High Gen Pressure Override
- WARNING – High Gen 1 Pressure Override*
- WARNING – High Gen 2 Pressure Override*
- WARNING – High Gen Temperature Override
- WARNING – High Gen 1 Temp Override*
- WARNING – High Gen 2 Temp Override*

Steam Valve Calibration

Reference:

Form 155.17-O2
Form 155.17-M2 pg. 65

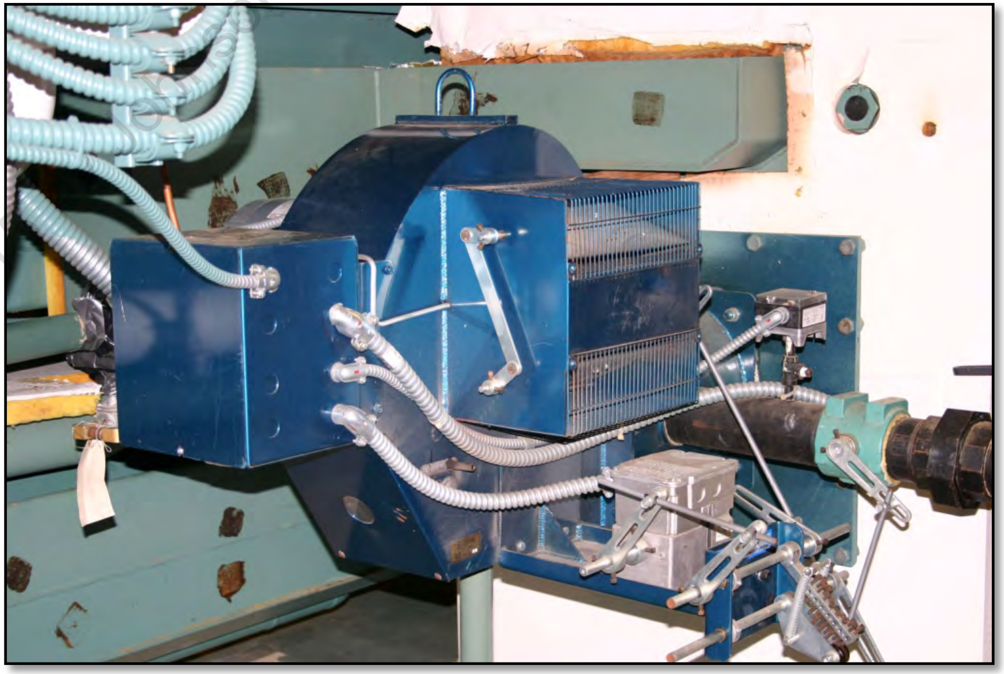
- Steam Valve Control Calibration
- Program Steam valve Setpoints

Gas/Oil Burner Calibration

Reference:

Form 155.17-M2 (pg 66)
Form 155.17-NM1

- Burner Link Adjustment
- Burner Motor Full Travel Calibration



System Safety & Cycling Controls

Reference:

Form 155.17-O2

- Limited Dilution Cycle Standby Power Supply
- Electro-mechanical cutout switches

Troubleshooting

Reference:

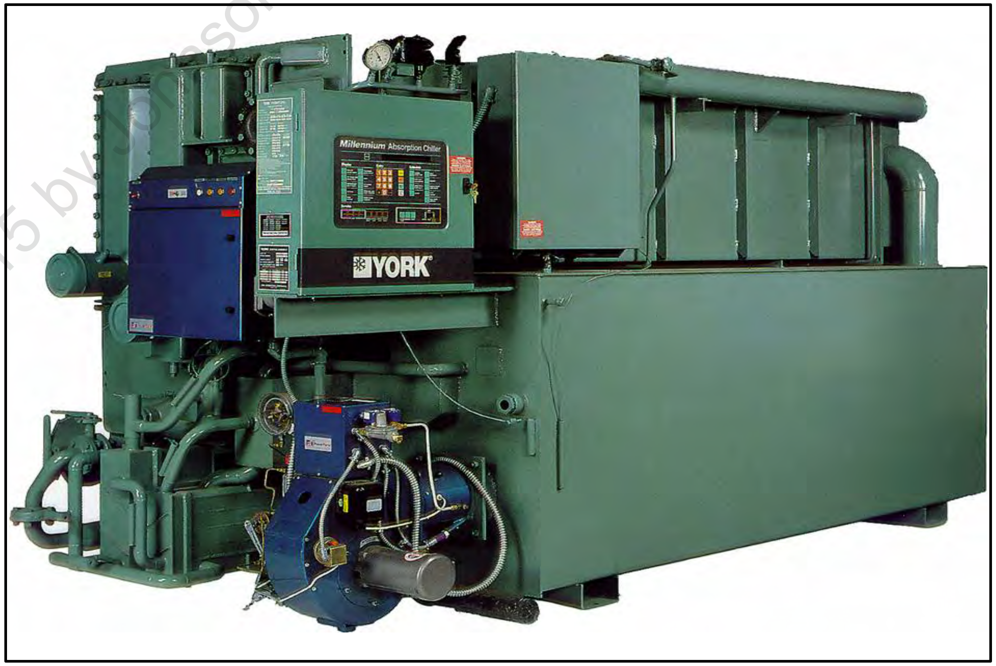
Form 155.17-M2 (pg 74-96)

- Digital Inputs
- Relay Outputs
- Transducers and Thermistors
- Keypad Display
- Keypad Keys
- Steam Valve Actuator Control Outputs
- 4-20mA Buring Firing Rate Control Ouptut
- Leaving Water Temp Remote Setpoint Interface
- Load Limit Remote Setpoint Interface
- EMI Noise

Section 4: Chiller Startup

Section 4: Chiller Startup

- Pre-startup activities and startup procedures
- Adjustments following initial startup
- Purging
- Performance verification
- Startup documents
- Finalizing startup



Pre-Startup Procedures

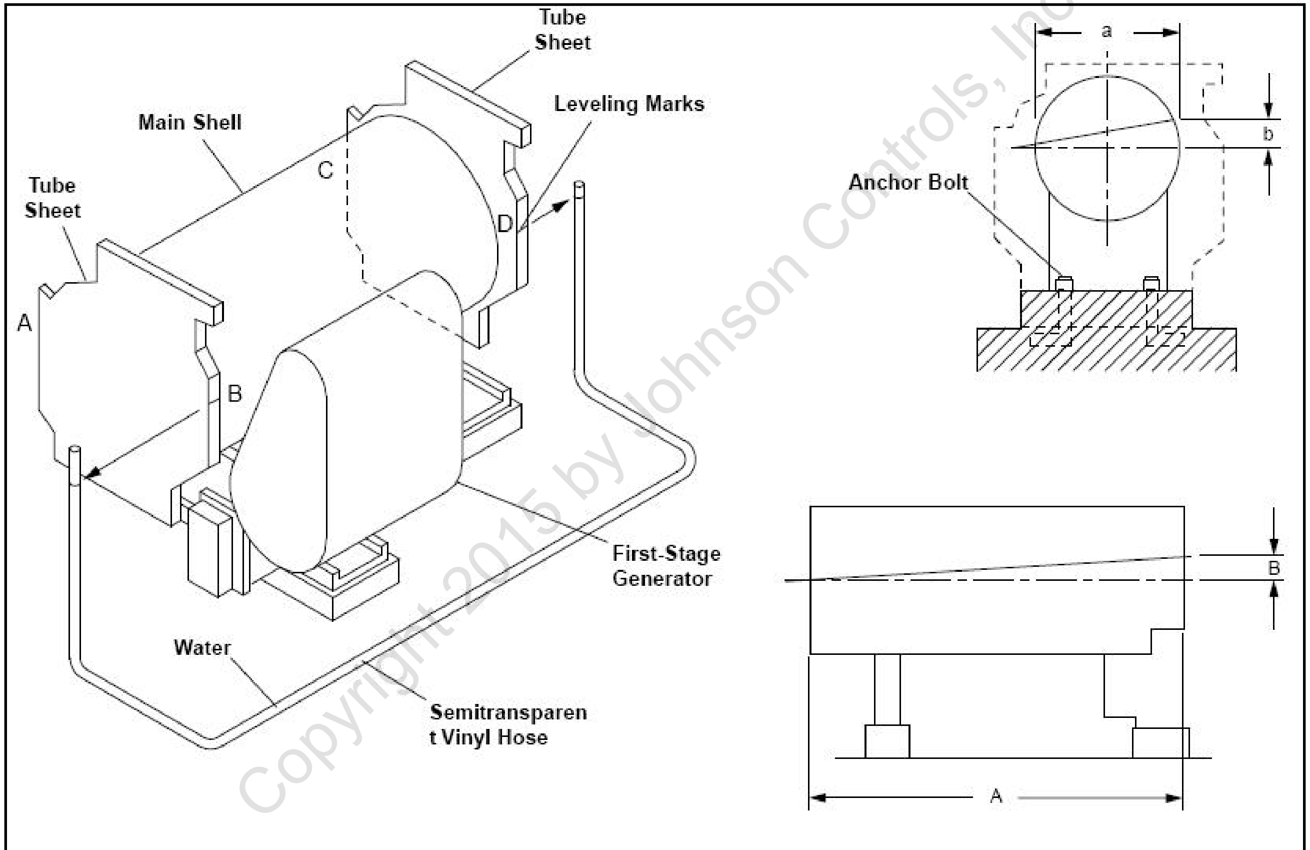
ParaFlow Maintenance Manual: Startup Section

Forms:

- 155.17-F2 ParaFlow Chiller-Heater Pre-Start Checklist
- 155.17-SU1 ParaFlow Startup Report Form (coming soon)
- 155.17-SU2 Startup Instructions for ParaFlow

Pre-Startup Procedures

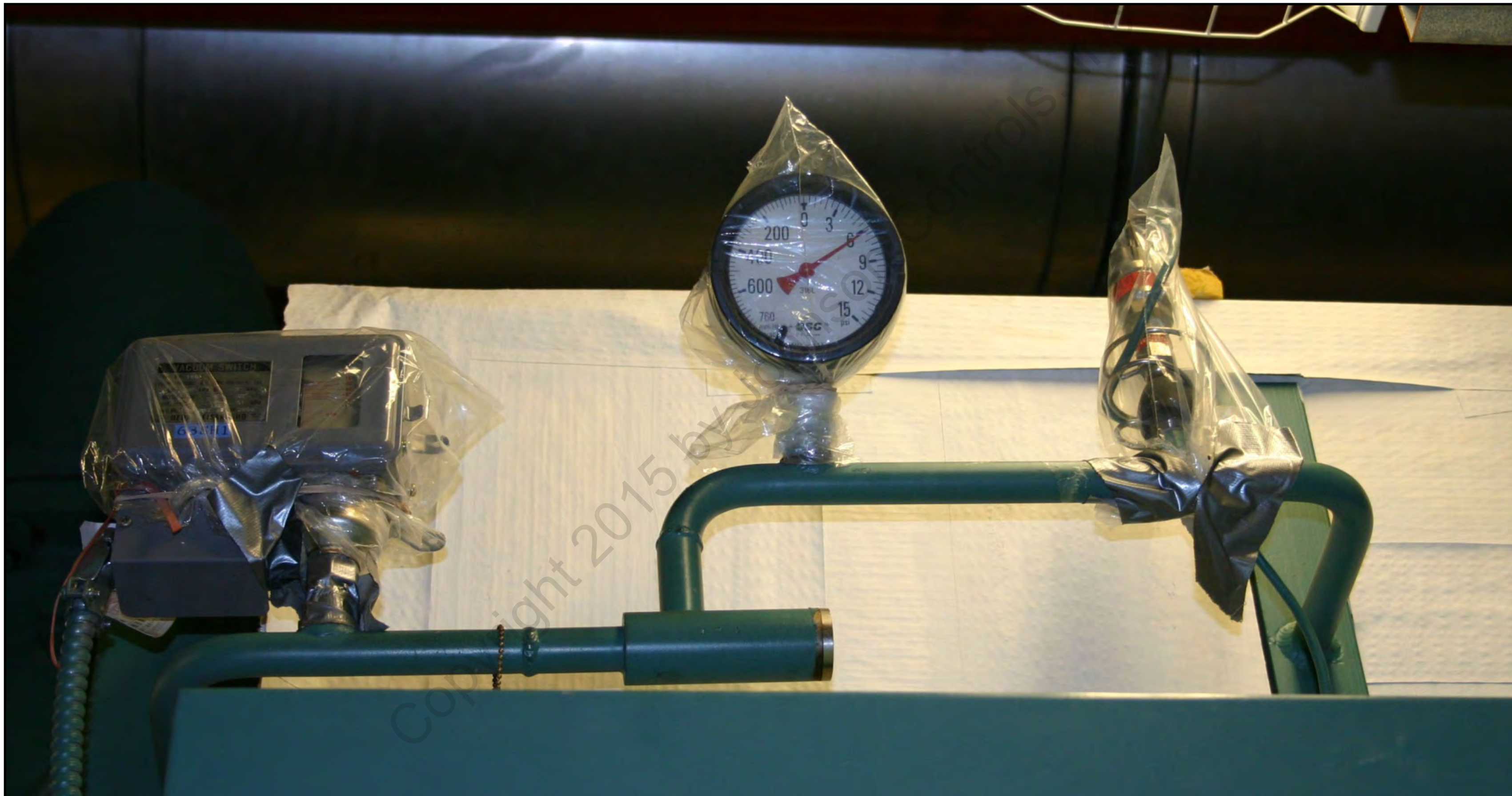
- Leveling the Unit



$\frac{a}{1000} = \frac{A}{1000} = B = b$ Maximum Allowable Out Of Level Tolerance Between Any 2 Corners

Pre-Startup Procedures

- Leveling the Unit
- Testing the factory holding charge

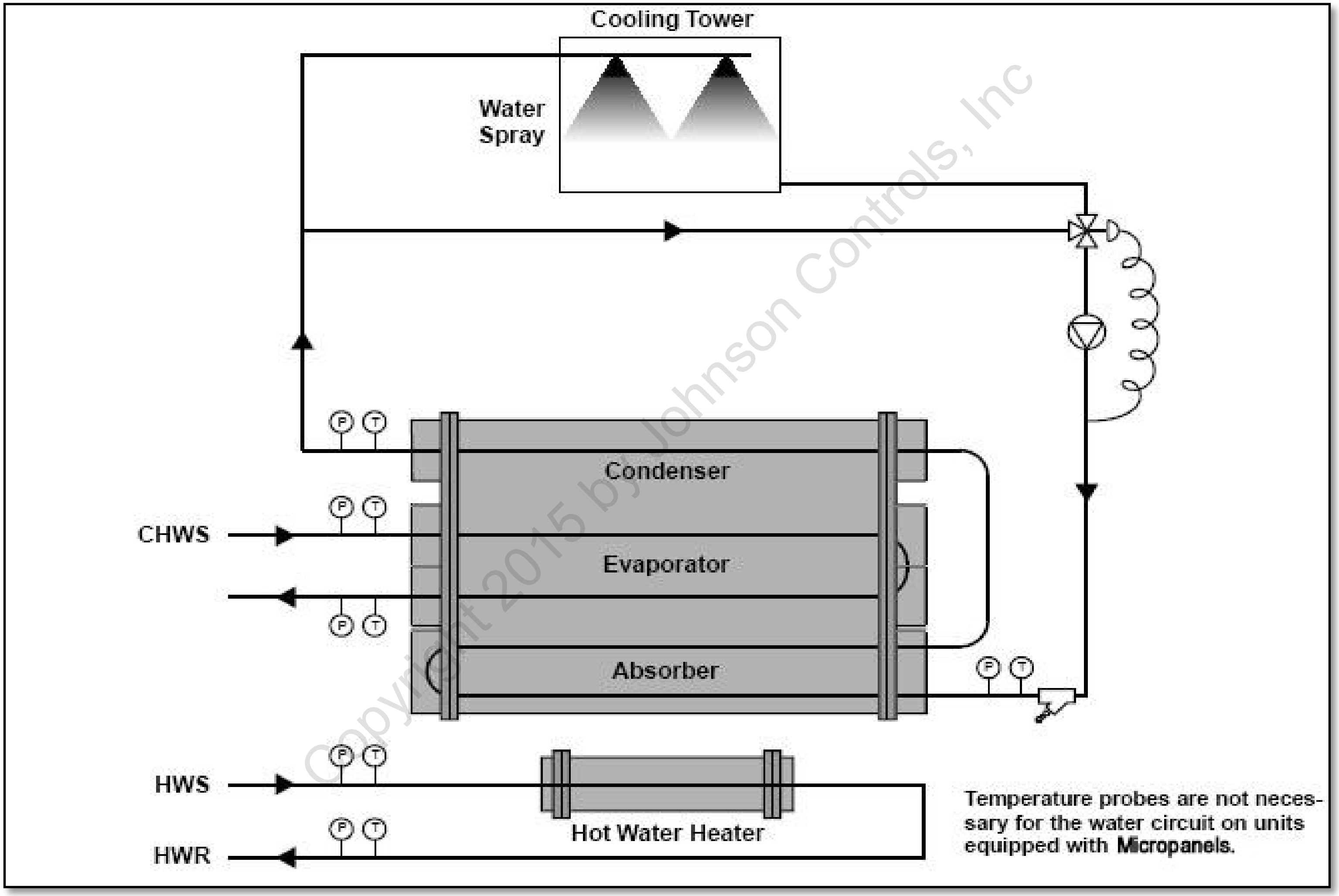


200
600
760
0
3
6
9
12
15

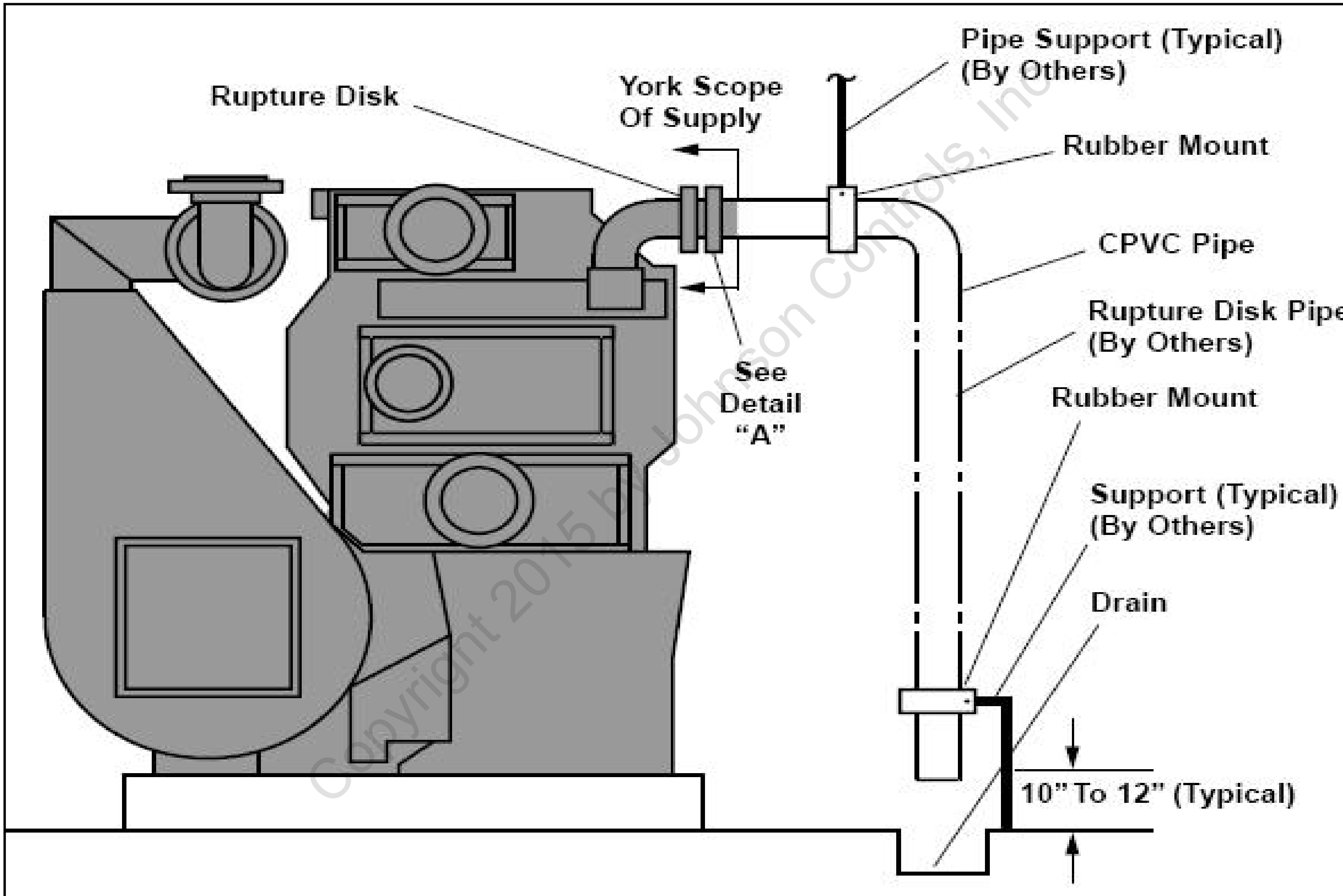
Pre-Startup Procedures

- Leveling the Unit
- Testing the factory holding charge
- Confirm building connections

Unit Piping Schematic



Rupture disk arrangement



Pre-Startup Procedures

- Leveling the Unit
- Testing the factory holding charge
- Confirm building connections
- Burner/burner control panel checks, setting hi/low pressure regulators, verifying gas pressure

Burner and Burner Control Panel

Pre-Startup Procedures

- Leveling the Unit
- Testing the factory holding charge
- Confirm building connections
- Burner/burner control panel checks, setting hi/low pressure regulators, verifying gas pressure
- Check valve positions (PMM: Valves)

Check Valve Positions

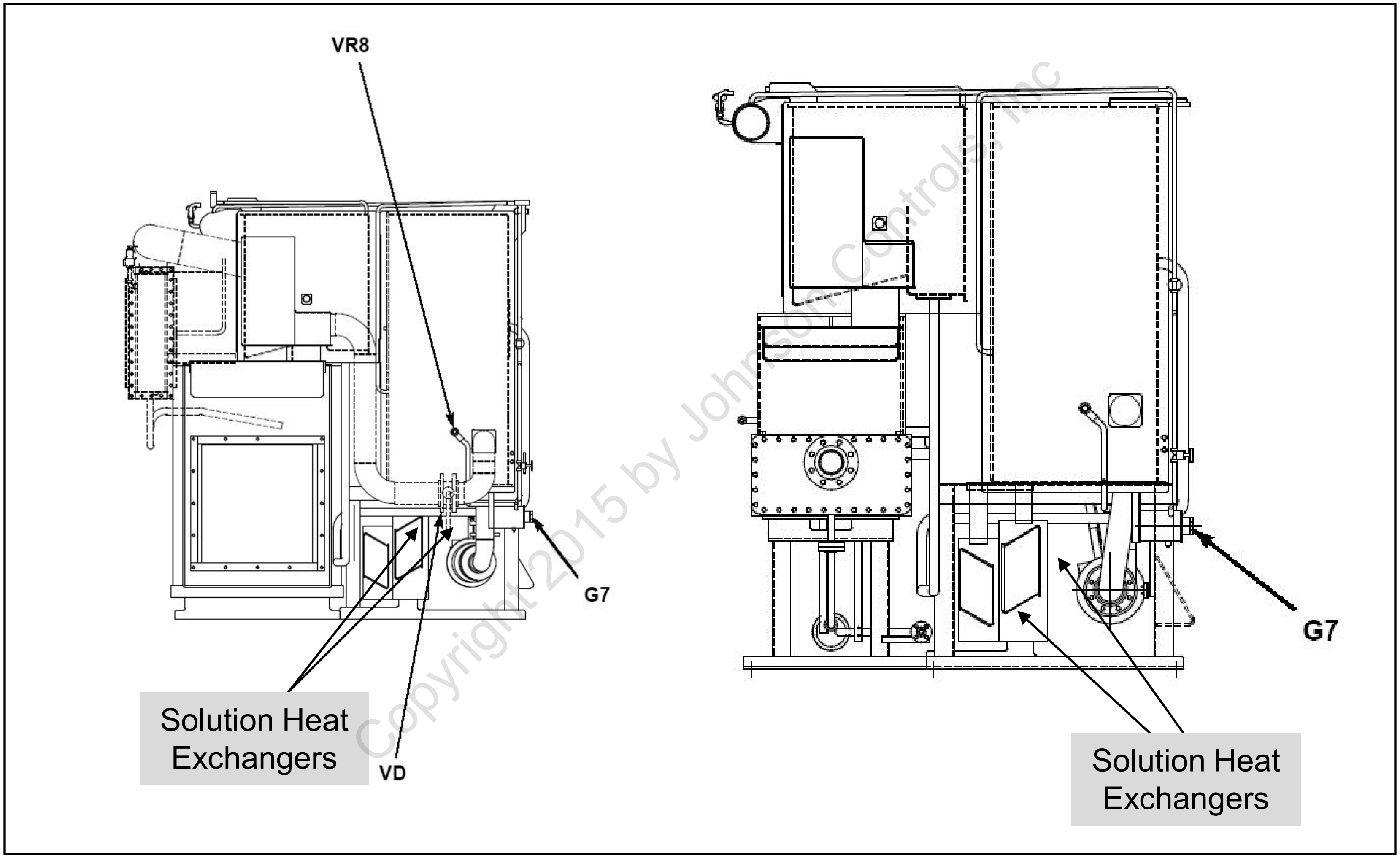
- ParaFlow Maintenance Manual: Valve Settings

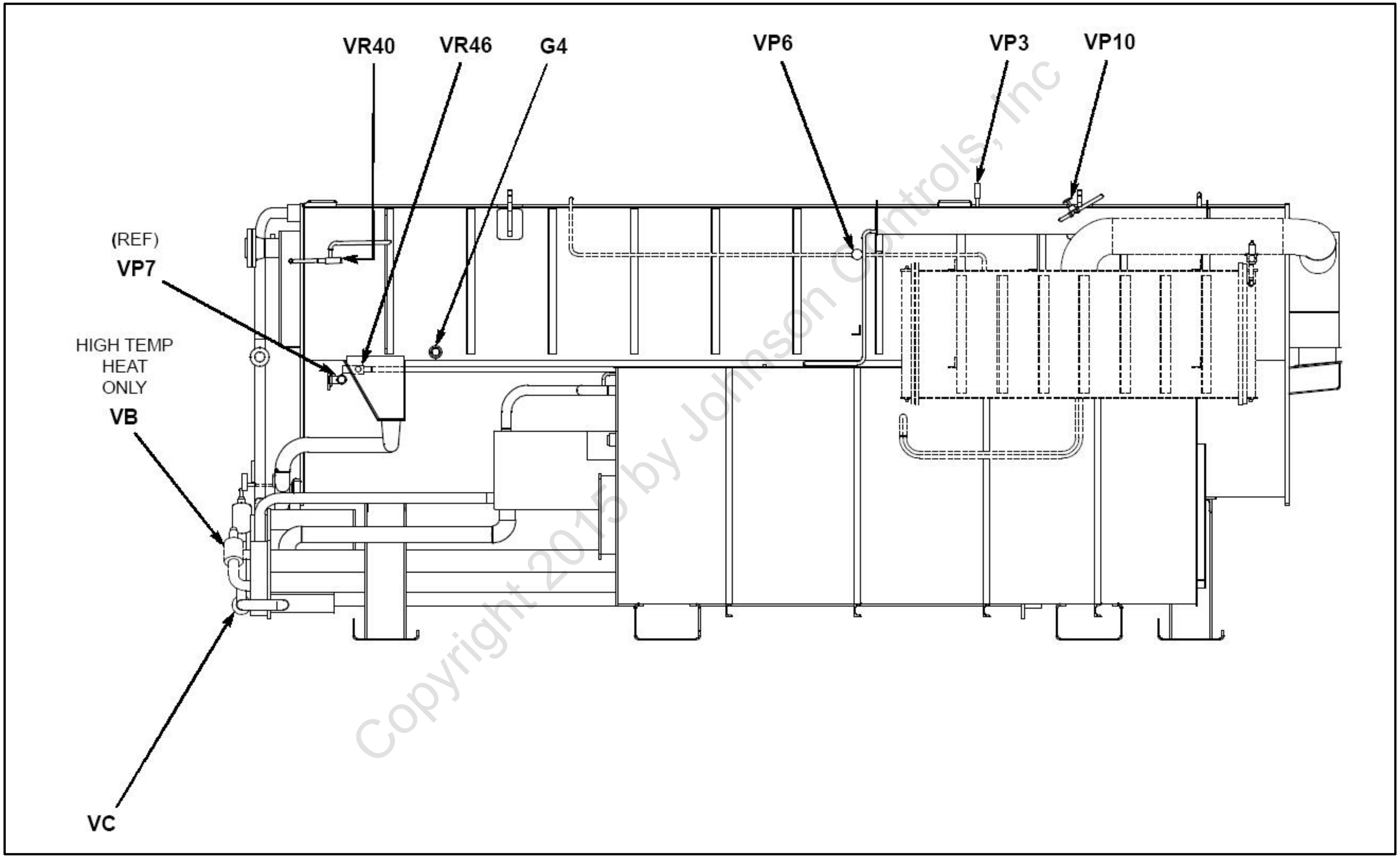
VALVES

YPC-DF-16SL-19S

YPC-DF-16SL-19S					
Old	New	Name and Location of Valve	Cooling	New Style †	Heating[1]
V2	VS1	High Temperature Generator (Strong Solution Return)	1-1/2 Turns Open	2-1/2	
V1	VS2	Low temperature Generator (Weak Solution Supply)	1-1/4 Turns Open	2-1/4	
V8	VR8	Refrigerant Blowdown Valve	Fully Closed		
V9	VR9	Refrigerant Pump Isolation Valve (Suction)	Fully Open		
V10	VR10	Refrigerant Pump Isolation Valve (Discharge)	Fully Open		
V11	VR11	Refrigerant Sampling Valve (Discharge Refrigerant Pump)	Normally Closed		
V12	VS12	Main Solution Pump Isolation Valve (Suction)	Fully Open		
V15	VS13	Main Solution Pump Isolation Valve (Discharge)	Fully Open		
V14	VS23	Strong Solution Spray Pump Isolation Valve (Discharge)	Fully Open		
V13	VS22	Strong Solution Spray Pump Isolation Valve (Suction)	Fully Open		
V18	VS18	Solution Sampling Valve (High Temperature Generator Return)	Normally Closed		
V19	VS19	Solution Sampling Valve (Low Temp. Heat Exchanger, Weak Solution Inlet)	Normally Closed		
V20	VS17	Solution Sampling Valve ((Low Temperature Generator Return)	Normally Closed		
V21	VS25	Solution Sampling Valve (Discharge Strong Solution Spray Pump)	Normally Closed		

* Individual Exercise

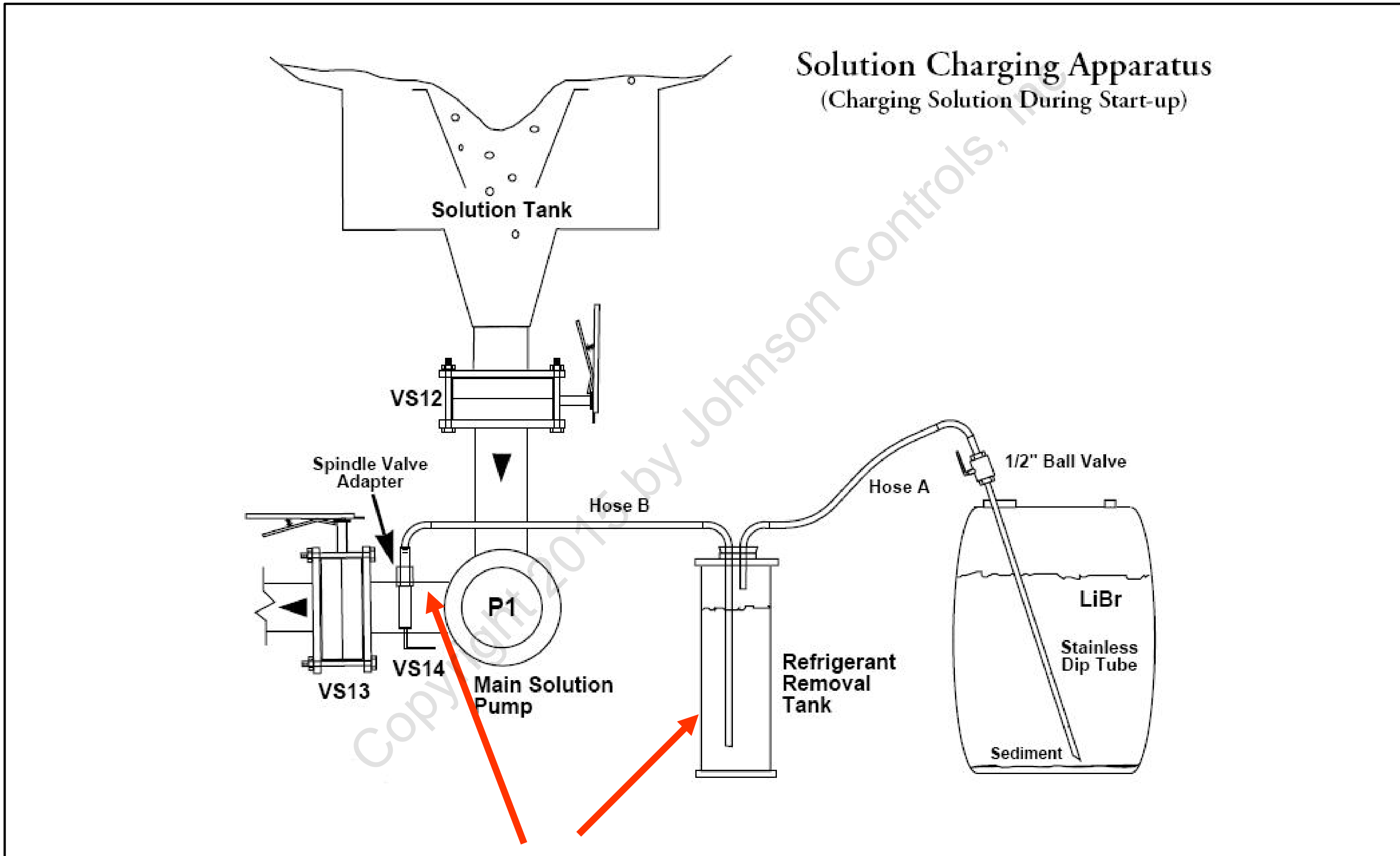

VR8
G7
VD
Solution Heat Exchangers
G7
Solution Heat Exchangers


VR40
VR46
G4
VP6
VP3
VP10
(REF)
VP7
HIGH TEMP
HEAT
ONLY
VB
VC

Pre-Startup Procedures

- Leveling the Unit
- Testing the factory holding charge
- Confirm building connections
- Burner/burner control panel checks, setting hi/low pressure regulators, verifying gas pressure
- Check valve positions (PMM: Valves)
- Evacuate and charge (if charge is shipped separate)

Evacuate & Charge

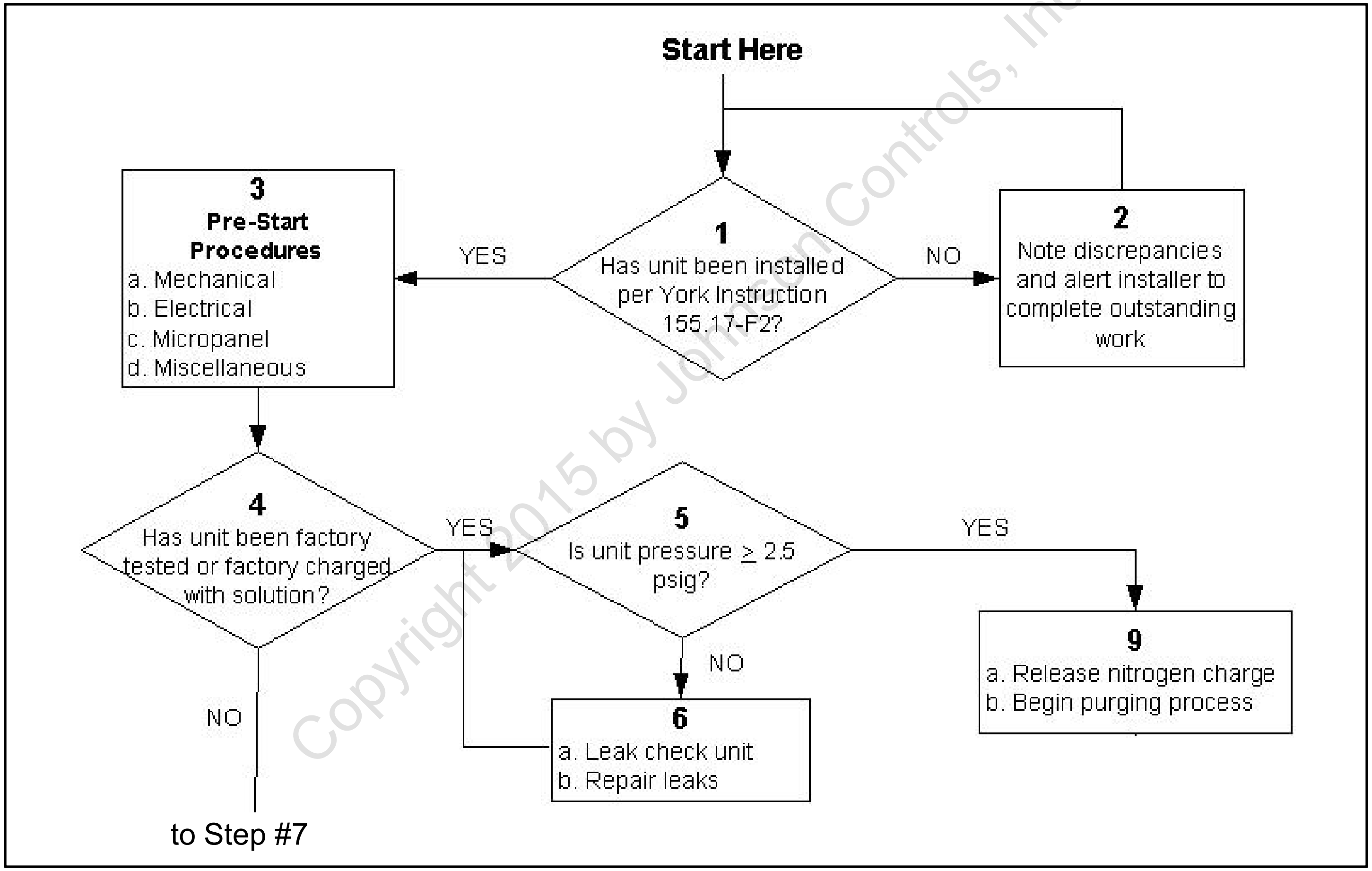


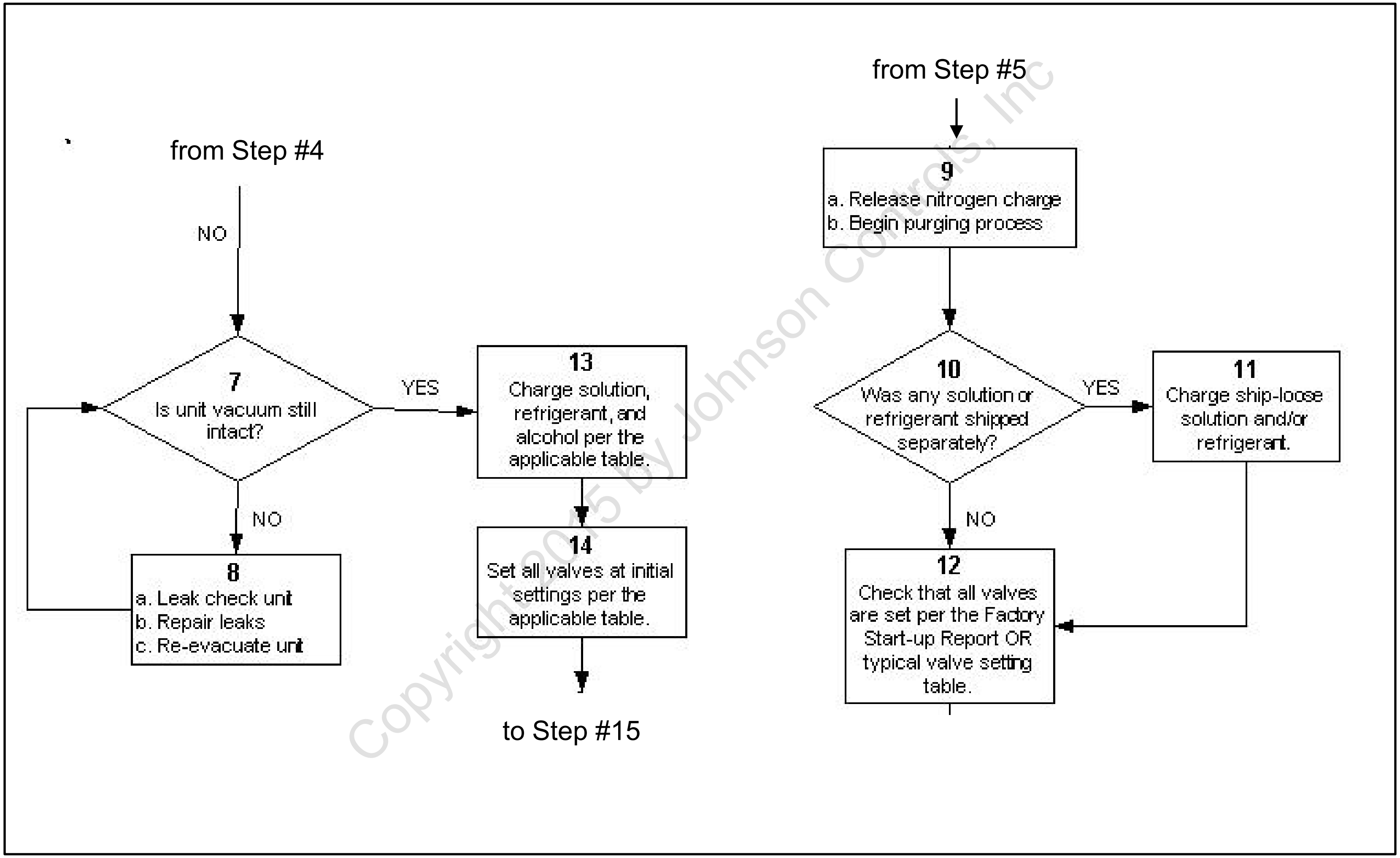
Pre-Startup Procedures

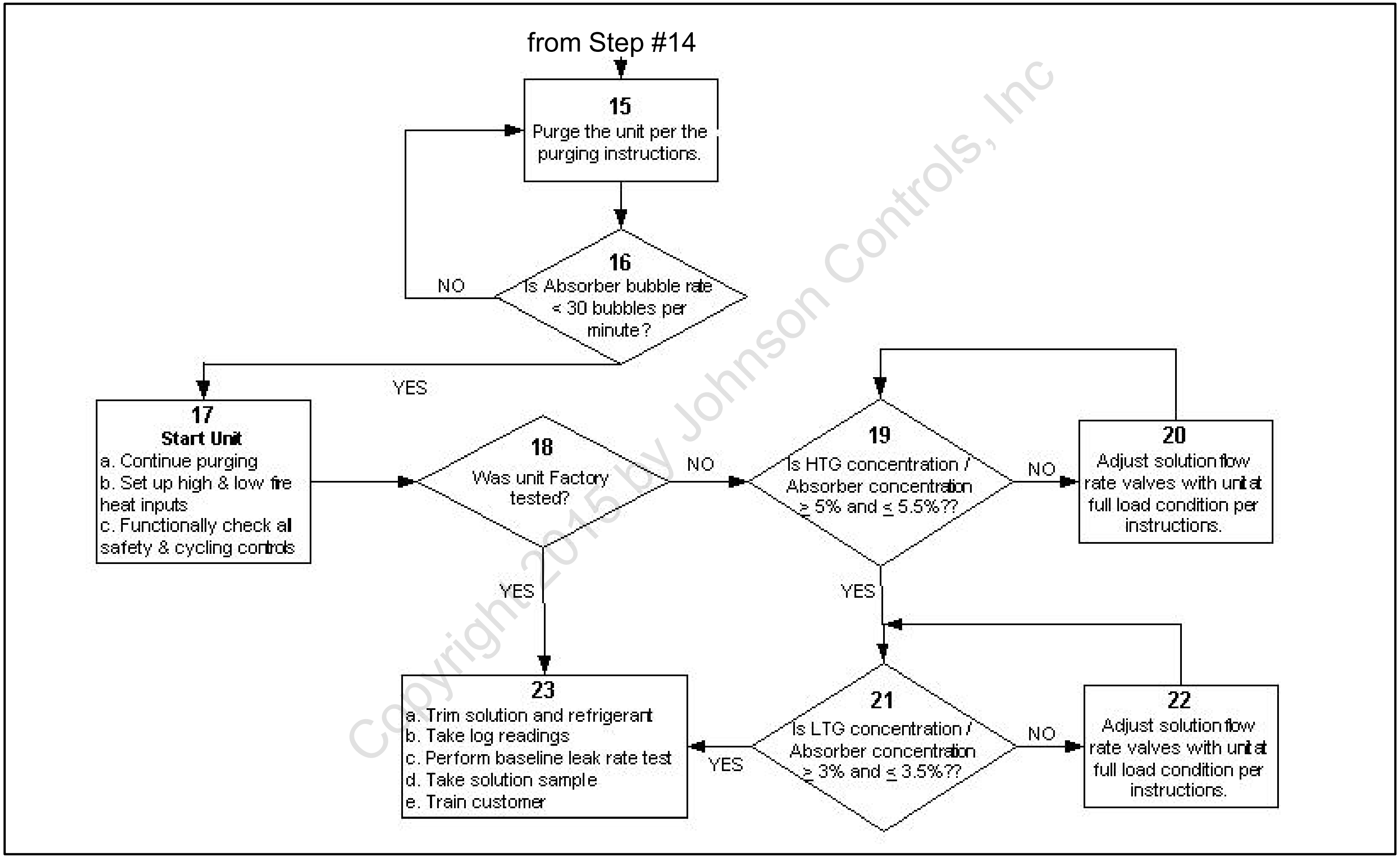
- Leveling the Unit
- Testing the factory holding charge
- Confirm building connections
- Burner/burner control panel checks, setting hi/low pressure regulators, verifying gas pressure
- Check valve positions (PMM: Valves)
- Evacuate and charge (if charge is shipped separate)
- Check pumps
- Power Checks (on/off)
- Solution and Refrigerant pump flow direction
- Check safety controls
- Micropanel functionality and jumper position checks

Startup Procedures

- ParaFlow Maintenance Manual: Startup



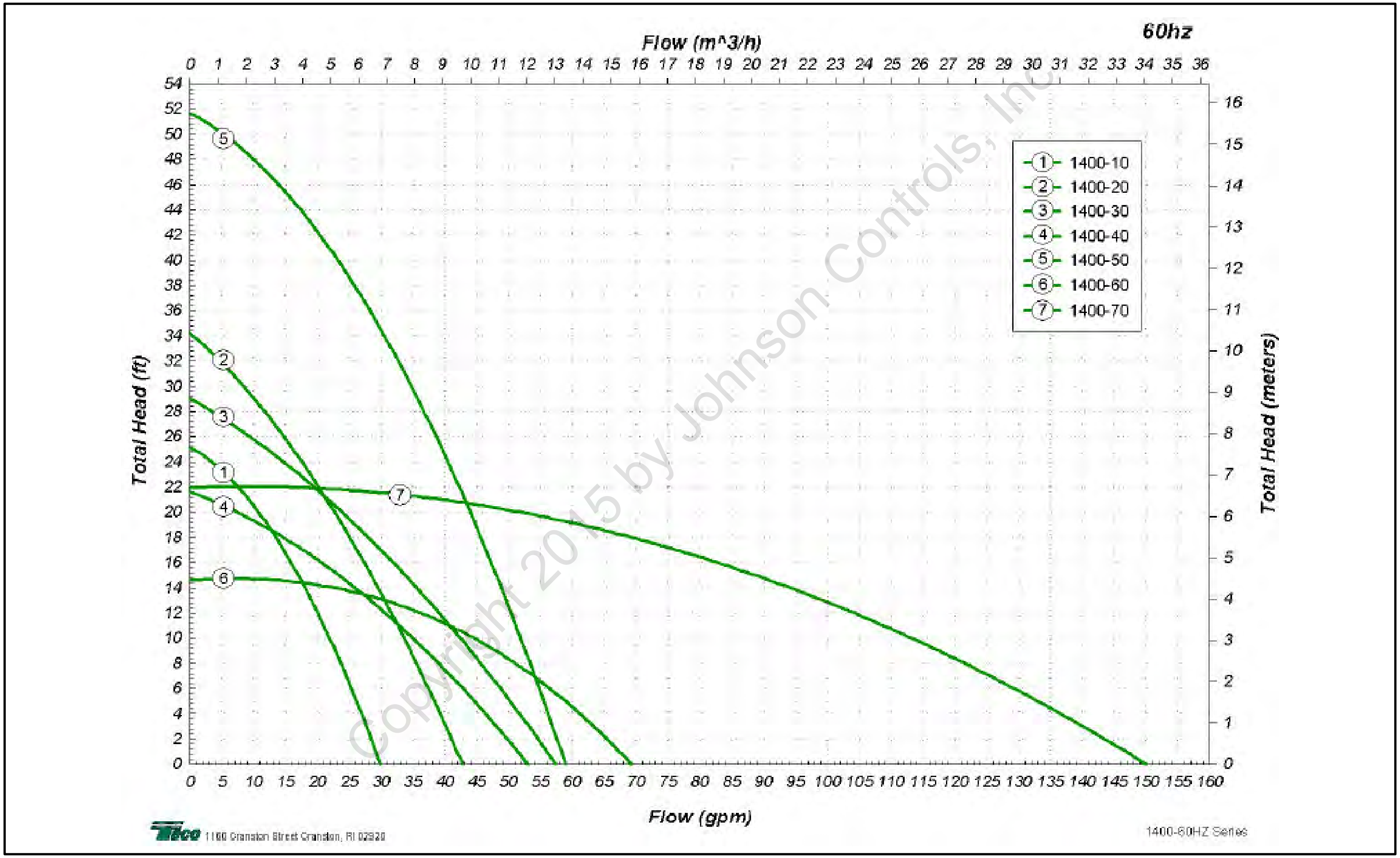

from Step #4
NO
7
Is unit vacuum still intact?
YES
NO
8
a. Leak check unit
b. Repair leaks
c. Re-evacuate unit
13
Charge solution, refrigerant, and alcohol per the applicable table.
14
Set all valves at initial settings per the applicable table.
to Step #15
from Step #5
9
a. Release nitrogen charge
b. Begin purging process
10
Was any solution or refrigerant shipped separately?
YES
11
Charge ship-loose solution and/or refrigerant.
NO
12
Check that all valves are set per the Factory Start-up Report OR typical valve setting table.



from Step #14
15
Purge the unit per the purging instructions.
16
Is Absorber bubble rate < 30 bubbles per minute?
NO
YES
17
Start Unit
a. Continue purging
b. Set up high & low fire heat inputs
c. Functionally check all safety & cycling controls
18
Was unit Factory tested?
NO
YES
19
Is HTG concentration / Absorber concentration ≥ 5% and ≤ 5.5%??
NO
YES
20
Adjust solution flow rate valves with unit at full load condition per instructions.
21
Is LTG concentration / Absorber concentration ≥ 3% and ≤ 3.5%??
NO
YES
22
Adjust solution flow rate valves with unit at full load condition per instructions.
23
a. Trim solution and refrigerant
b. Take log readings
c. Perform baseline leak rate test
d. Take solution sample
e. Train customer

Startup Procedures

- Water flow rates and balancing

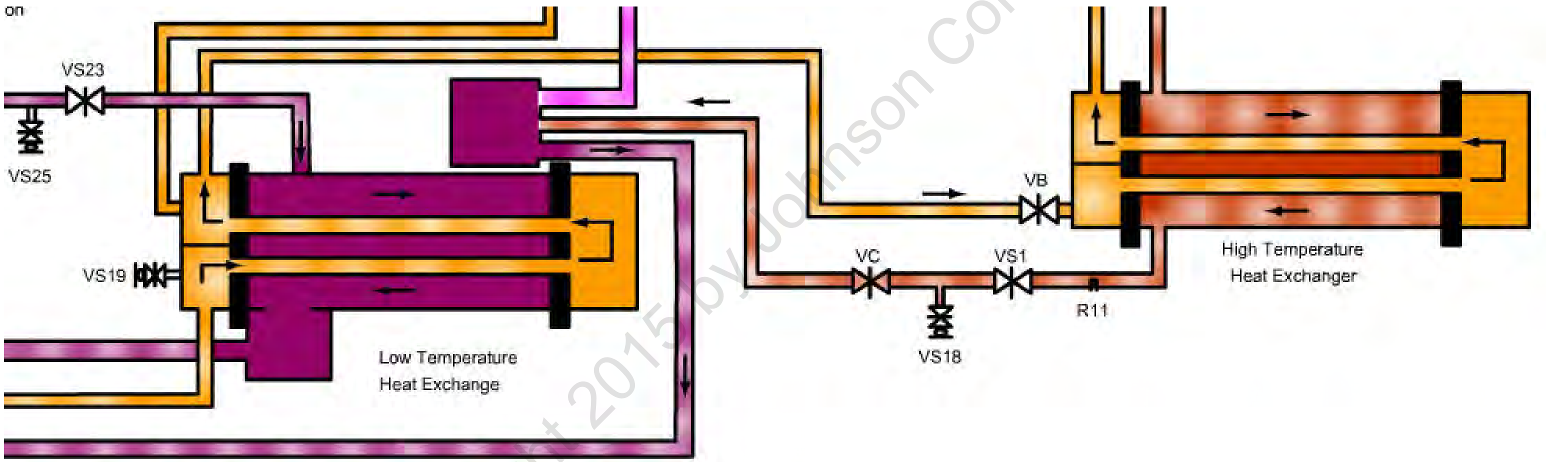


60hz
Flow (m^3/h)
Total Head (ft)
Total Head (meters)
Flow (gpm)
1400-10
1400-20
1400-30
1400-40
1400-50
1400-60
1400-70
Copyright 2015 by Johnson Controls, Inc.
1160 Cranston Street Cranston, RI 02920
1400-60HZ Series

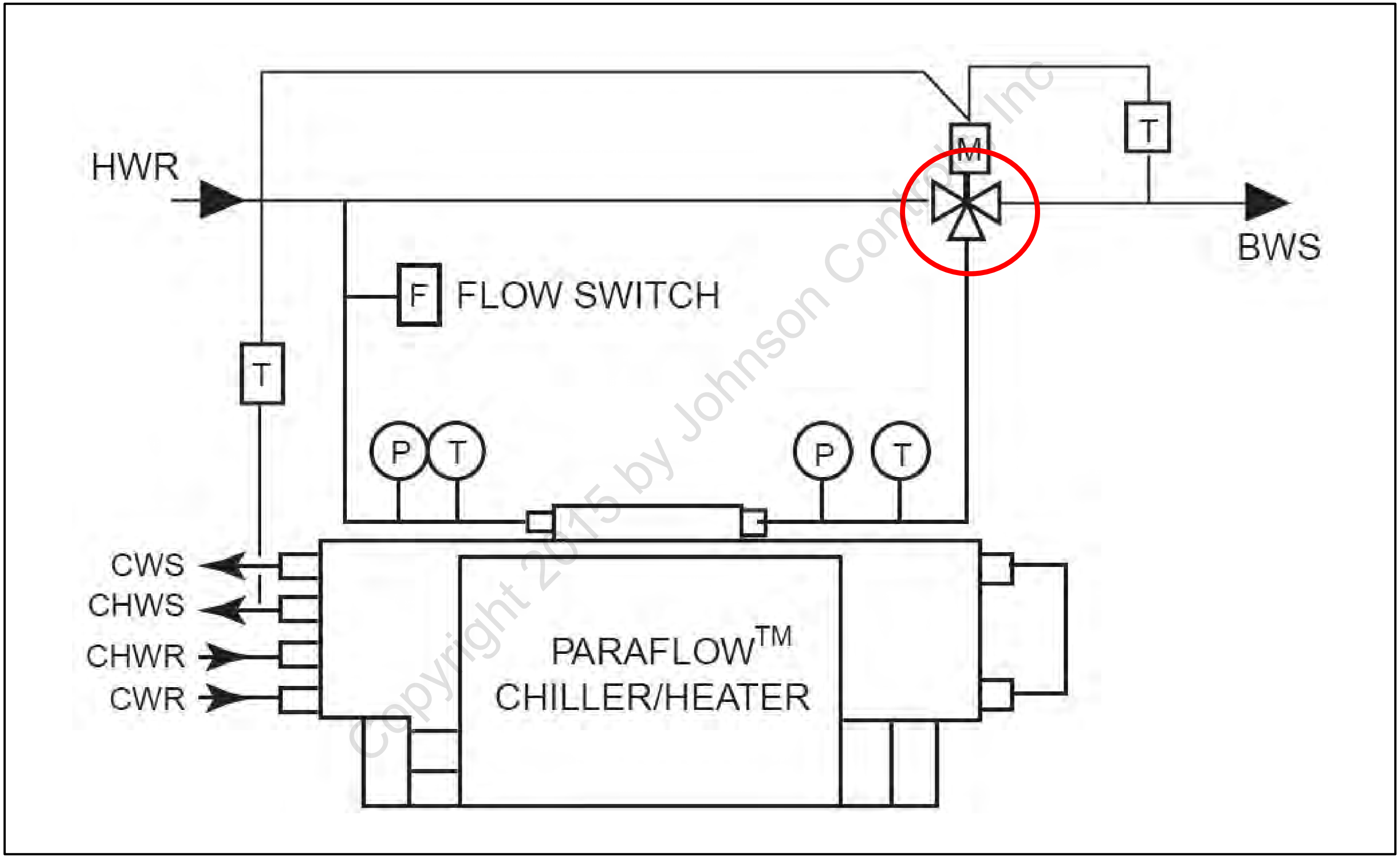
Startup Procedures

- Water flow rates and balancing
- Heat Exchanger Flow

Heat Exchanger Flow



Simultaneous Operation

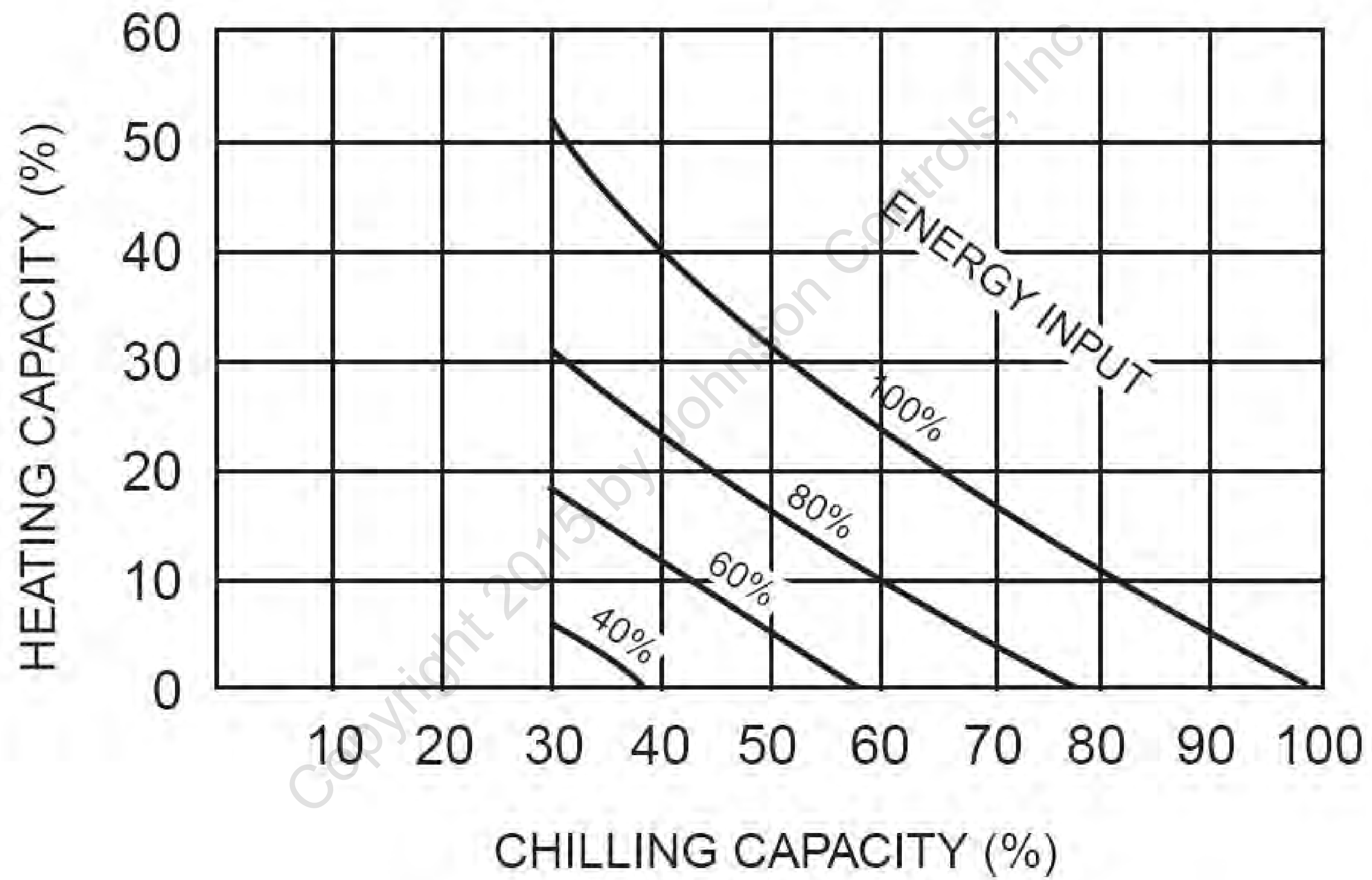


When the YORK ParaFlow™ Chiller/Heater is in the heating mode, the mixing valve must be in the open position to allow full flow through the hot water heat exchanger. The hot water controller will then modulate the burner to meet load variations and the unit will operate in the normal manner.

Startup Procedures

- Water flow rates and balancing
- Heat Exchanger Flow
- Simultaneous Heating/Cooling

Simultaneous Heating/Cooling



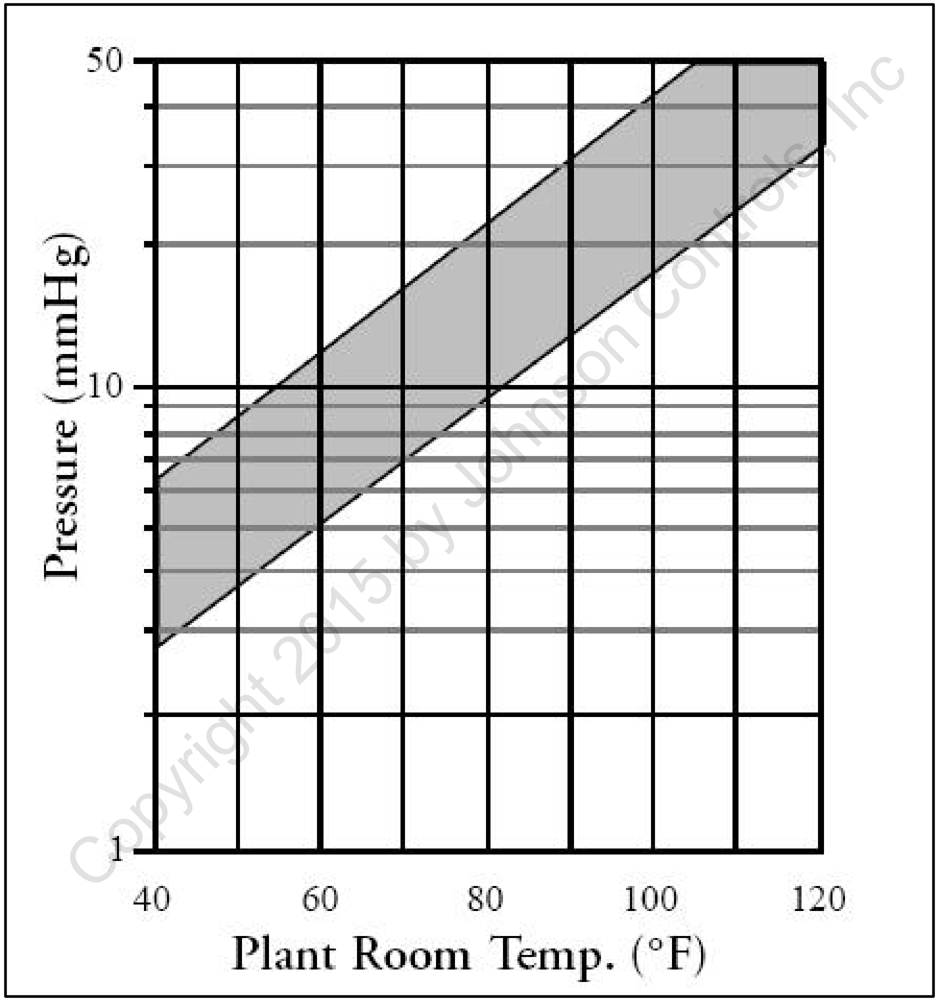
Startup Procedures

- Water flow rates and balancing
- Heat Exchanger Flow
- Simultaneous Heating/Cooling
- Charging Solution
- Adjust valves

Adjustments

- Solution flow and balancing
- Obtaining sight glass levels
- Final valve settings
- Controlling the heat source
- Controlling the cooling towers
- Trimming the solution and refrigerant charges
- Take a solution sample to check concentration requirements
- Full load vs partial load

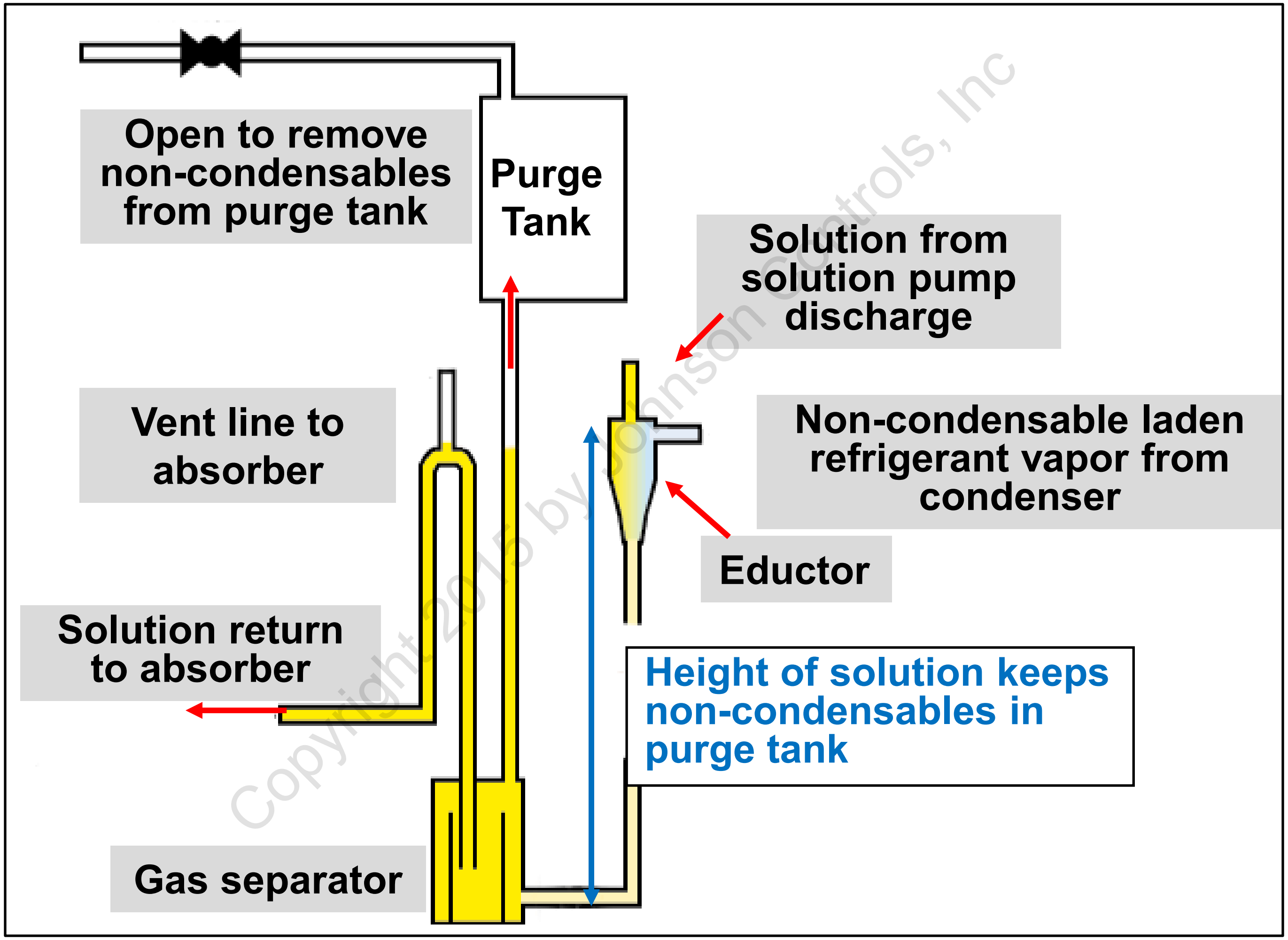
Plant Room Temp vs Pressure



Purging Procedures

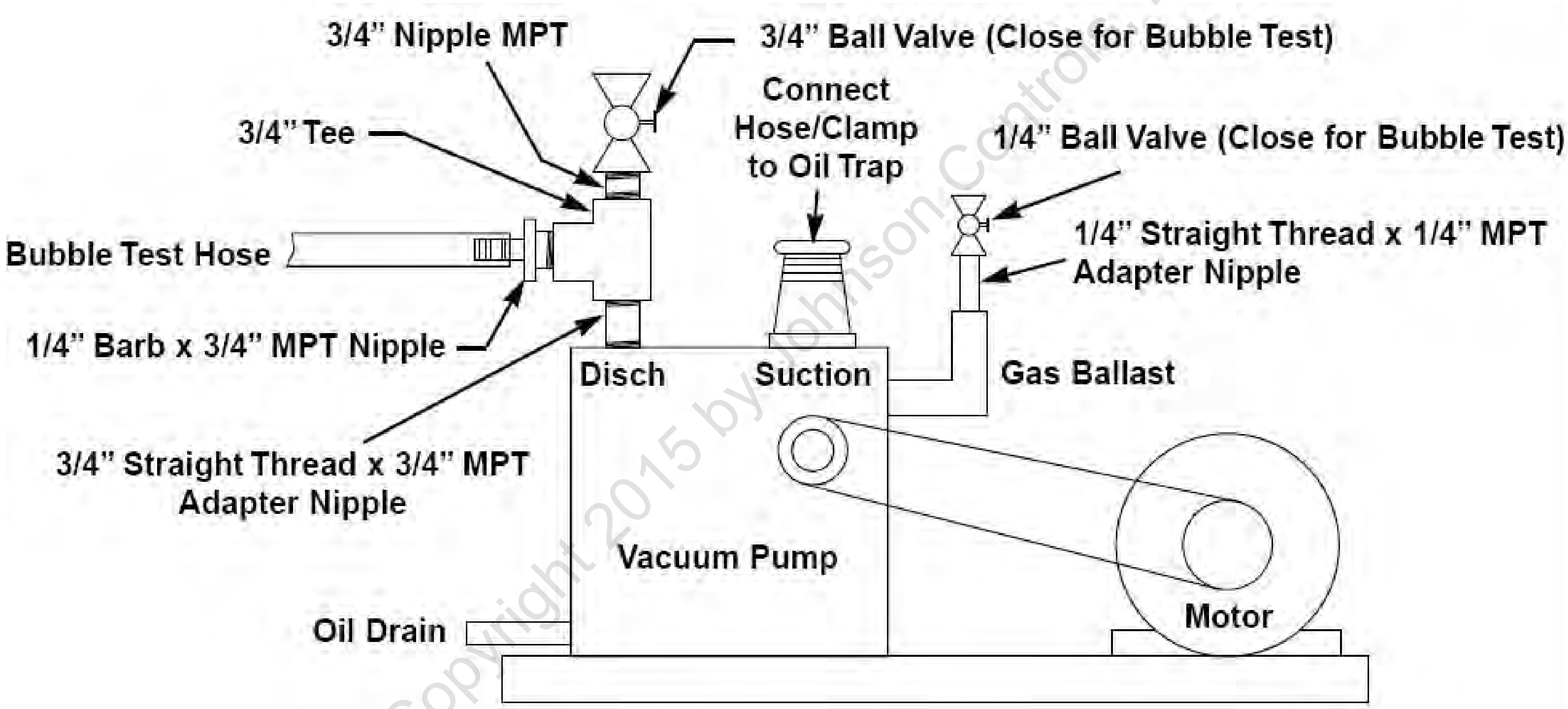
- Check the integrity of the purge pump
- Cold Purging
- Hot Purging
- Initial Purging
- Force Purging
- Purging the Hot Water Heat Exchanger

Purging the Unit



Purge System

Vacuum Pump Setup

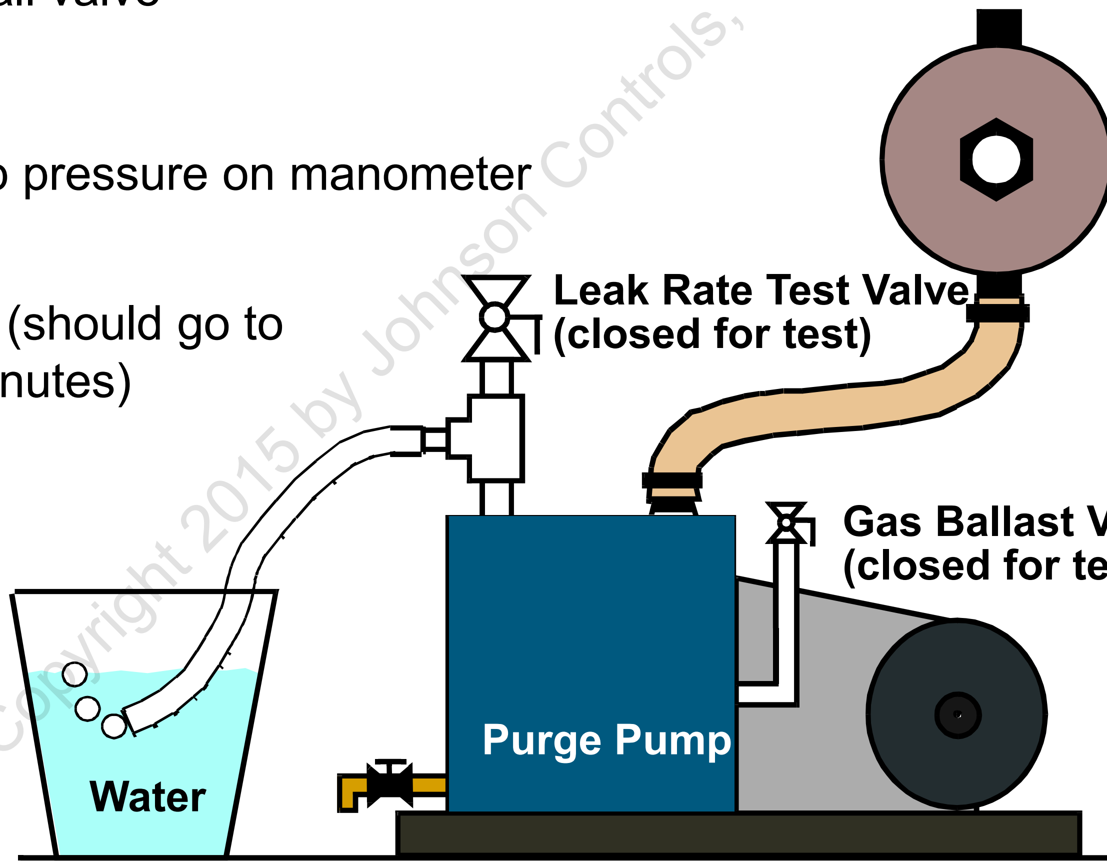


Manually Starting the Vacuum Pump

- Start pump with gas ballast closed (prevent oil spatter)
- Open gas ballast fully
- Warm up pump for 20 minutes
- Open VP5
- Confirm pump is capable of pulling to 3mm Hg absolute

Purge Procedures

1. Close balast valve
2. Close discharge ball valve
3. Close VP2 & VP4
4. Check purge pump pressure on manometer (3 mm Hg or less)
5. Check bubble rate (should go to zero after a few minutes)

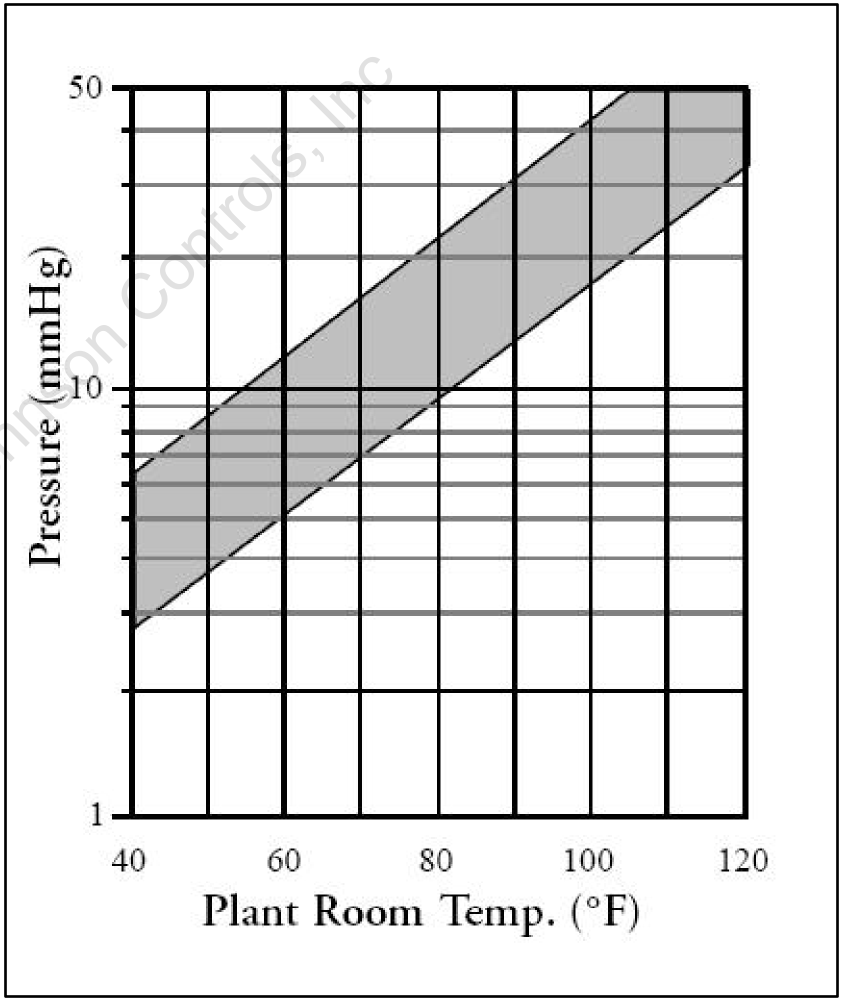


Cold Purging

What is a cold purge?

Cold purging is when you purge from the Purge Tank using VP2, the Absorber using VP4, from the Condenser using VP3, and the HWHX using VP6.

- Start solution pump and continue purging until range in graph is met



Hot Purging

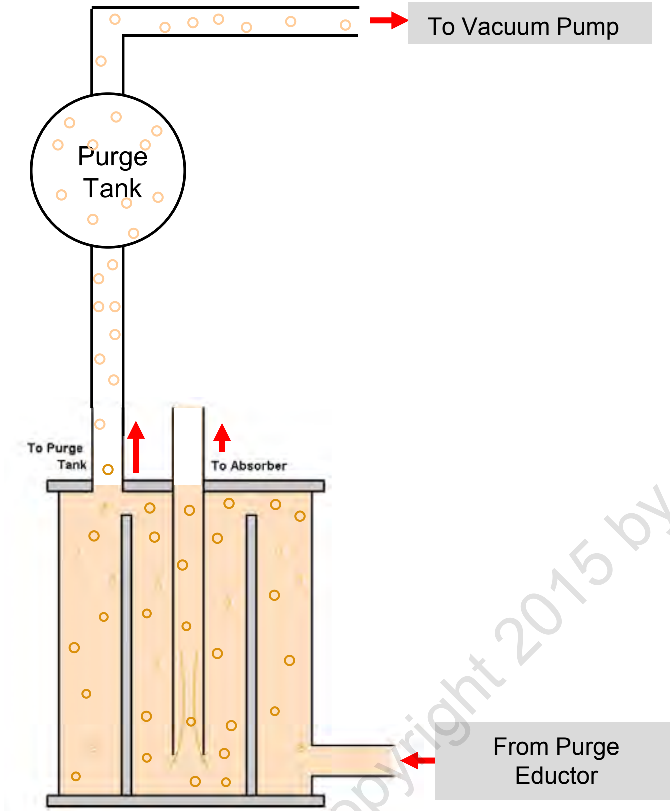
1. Turn off refrigerant pump
2. Turn off tower water
3. Turn on chilled water
4. Jump out tower water flow switch
5. Apply minimum heat input, 200°F max. from 1st stage
6. Purge from Absorber only
7. Check purge tank, keep w/in 30-60 mm Hg range
8. Continue until bubble rate equals 30 bubbles per minute

Purging During Initial Operation

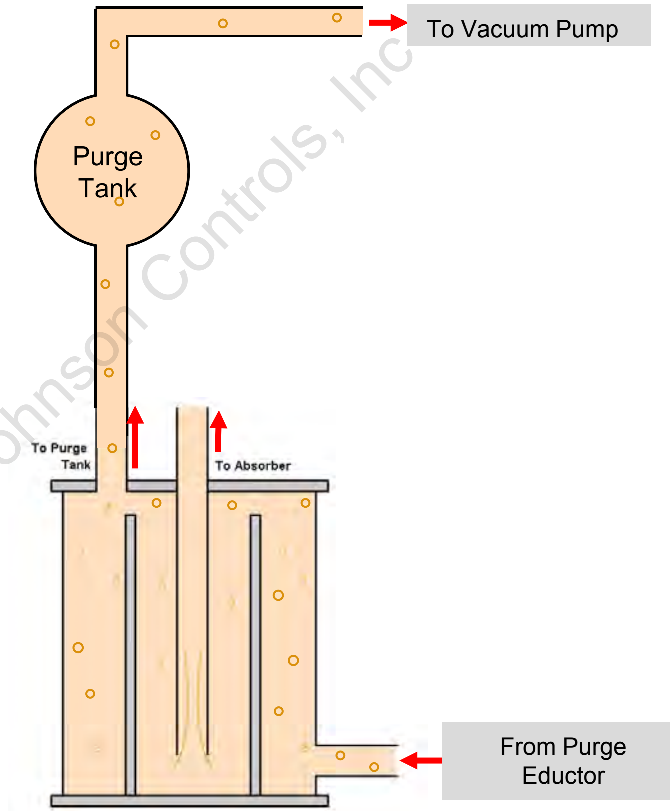
1. Remove all jumpers
2. If initial commissioning, set up burner
3. Start chiller water pump then tower water pump.
4. With refrigerant pump OFF, fire the unit at low-medium until enough refrigerant has been created to prevent the refrigerant pump from going dry.
5. Turn on refrigerant pump.
6. Fire at highest possible rate for 20 minutes, watch 1st stage pressure.
7. Blowdown refrigerant using VR8
8. Shut down unit and go thru dilution cycle
9. Watch purge tank pressure (30-60 mm Hg)
10. Re-start unit and repeat this procedure (until you maintain a high firing rate without 1st stage generator pressure problems)

Purging the Absorber and Purge Tank should be done frequently during initial 40 hours of operation.

Purge System Limitations



Purge Tank Pressure = > 100 mm Hg Max.
Absorber Pressure = 6 mm Hg = Normal
Result: Non-condensables backflow into Absorber



Purge Tank Pressure = 3 mm Hg = Very low min.
Absorber Pressure = > 10 mm Hg
Vacuum Pump Running
Result: Solution is drawn into the vacuum pump

Force Purging

Purpose: to ensure that we can form a vortex in the Absorber.

- Make sure the unit has been charged properly
- If the solution level in Absorber is only slightly high:
  - Shut burner off, the float valve will open in HTG causing the Absorber level to drop thus creating a vortex
  - Repeat this process as necessary

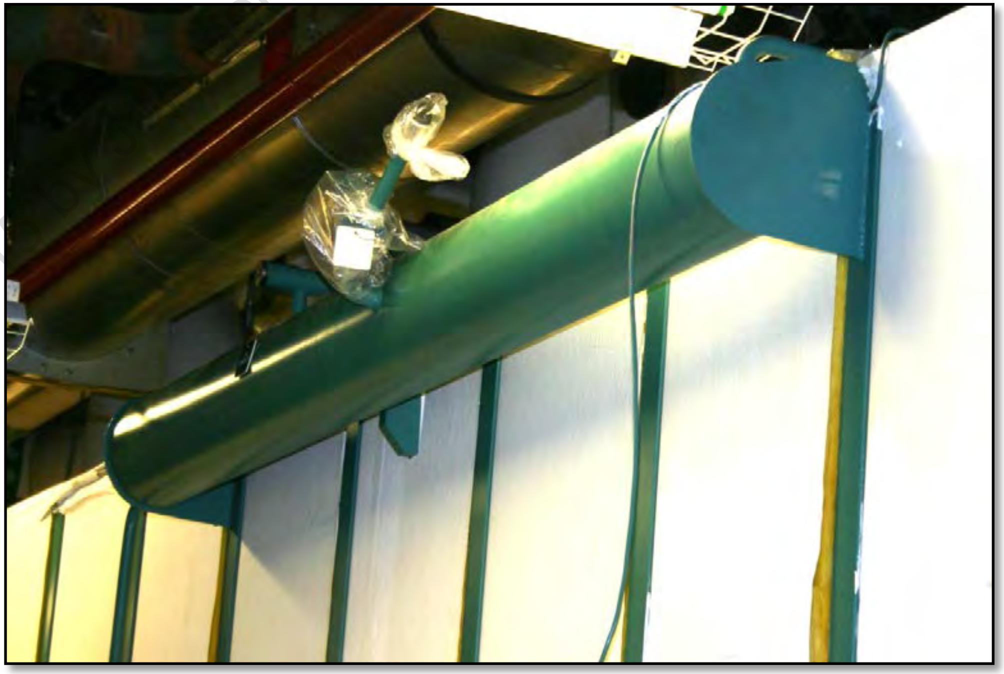
Force Purging

- To stack the charge in the 1st Stage:
  - Place unit in dilution cycle
  - Close VC and watch the level in the Absorber fall until a vortex forms as seen in the sight glass
  - Open VC slightly to maintain vortex
  - Monitor purge tank pressure and purge as needed (maintain 30-60 mm Hg)

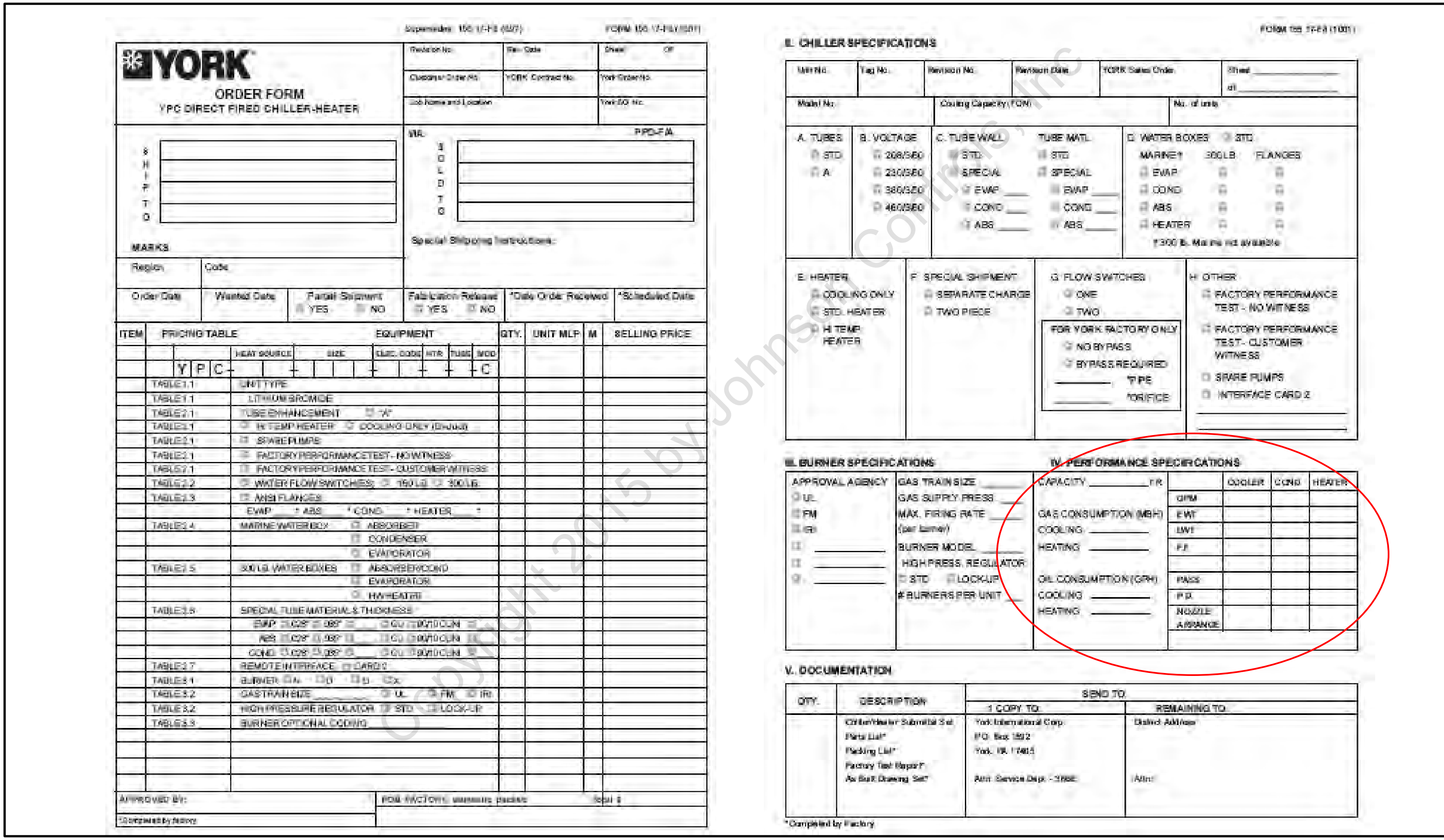
Do not overstack as severe refrigerant contamination WILL occur.

Manually Purging the Purge Tank

- Purge when the purge tank pressure is > 60 mmHg
- Purge down to 30 mmHg



Verify Performance to Specifications



FORM 155.17-F6 (10/01)

YORK ORDER FORM
YPC DIRECT FIRED CHILLER-HEATER

Revision No.	Rev. Date	Sheet Of
Customer Order No.	YORK Contract No.	York Order No.
Job Name and Location		York S.O. No.

SHIP TO | VIA | PPD-F/A | SOLD TO
Special Shipping Instructions:
MARKS
Region | Code
Order Date | Wanted Date | Partial Shipment ☐ YES ☐ NO | Fabrication Release ☐ YES ☐ NO | *Date Order Received | *Scheduled Date

ITEM	PRICING TABLE	EQUIPMENT	QTY.	UNIT MLP	M	SELLING PRICE
		HEAT SOURCE / SIZE / ELEC. CODE / HTR / TUBE / MOD				
		Y P C – – – – – C				
	TABLE 1.1	UNIT TYPE				
	TABLE 1.1	LITHIUM BROMIDE				
	TABLE 2.1	TUBE ENHANCEMENT ☐ "A"				
	TABLE 2.1	☐ HI TEMP HEATER ☐ COOLING ONLY (D+J+L)				
	TABLE 2.1	☐ SPARE PUMPS				
	TABLE 2.1	☐ FACTORY PERFORMANCE TEST - NO WITNESS				
	TABLE 2.1	☐ FACTORY PERFORMANCE TEST - CUSTOMER WITNESS				
	TABLE 2.2	☐ WATER FLOW SWITCHES: ☐ 150 LB ☐ 300 LB				
	TABLE 2.3	☐ ANSI FLANGES				
		EVAP ___ * ABS ___ * COND ___ * HEATER ___ *				
	TABLE 2.4	MARINE WATER BOX ☐ ABSORBER				
		☐ CONDENSER				
		☐ EVAPORATOR				
	TABLE 2.5	300 LB. WATER BOXES ☐ ABSORBER/COND				
		☐ EVAPORATOR				
		☐ HW HEATER				
	TABLE 2.6	SPECIAL TUBE MATERIAL & THICKNESS				
		EVAP ☐ .028" ☐ .035" ☐ ___ ☐ CU ☐ 90/10 CUNI ☐				
		ABS ☐ .028" ☐ .035" ☐ ___ ☐ CU ☐ 90/10 CUNI ☐				
		COND ☐ .028" ☐ .035" ☐ ___ ☐ CU ☐ 90/10 CUNI ☐				
	TABLE 2.7	REMOTE INTERFACE ☐ CARD 2				
	TABLE 3.1	BURNER ☐ A ☐ D ☐ B ☐ X				
	TABLE 3.2	GAS TRAIN SIZE ___ ☐ UL ☐ FM ☐ IRI				
	TABLE 3.2	HIGH PRESSURE REGULATOR ☐ STD ☐ LOCK-UP				
	TABLE 3.3	BURNER OPTIONAL CODING ___				

APPROVED BY: | FOB FACTORY, ... Total $
*Completed by factory

FORM 155.17-F6 (10/01)

II. CHILLER SPECIFICATIONS

Unit No.	Tag No.	Revision No.	Revision Date	YORK Sales Order	Sheet ___ of ___
Model No.	Cooling Capacity (TON)		No. of units		

A. TUBES: ☐ STD ☐ A
B. VOLTAGE: ☐ 208/3/60 ☐ 230/3/60 ☐ 380/3/50 ☐ 460/3/60
C. TUBE WALL: ☐ STD ☐ SPECIAL ☐ EVAP ___ ☐ COND ___ ☐ ABS ___ — TUBE MAT'L: ☐ STD ☐ SPECIAL ☐ EVAP ___ ☐ COND ___ ☐ ABS ___
D. WATER BOXES ☐ STD — MARINE† / 300 LB / FLANGES: ☐ EVAP ☐ COND ☐ ABS ☐ HEATER
† 300 lb. Marine not available
E. HEATER: ☐ COOLING ONLY ☐ STD. HEATER ☐ HI TEMP HEATER
F. SPECIAL SHIPMENT: ☐ SEPARATE CHARGE ☐ TWO PIECE
G. FLOW SWITCHES: ☐ ONE ☐ TWO
FOR YORK FACTORY ONLY: ☐ NO BYPASS ☐ BYPASS REQUIRED ___ *PIPE ___ *ORIFICE
H. OTHER: ☐ FACTORY PERFORMANCE TEST - NO WITNESS ☐ FACTORY PERFORMANCE TEST - CUSTOMER WITNESS ☐ SPARE PUMPS ☐ INTERFACE CARD 2

III. BURNER SPECIFICATIONS

APPROVAL AGENCY: ☐ UL ☐ FM ☐ IRI ☐ ___ ☐ ___ ☐ ___
GAS TRAIN SIZE ___
GAS SUPPLY PRESS ___
MAX. FIRING RATE ___ (per burner)
BURNER MODEL ___
HIGH PRESS. REGULATOR ☐ STD ☐ LOCK-UP
BURNERS PER UNIT ___

IV. PERFORMANCE SPECIFICATIONS

CAPACITY ___ TR
GAS CONSUMPTION (MBH): COOLING ___ HEATING ___
OIL CONSUMPTION (GPH): COOLING ___ HEATING ___

	COOLER	COND	HEATER
GPM			
EWT			
LWT			
F.F.			
PASS			
P.D.			
NOZZLE ARRANGE			

V. DOCUMENTATION

QTY.	DESCRIPTION	SEND TO: 1 COPY TO	SEND TO: REMAINING TO
	Chiller/Heater Submittal Set Parts List* Packing List* Factory Test Report* As Built Drawing Set*	York International Corp. P.O. Box 1592 York, PA 17405 Attn: Service Dept. - 3666	District Address Attn:

*Completed by Factory

Performance Specifications

IV. PERFORMANCE SPECIFICATIONS

CAPACITY __________ T.R.

GAS CONSUMPTION (MBH)

COOLING __________

HEATING __________

OIL CONSUMPTION (GPH)

COOLING __________

HEATING __________

	COOLER	COND.	HEATER
GPM			
EWT			
LWT			
F.F.			
PASS			
P.D.			
NOZZLE ARRANGE			

Adjusting Valves

VALVES

YPC-DF-16SL-19S

YPC-DF-16SL-19S					
Old	New	Name and Location of Valve	Cooling	New Style †	Heating[1]
V2	VS1	High Temperature Generator (Strong Solution Return)	1-1/2 Turns Open	2-1/2	
V1	VS2	Low temperature Generator (Weak Solution Supply)	1-1/4 Turns Open	2-1/4	
V8	VR8	Refrigerant Blowdown Valve	Fully Closed		
V9	VR9	Refrigerant Pump Isolation Valve (Suction)	Fully Open		
V10	VR10	Refrigerant Pump Isolation Valve (Discharge)	Fully Open		
V11	VR11	Refrigerant Sampling Valve (Discharge Refrigerant Pump)	Normally Closed		
V12	VS12	Main Solution Pump Isolation Valve (Suction)	Fully Open		
V15	VS13	Main Solution Pump Isolation Valve (Discharge)	Fully Open		
V14	VS23	Strong Solution Spray Pump Isolation Valve (Discharge)	Fully Open		
V13	VS22	Strong Solution Spray Pump Isolation Valve (Suction)	Fully Open		
V18	VS18	Solution Sampling Valve (High Temperature Generator Return)	Normally Closed		
V19	VS19	Solution Sampling Valve (Low Temp. Heat Exchanger, Weak Solution Inlet)	Normally Closed		
V20	VS17	Solution Sampling Valve ((Low Temperature Generator Return)	Normally Closed		
V21	VS25	Solution Sampling Valve (Discharge Strong Solution Spray Pump)	Normally Closed		

Insulating the Unit

- Done only after system is running
- After initial leak checks have been performed

Startup Documentation

1. Warranty Communications Form
2. Installation Checklist and Request for Authorized Startup Engineer
3. Pre-start Checklist
4. Startup Report

All startup documentation is accessible through the JCI Portal/York Central Intranet Site/Product Technical Support webpage.

YORK®

START UP REPORT

PARAFLOW START UP REPORT

Supersedes: 155.17-SU1 (693) | 394 | Form 155.17-SU1

ParaFlow™ Start Up Report—For York Internal Use Only

Job Name: ______________________________ York Order No.: ______________

Model No.: ______________ Ser.No.: ______________ Start-Up Date: __________

Name of Service Engr: ______________________ Serv.Mgr Signature: __________

Completed Items to be initialed by Service Engineer Upon Completion

______Submittal Dwgs, Factory Test Report, Burner Info (if Applicable) on site.

______Unit arrived on site with Factory Nitrogen charge-(if not explain on page 2).

______Unit Leveled within 1 inch in 1000 inches.

______Rupture Disk correctly piped with CPVC, adequately supported, coated with Vac-Sealant,Torqued.

______Vacuum Pump piped per York Service Bulletin 155.17 NM1 (SB9) with leak test kit fittings.

______Unit Evacuated to _____ mm Hg absolute.

______Refrigerant Charged with _______gal of de-ionized water.

______Solution Charged with ______gal of _____% LiBr.

______Pump Rotation Check (Vacuum, Solution(s), Refrigerant).

______Burner Fan Rotation checked.

______Vacuum Pump capable of attaining _____mm Hg absolute with gas ballast full open.

______Valve settings checked and confirmed per Factory Test Report.

______Purge Check valve (Vp8) operation confirmed.

______Permanent Valve Indentification Tags installed.

______Chilled Water Flow Switch and/or Differential Press. Switch operation confirmed.

______Low Refrigerant Temperature Cut-Out Calibration and Operation Confirmed. _____ °F cut-out.

______Low Refrigerant Temperature Cut-Out sensing bulb in well with heat conductive compound and insulated.

______Refrigerant temperature thermister (Micro units only) in well with heat conductive compound and insulated.

______High Pressure Cut-out(s) calibration confirmed. Switch operation confirmed. _____ psia cut-out

______All other safety controls—calibration and operation confirmed.

______All temperature sensing elements in correct wells with heat conductive compound.

______High Stack Temp. Operation -Remove T/C+ wire from Term. Strip and confirm S/D(if applicable).

______Unit Full Load Operation observed.

______Refrigerant Charge adjusted (Design conditions and NO AIR):
G Series–so refrigerant just ready to spill at full load (design capacity).
S Series–so refrigerant level is in correct sight glass location.

Startup Documentation

1. Installation Checklist and Request for Authorized Startup Engineer
2. Pre-start Checklist
3. Startup Report
4. Unit Log Sheet

FORM: 155.17-LS1

YORK Direct-Fired ParaFlow™ Unit Log Sheet

CUSTOMER NAME			
JOB LOCATION		MODEL	
SERIAL NO.		YORK ORDER NO.	
DATE		BY	
PURPOSE OF TEST			

Machine Operating Mode: ☐ **Chilling** ☐ **Heating**

ITEM		Field Data	Field Data	Field Data
	HOUR METER			
BURNER "A"	FIRING RATE (%)			
	GAS FLOW (SCFH)			
	OIL FLOW (GPM)			
	BTU's/SCF or GAL			
	STACK TEMP (°F)			
	MANFLD PRESS (in H20)			
	OXYGEN (%)			
	CO2 (%)			
	CO (ppm)			
	NOX (ppm)			
BURNER "B" (If Applicable)	FIRING RATE (%)			
	GAS FLOW (SCFH)			
	OIL FLOW (GPM)			
	BTU's/SCF or GAL			
	STACK TEMP (°F)			
	MANFLD PRESS (in H20)			
	OXYGEN (%)			
	CO2 (%)			
	CO (ppm)			
	NOX (ppm)			
CHILLED WATER	CHW TEMP. IN. (°F)			
	CHW TEMP. OUT. (°F)			
	TEMP. DIFFERENCE (°F)			
	FOULING FACTOR			
	PASS ARRANGEMENT			
	PRESSURE DROP (PSI)			
	FLOW RATE (GPM)			
	TONS			
TOWER WATER	ABS. INLET TEMP. (°F)			
	ABS. OUTLET TEMP. (°F)			
	TEMP. DIFFERENCE (°F)			
	FOULING FACTOR			
	PASS ARRANGEMENT			
	COND. INLET TEMP. (°F)			
	COND. OUT TEMP. (°F)			
	TEMP. DIFFERENCE (°F)			
	FOULING FACTOR			
	PASS ARRANGEMENT			
	PRESSURE DROP (PSI)			
	FLOW RATE (GPM)			

page 1 of 3

FORM: 155.19-LS1

YORK Steam-Fired ParaFlow™ Unit Log Sheet

CUSTOMER NAME			
JOB LOCATION		MODEL	
SERIAL NO.		YORK ORDER NO.	
DATE		BY	
PURPOSE OF TEST			

Machine Operating Mode: Chilling

ITEM		Field Data	Field Data	Field Data
	HOURMETER			
CAPACITY CONTROL POSITION (% open)				
STEAM	INLET PRESS. (PSI)			
	INLET TEMP. (°F)			
CONDENSATE	FLOW RATE (lbs/hr)			
	OUTLET TEMP (°F)			
	OUTLET PRESS. (PSI)			
CHILLED WATER	INLET TEMP. (°F)			
	OUTLET TEMP. (°F)			
	TEMP. DIFFERENCE (°F)			
	FOULING FACTOR			
	PASS ARRANGEMENT			
	PRESSURE DROP (PSI)			
	FLOW RATE (GPM)			
	TONS			
TOWER WATER	ABS. INLET TEMP. (°F)			
	ABS. OUTLET TEMP. (°F)			
	TEMP. DIFFERENCE (°F)			
	FOULING FACTOR			
	PASS ARRANGEMENT			
	COND. INLET TEMP. (°F)			
	COND. OUT TEMP. (°F)			
	TEMP. DIFFERENCE (°F)			
	FOULING FACTOR			
	PASS ARRANGEMENT			
	PRESSURE DROP (PSI)			
	FLOW RATE (GPM)			
1ST STAGE GENERATOR	SOLUTION IN (°F)			
	SOLUTION OUT (°F)			
	PRESSURE (mmHg abs.)			
	CONCENTRATION (% wt)			
	LIQUID LEVEL	○	○	○
2ND STAGE GENERATOR	SOLUTION IN (°F)			
	SOLUTION OUT (°F)			
	CONCENTRATION (% wt)			
	REFRIGERANT OUT (°F)			
	LIQUID LEVEL	○	○	○

page 1 of 2

Startup Documentation

1. Installation Checklist and Request for Authorized Startup Engineer (Form 155.17-N1)
2. Pre-start Checklist (Form 155.17-F2)
3. Startup Report (Form 155.17-SU1)
4. Unit Log Sheet (Form 155.17-LS1 & Form 155.19-LS1)
5. Purge Trending Log Form
6. Solution Sample Submittal Form (Form 155.17-RA1)

Finalizing Startup

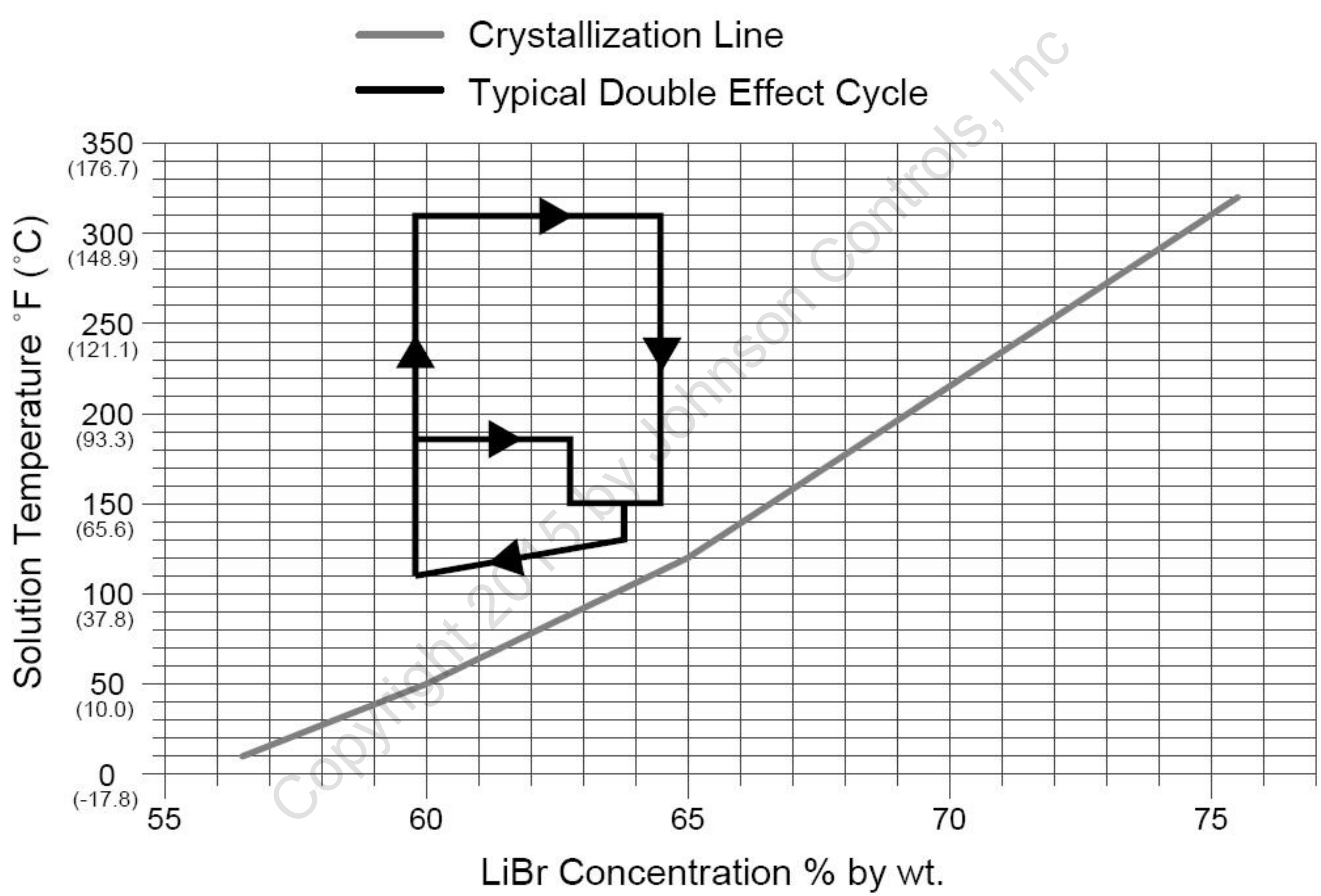
- Solution Sample
- Customer Training (orientation)
  - Proper chiller operation
  - Proper purging procedures
  - Purge pump care
  - Purge trending training
- Customer Sign-off
- Mail startup forms to Office

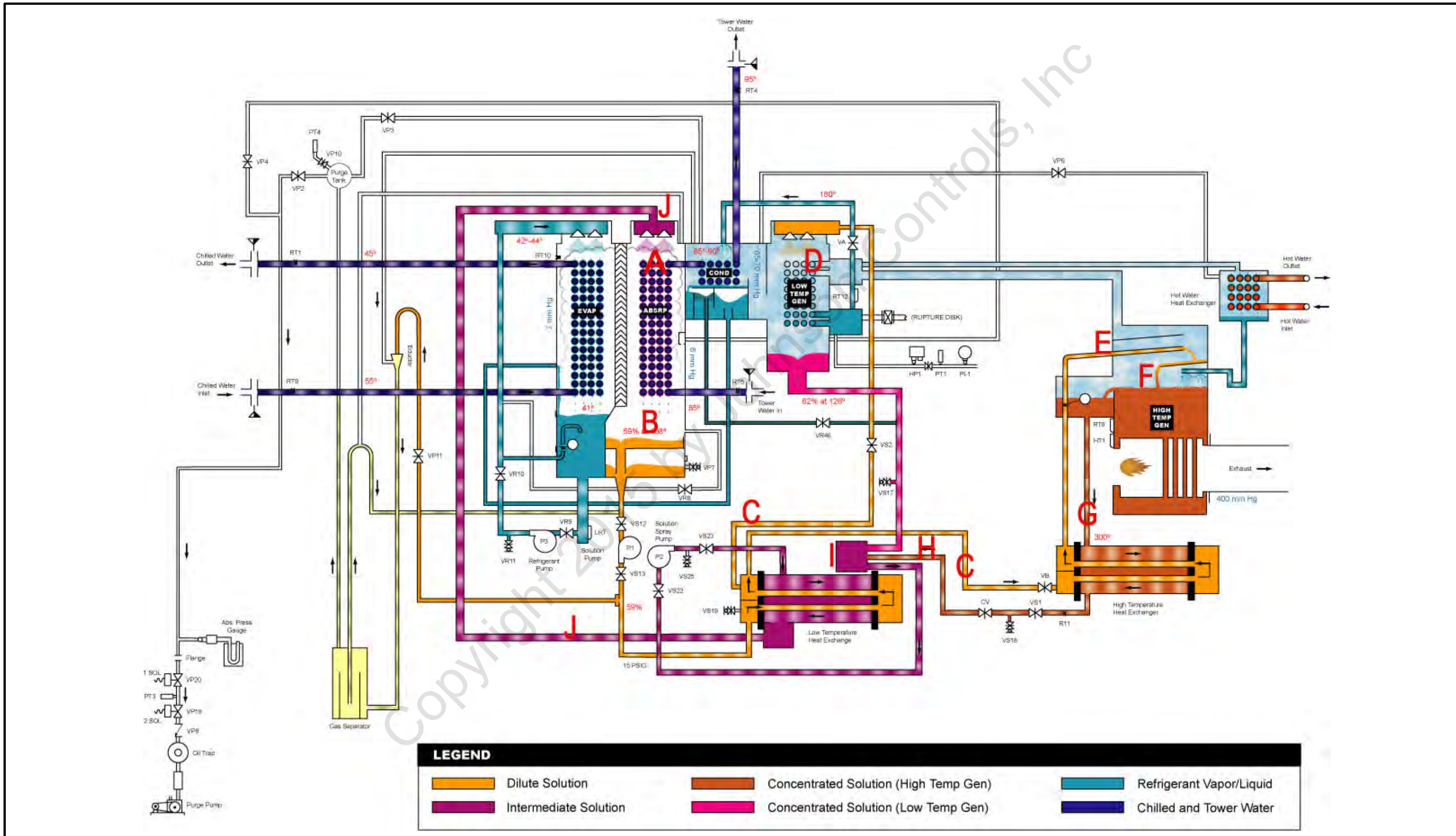
Questions

Section 5: Crystallization

Section 5: Crystallization

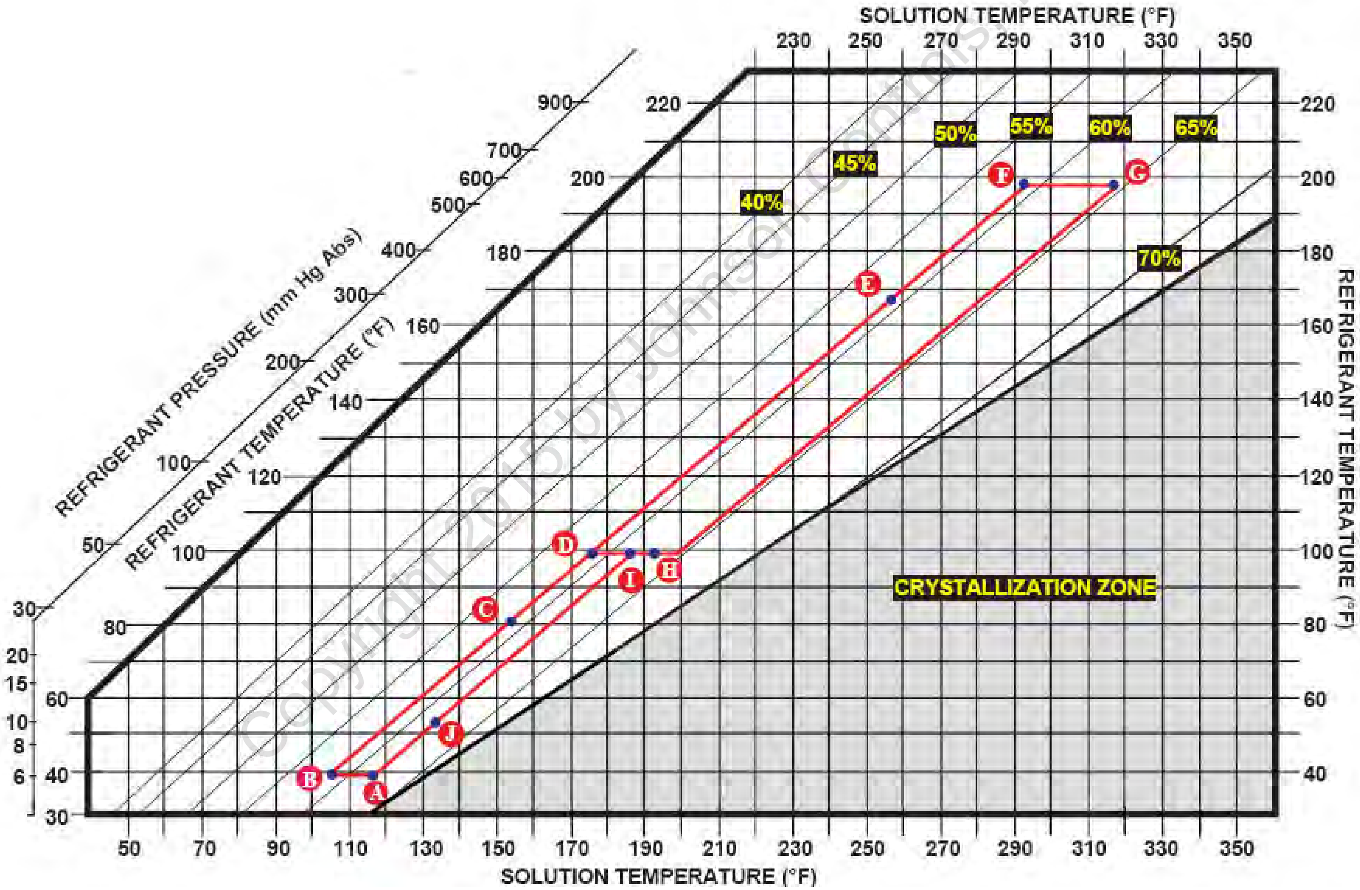
- What is Crystallization?
- Why does it occur?
- Where does it occur?
- How do you check for crystallization?
- How do you prevent crystallization?
- How do you de-crystallize the unit?


Crystallization Line
Typical Double Effect Cycle
Solution Temperature °F (°C)
350
(176.7)
300
(148.9)
250
(121.1)
200
(93.3)
150
(65.6)
100
(37.8)
50
(10.0)
0
(-17.8)
55
60
65
70
75
LiBr Concentration % by wt.
Copyright 2015 by Johnson Controls, Inc

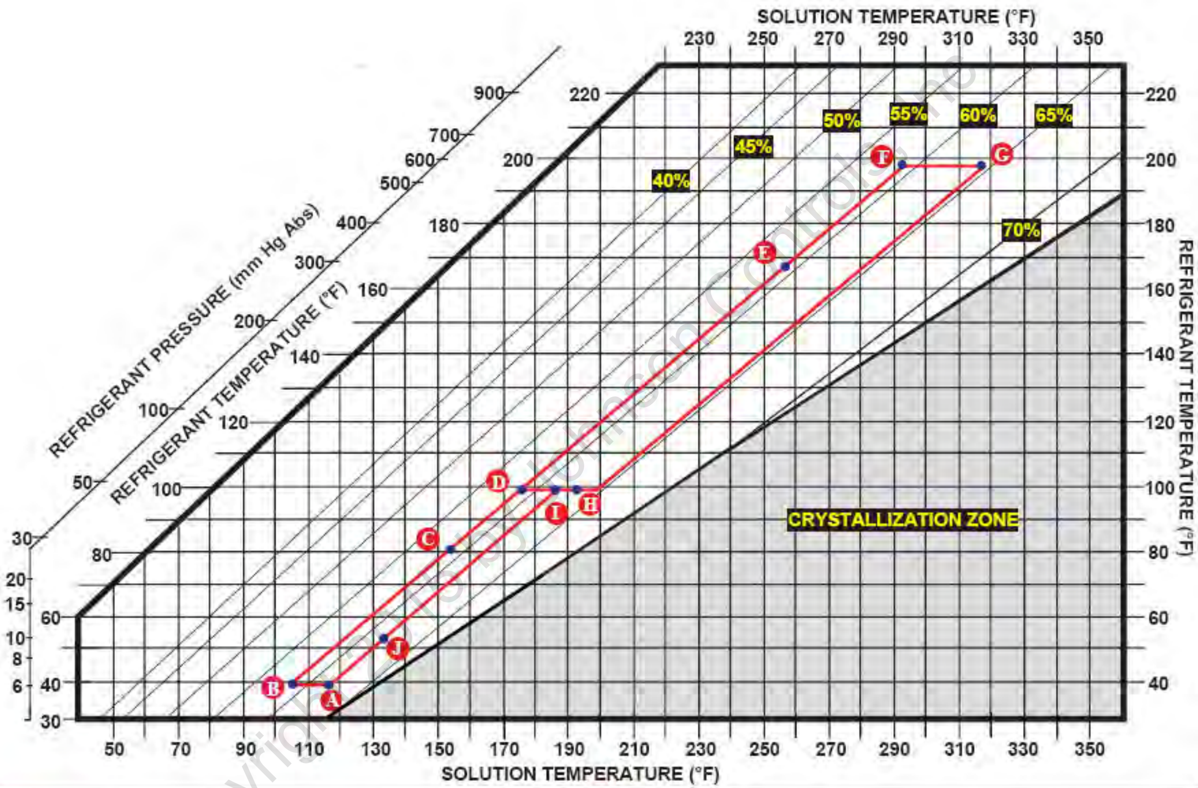

Tower Water Outlet
Chilled Water Outlet
Chilled Water Inlet
EVAP
ABSRP
COND
LOW TEMP GEN
HIGH TEMP GEN
(RUPTURE DISK)
Hot Water Outlet
Hot Water Inlet
Hot Water Heat Exchanger
Tower Water In
Exhaust
Solution Spray Pump
Refrigerant Pump
Solution Pump
Low Temperature Heat Exchange
High Temperature Heat Exchanger
Gas Separator
Purge Tank
Oil Trap
Purge Pump
Abs. Press Gauge
A
B
C
D
E
F
G
H
I
J
LEGEND
Dilute Solution
Intermediate Solution
Concentrated Solution (High Temp Gen)
Concentrated Solution (Low Temp Gen)
Refrigerant Vapor/Liquid
Chilled and Tower Water

PTX Diagram

Locate the reference points of the solution and mark them on the YPC flow diagram using a dry erase marker.



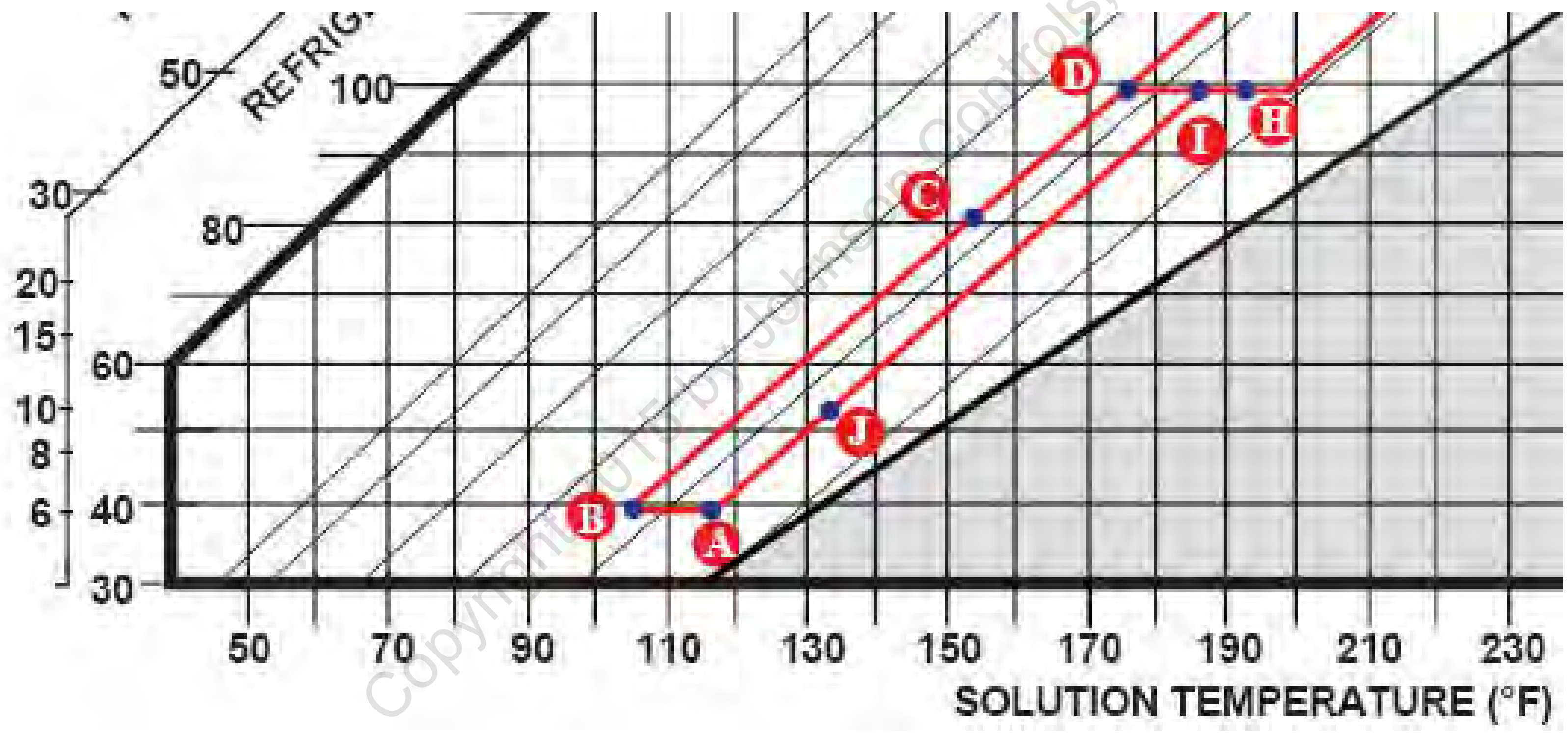
PTX Diagram



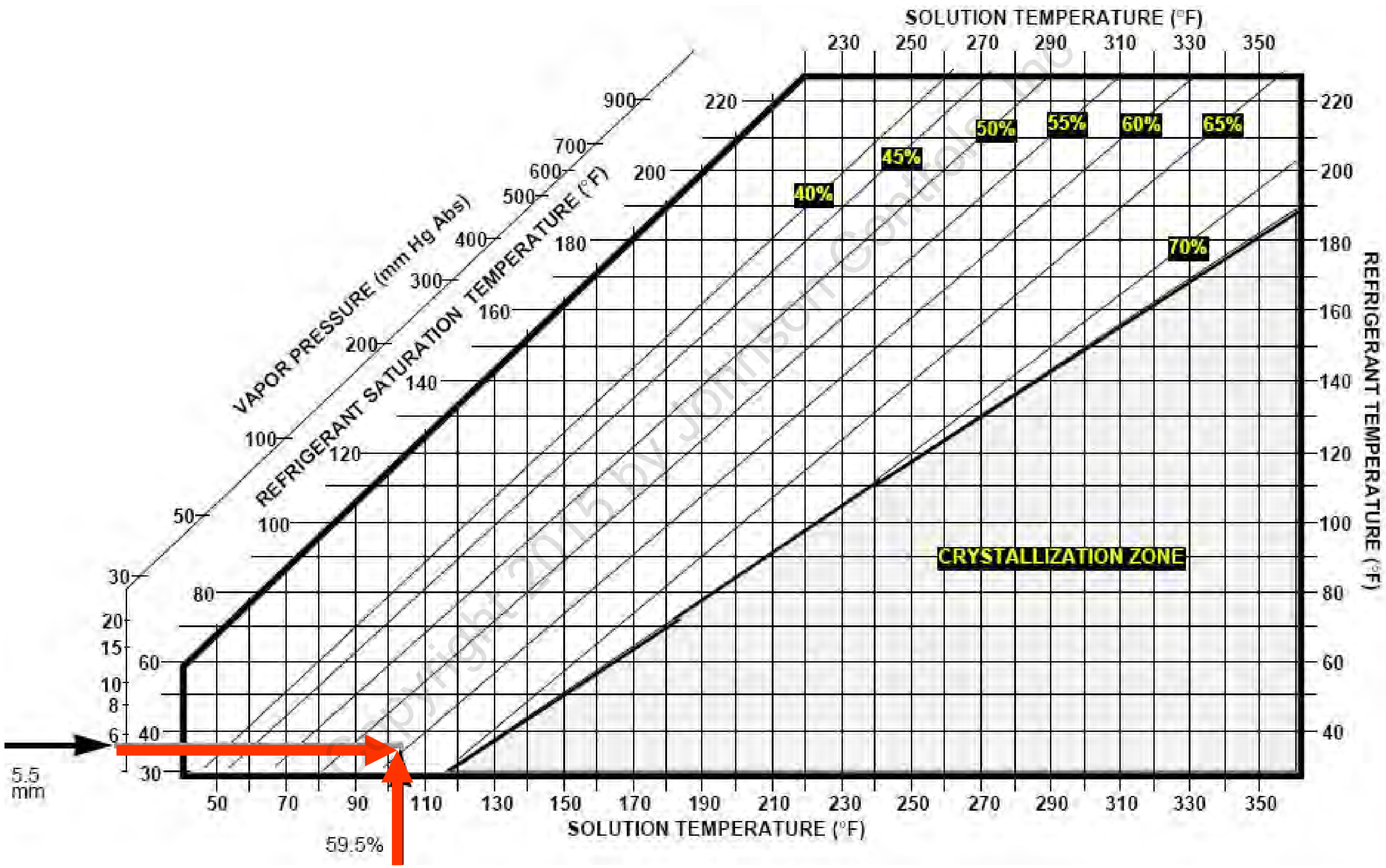
- **A** 61.6% -Absorption of Refrigerant Vapor in Absorber Begins
- **B** 59% -approx 106°F-Solution Leaves the Absorber-To Heat-X
- **C** 59% -approx 154°F-Solution Leaves MT Heat-X -Enters LTG
- **D** 59% -approx 175°F-Refrigerant Generation Begins in LTG
- **E** 59% -approx 257°F-Solution Leaves HT Heat-X -Enters HTG
- **F** 59% -approx 292°F-Refrigerant Generation Begins in HTG
- **G** 64.5% -approx 318°F-Solution Leaves HTG
- **H** 63.4% -Solution From LTG and HTG Mix
- **I** 61.6% -Solution From LTG and HTG Mix With 59% Eductor Flow
- **J** 61.6% -approx 136°F-Solution Enters the Absorber Sprays

Absorber Subcooling

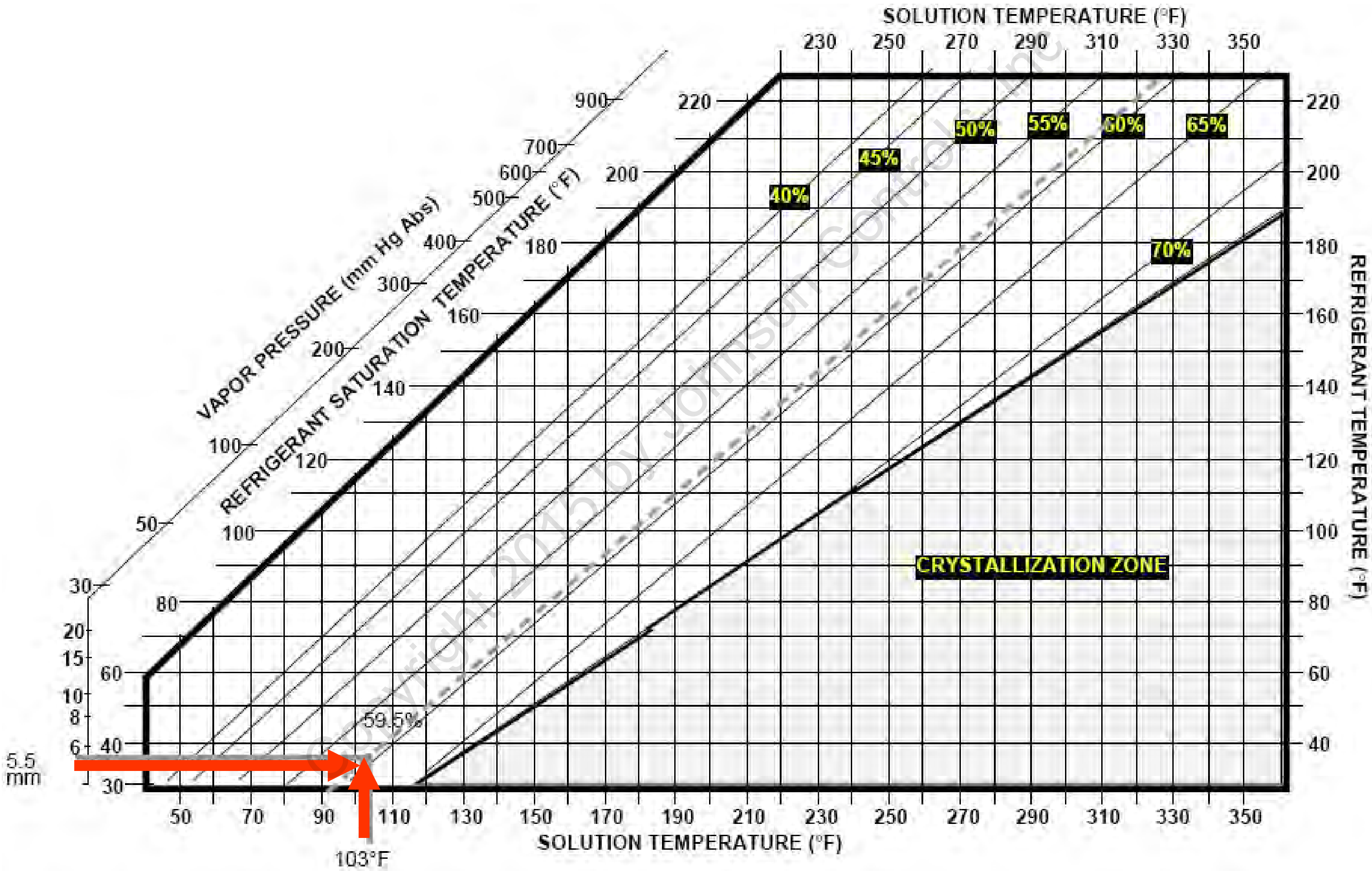
ParaFlow Maintenance Manual: Purging, pg 3 (Tab 6)



Absorber Subcooling Calculation



Absorber Subcooling Calculation



Decrystallization Process

Class Exercise

Scenario: You're on the job and the S-unit is causing you some problems that indicate it may be crystallizing.

- What do you do now?
- What is your first step?
- What is your second step?

Using the flipchart, outline your decrystallization strategy.

Section 6: Operations and Maintenance PM and Tools

Section 6: Operation & Maintenance

- Preventive Maintenance Schedules
- O&M Tools
- Solution Chemistry
- Corrosion
- Chemical Sampling
- Refrigerant Contamination
- Purging
- Simultaneous Heating/Cooling
- Pump Maintenance
- Water Treatment
- Tube Maintenance
- Valve Maintenance

Preventive Maintenance

ParaFlow Maintenance Manual: Service Procedure

YORK

Maintenance Requirements for York ParaFlow™ Absorption Units (Direct-Fired Machines)

Procedure	Daily	Weekly	Monthly	Cooling Season	Yearly	Every __*__ Hours
Record operating pressures and temperatures and concentrations	X					
Record liquid sight glass levels	X					
Record purge frequency	X					
Record purge tank pressure and purge only as necessary. Trend purge tank pressure differences (not required on units equipped with Smart-Purge™).	X					
Visually inspect burner valves, linkages, and components	X					
Record gas or oil pressure to burner	X					
Check refrigerant specific gravity and blow down refrigerant as needed		X				
Performance test vacuum pump. Replace oil and/or flush pump as required.			X			
Check vacuum pump belt tension. Replace if worn.			X			
Record stack temperature, $\%O_2$, $\%CO_2$, %CO, and $\%NO_x$ as required			X			
Take solution sample and send to lab for analysis. Add inhibitors as needed. (see note 2)				Twice Minimum		
Open and inspect purge tank solenoid valve. Clean or replace as necessary (units equipped with Smart-Purge™ only).					X	
Check level of the unit					X	
Calibrate safety controls					X	
Check pilot flame signal and adjust pilot as required					X	
Leak test machine (see note 1)						As Required

For operating and maintenance requirements listed above, refer to appropriate service literature or contact your local YORK service office.

O&M Tools

- Noncontact infrared laser thermometer
- Pressure gauge
- Spindle Valve Adapter
- Bell&Gossett Motor Direction Indicator
- Vacuum Flask
- Refrigerant Removal Cylinder
- Hydrometers
- Graduated Cylinder (comes in loose ship box)
- Combustion analyzer
- Flashlight

Solution Sampling

- Solution Sampling Video
- Solution Chemistry

Solution Chemistry

Absorption units today use:

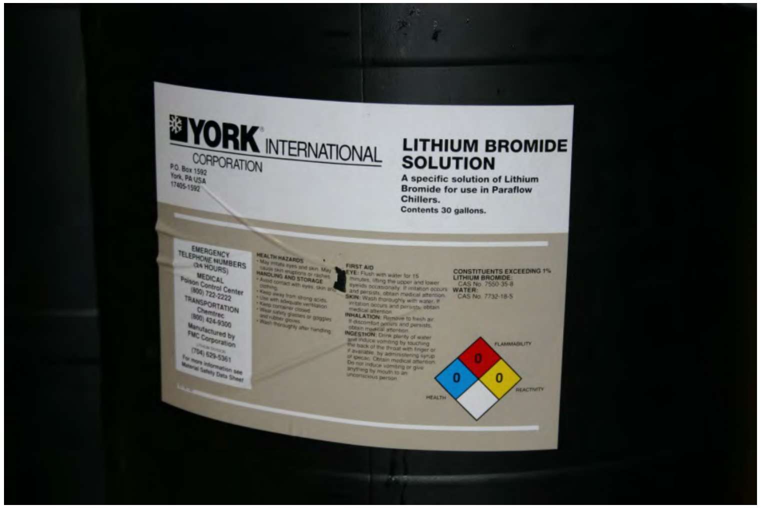
- Lithium Bromide as the absorbent
- De-ionized water as the refrigerant
- Octyl alcohol (2-ethyl,1-hexanol) as a wetting agent

Solution

Lithium Bromide (LiBr) is a form of salt dissolved in water to form a solution (53-55% by weight lithium bromide to water). For comparison, salt water is about 3% by weight.

Reasons for using LiBr:

- It has a very high affinity for water
- The vapor pressure is approximately zero. It does not boil
- Refrigerant is easily separated from it by adding heat
- It is environmentally friendly
- Relativity low cost



Refrigerant

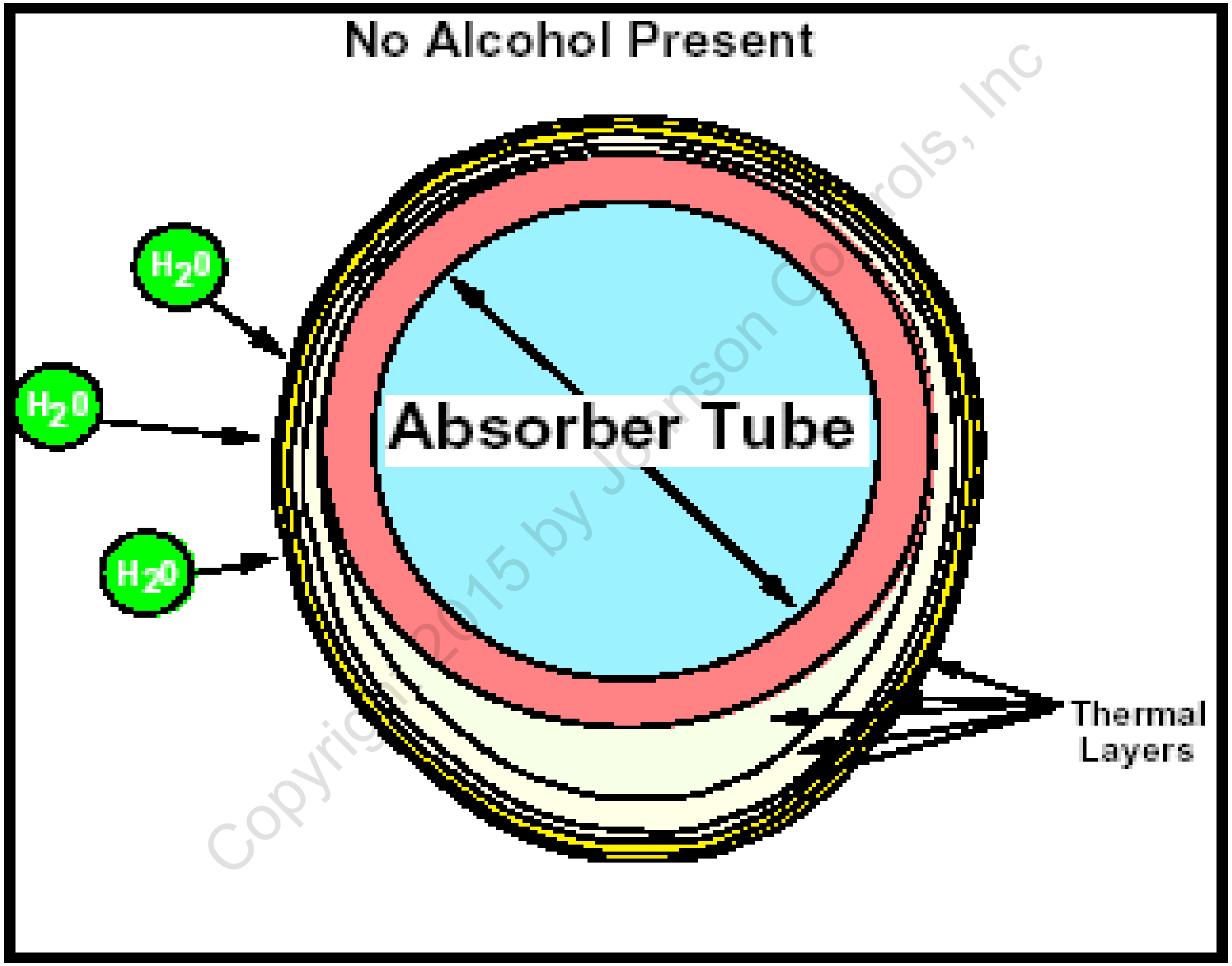
- De-ionized water is water that has the total mineral content removed
- York purchases refrigerant already de-ionized. Normally use the ion exchange method if additional refrigerant is needed
- Safe in all respects
- Low cost
- Water as refrigerant is extremely efficient, transferring about 1000 BTU's per pound

Alcohol

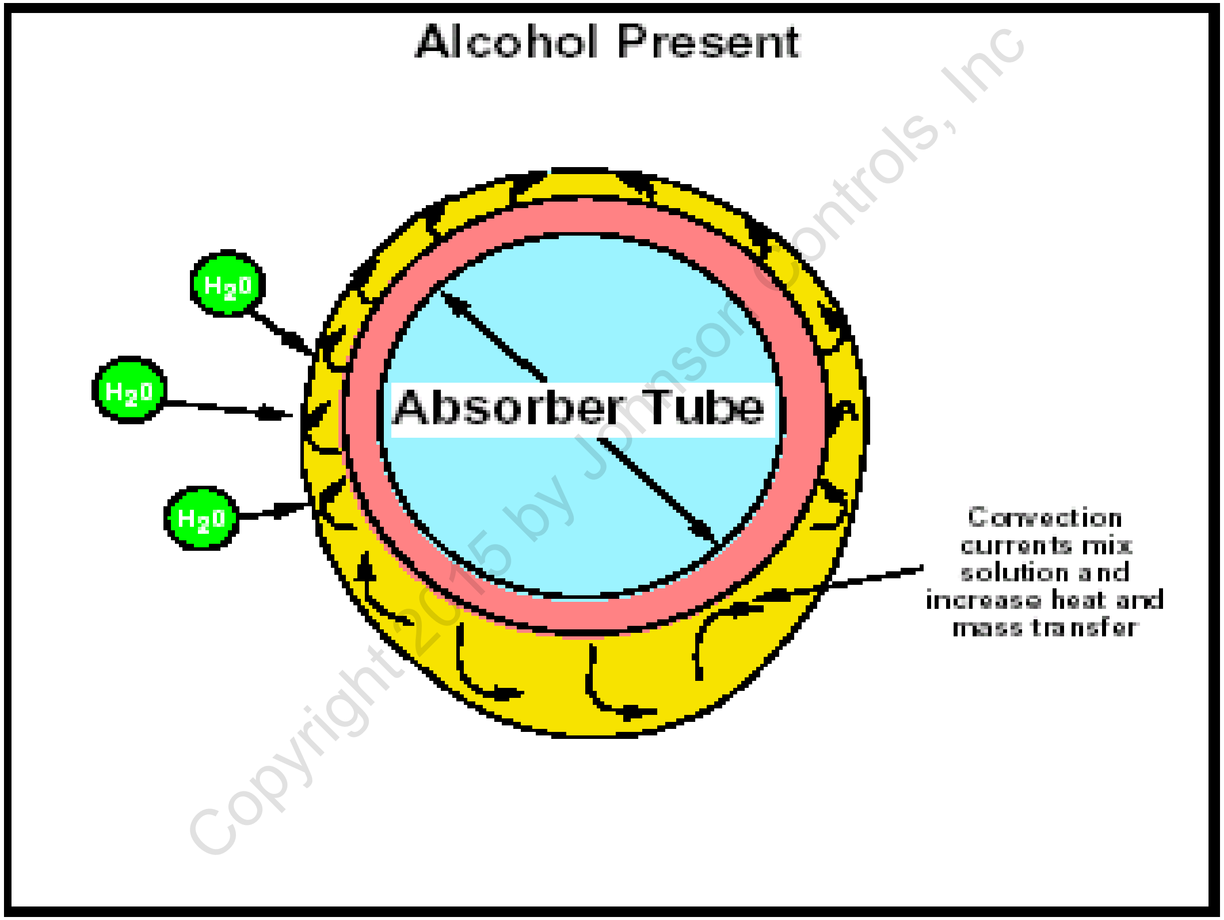
Octyl alcohol, is used to enhance the absorption capability of the solution.

- Provides an 10-15% increase in capacity
- Stirs up solution layers surrounding the absorber tubes
- Alcohol's S.G. is .83 causing it to float on top of the solution in the Absorber
- Add alcohol in small amounts (about 1 quart at a time). Monitor system performance, stop adding alcohol when performance does not improve

Alcohol


No Alcohol Present
H_2O
H_2O
H_2O
Absorber Tube
Thermal
Layers

Alcohol

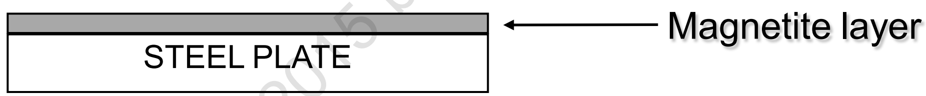


Alcohol Present
H2O
H2O
H2O
Absorber Tube
Convection currents mix solution and increase heat and mass transfer

Inhibitors

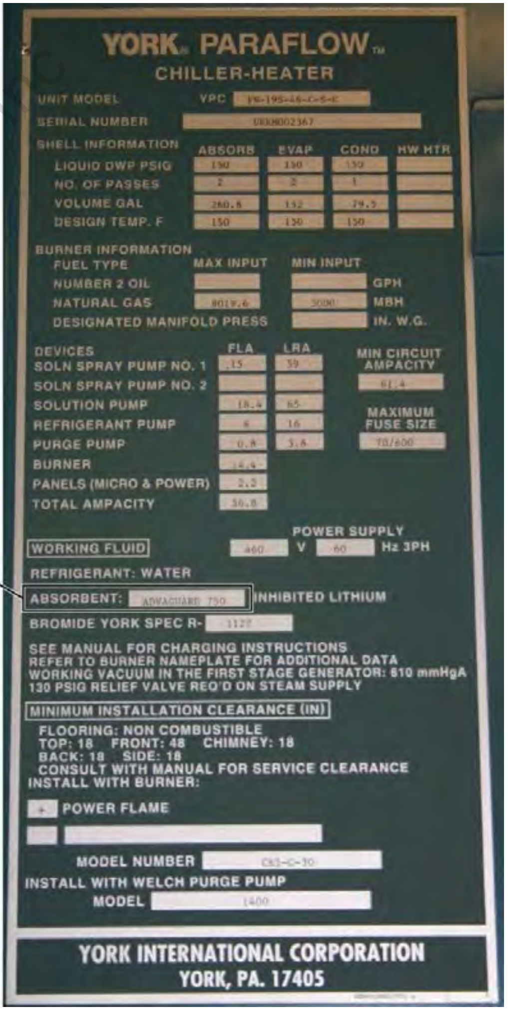
Corrosion Protective Mechanism

Inhibitors help promote the formation of a protective iron oxide film on the inside steel surfaces of the vessel. This protective film is referred to as Magnetite (Fe_3O_4). This iron oxide layer, not the actual inhibitor, helps to reduce corrosion rates in the machine.



Inhibitors

To determine which inhibitor is in your unit, refer to the unit nameplate on the side of the control panel.



Inhibitors

Chromate: Li_2CrO_4

- Used specifically in single stage (IsoFlow) units
- Protects internal steel and non-ferrous surfaces
- The only inhibitor where it's concentration can be tested in the field. This is mainly determined by it's yellowish color
- Contains hazardous chromium compounds, which are potential carcinogens. Production to be terminated in the near future
- Dispose of according to EPA, city and state regulations

Inhibitors

Nitrate: $LiNO_3$

- Used in older two stage (ParaFlow & Hitachi) units
- Fast oxidizer, forms protective magnetite film in a relative short period of time
- Consumes hydrogen
- Potentially generates NOx gases
- In presence of oxygen, forms ammonia and rapidly depletes the nitrate
- Magnetite film formed is not overly stable. Very susceptible to pitting corrosion

Inhibitors

Molybdate: Li_2MoO_4

- Used in single stage (IsoFlow) units for a brief period (Jan 1999 to June 2000). Used in two stage (ParaFlow) units from July 1993 till June 2000
- Non-toxic, usually not a problem to dispose
- Forms a tighter, more adherent film then when using nitrate inhibitor only
- Low tolerance to air in the system causing magnetite film layer to quickly break down and contaminate lithium bromide with solids
- Has limited solubility in lithium bromide solution, sometimes difficult to maintain a stable concentration of molybdate in solution. Solubility limit is about 600 mg/l. (cont'd)

Inhibitors

Molybdate, (cont'd.):

- Nitrate inhibitor is supplied with solution to help form a rough layer of magnetite as well as control hydrogen generation during initial start-up. Over the next 200 hours of operation, the molybdate will help to refine this film
- Susceptible to hydrogen generation issues when air leak is present and when inhibitors are low or depleted. Nitrate addition is required to re-form magnetite film after leak is repaired
- Low tolerance to temperatures greater than 320º F
- **Note:** Some competitors will often times put palladium cells in their units. These cells combat the hydrogen generation issues, however, this will mask an air infiltration problem

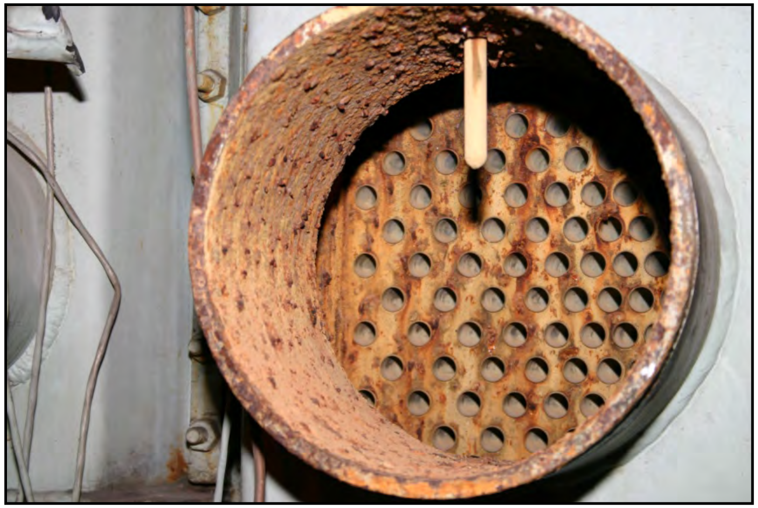
Inhibitors

ADVAGuard 750

- Currently used in YORK's complete line of absorption chiller products since June 2000
- Two-part inhibitor; Advaguard 750A and Advaguard 750B
- Developed for the triple-effect prototype unit. More tolerant to higher temperatures
- 8 times lower hydrogen generation and corrosion rates than molybdate
- Forms thicker, more stable magnetite film layer than previous inhibitors
- Compatible with nitrate and molybdate inhibitors after flush
- **Not** Compatible with chromate
- Requires a tighter, lower alkalinity range for both components to operate in
- Cost is substantially higher than previous inhibitors

Types of Corrosion

- **General Corrosion** – Uniform corrosion measured in (mils/yr)
  - Corrosion occurs slowly over time and is typically predictable
  - Adding inhibitors and the formation of a magnetite film (Fe_3O_4) helps reduce general corrosion rates
  - General corrosion rates will increase if inhibitors are not maintained



Types of Corrosion

- **Galvanic Corrosion** – caused by two dissimilar metals in contact with each other and the same electrolyte
  - Sometimes this can be used to our advantage
  - Anodes must be used whenever coatings are applied to water boxes or end sheets

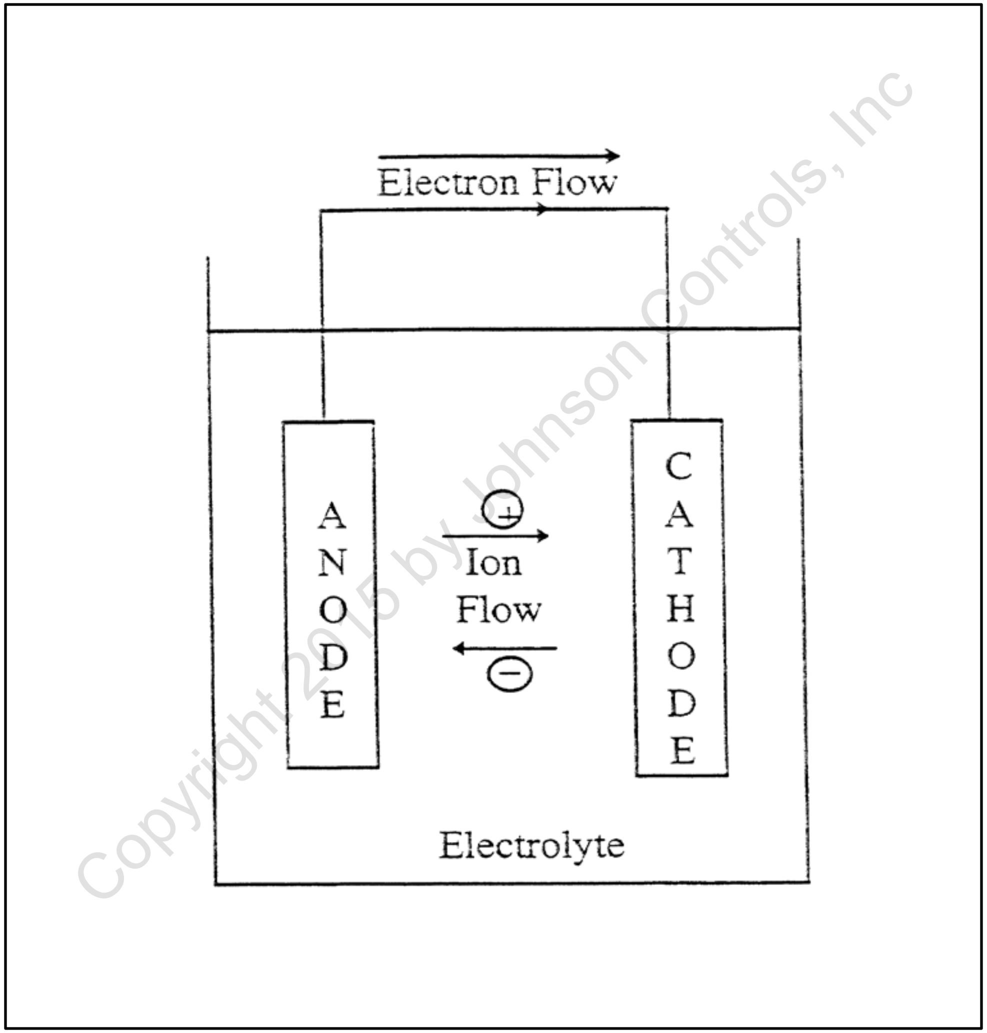
Types of Corrosion

Electrochemical Process

- Requires four factors to be present
  - Anode – the place where metal is lost and electrons are produced
  - Cathode – where electrons produced at the anode are consumed
  - Metallic path – which conducts electrons from anodic to cathodic sites
  - Electrolyte – which provides reactants for the cathodic reactions and allows the flow of ions

For galvanic corrosion to occur, all of these elements must be present and active.

Electrochemical Process



Corrosion Rates

- **Major factors affecting corrosion rates**
  - The difference between the metals and alloys
  - The cathode to anode area ratio

Question: Which material will corrode preferentially (become the anode) in the following material pair?

Copper ☐
Steel ☐

Corrosion Rates

Question: We have two riveted assembles that are dropped into an electrolyte. One uses large steel plates with copper rivets and the other uses large copper plates with steel rivets.

Which assembly will fail first?

Steel plates with copper rivets ☐
Copper plates with steel rivets ☐

Galvanic Series (Seawater)

↑ Noble or cathodic	Platinum Gold Graphite Titanium Silver 18-8 Mo stainless steel (passive) 18-8 stainless steel (passive) Chromium stainless steel 11-30% Cr (passive) Inconel (passive) (80 Ni-13 Cr-7 Fe) Nickel (passive) Silver Solder Monel (70 Ni-30Cu Cupronickels (60-90 Cu-40-10 Ni) Bronzes (Cu-Sn) Copper Brasses (Cu-Zn) Inconel (active) Nickel (active) Tin Lead Lead/Tin Solders 18-8 Mo stainless steel (active) 18-8 stainless steel (active) Chromium stainless steel 11-30% Cr (active) Cast Iron Steel or Iron Cadmium Commercially pure aluminum (1100) Zinc Magnesium and magnesium alloys
Active or anodic ↓	

Types of Corrosion

- **Localized Corrosion**
  - Pitting Corrosion
    - Oxygen Differential Cell – Occurs when a localized area is at a lower oxygen concentration than the area immediately surrounding it Examples: Crevice Corrosion and Under-deposit Corrosion
    - Concentration Cell – Occurs when two dissimilar concentrated solutions of the same brine are in contact with each other on the same piece of material. The area of lower concentration becomes anodic and will corrode preferentially to the area of higher concentration

Chemical Sampling

Class Exercise

Describe the proper procedure for pulling a sample

Chemical Sampling

- Form included with the test kit
- Must be filled out completely
- Must include a purchase order number

Form 155.17-RA1 (495)

YORK — **Isoflow™ - Paraflow™**
Solution Sample Submittal Form

☐ RUSH (FOR REPAIRS OR TROUBLESHOOTING) or ☐ ROUTINE (FOR ROUTINE MAINTENANCE)

THIS FORM IS TO BE COMPLETELY FILLED OUT BY A QUALIFIED YORK SERVICE TECHNICIAN.
Complete this form for each sample submitted for analysis. The information supplied here will enable qualified YORK Chemical and Metallurgical refrigeration system chemists to better interpret the test results. This permits the development of reliable analysis and recommendations. Repetitive sampling and data submittal are very useful references for the historical analysis of chiller equipment.

A purchase order MUST be submitted with each sample to permit processing!

CUSTOMER NAME ______ CUSTOMER ID NO. ______
ADDRESS ______ TELEPHONE ( ) ______
CITY, STATE, ZIP CODE ______

YORK DISTRICT OFFICE: ______ ATTN: ______
PURCHASE ORDER NUMBER: ______ DISTRICT OFFICE NUMBER ______
TELEPHONE ( ) ______ FAX ( ) ______
DISTRICT OFFICE ADDRESS: ______

DATE SAMPLED: ______ DATE LAST ANALYSIS: ______ HOURMETER: ______
TYPE OF SOLUTION: ☐ NITRATE ☐ MOLYBDATE ☐ CHROMATE ☐ ADVAGuard(TM) 750

AT TIME OF SAMPLING:
SAMPLE CONCENTRATION = ______ (should be less than 54%) SOLUTION CHARGE (gallons) ______
SYSTEM WAS: ☐ RUNNING IN COOLING ☐ RUNNING IN HEATING ☐ NOT RUNNING
SAMPLE ENCLOSED: ☐ FILTERED ☐ UNFILTERED ☐ BOTH
SAMPLE WAS TAKEN FROM: ☐ ABSORBER ☐ OTHER ______

YORK SERIAL NO. ☐☐☐☐☐☐☐☐☐☐☐☐☐ Normal = 10 Characters; Early Houston = 13 Characters
YORK MODEL NO. ☐☐☐ – ☐☐☐ – ☐☐☐☐☐ – ☐☐☐ – ☐☐ – ☐☐ – ☐ → Blank = Nitrate; A or B = Molybdate

HITACHI SERIAL NO. ☐☐☐☐ – ☐☐☐☐ – ☐☐☐☐☐
HITACHI MODEL NO. ☐☐☐☐☐☐☐☐☐☐ – ☐☐ → Blank = Nitrate; A or B = Molybdate

☐ SEND THE NECESSARY CHEMICAL INHIBITORS TO THE FOLLOWING ADDRESS: ☐ Use York Office Address
COMPANY NAME ______ PHONE NUMBER ______
ADDRESS ______ (REQUIRED) ( ) ______
CITY, STATE, ZIP CODE ______ ATTN: ______

ADDITIONAL COMMENTS OR SPECIAL INSTRUCTIONS ______

Chemical Sampling

- Test Kit w/Solution Sample Submittal Form
- Extracting solution using Refrigerant Recovery Vessel
- Preventing air from entering the system

Preventing Air from Entering

- Always assume the unit is in a vacuum
- Isolation valves are your friend
- Use the flask
- Use a nitrogen bleed on the machine

Chemical Sampling

- Test Kit
- Extracting solution using Refrigerant Recovery Vessel
- Preventing air from entering the system
- Solution Chemical Maintenance

Adding Inhibitors

Nitrate or Molybdate:

- Only to be done in cooling mode
- Pull out of the machine at least 10 times more refrigerant (in weight) than inhibitor being added
- Pour in inhibitor and mix in a plastic bucket
- Connect hose to solution pump discharge sample valve and run solution into the bucket under the liquid level to clear air from the hose
- Keeping the hose under the liquid level, shut the solution pump off and let the mixture be sucked back into the absorber. Do not allow air into the machine!

Adding Inhibitors

Nitrate or Molybdate cont'd:

- Close all valves and rinse all equipment, tools and components with water that came into contact with the mixture
- The unit should continue to run (at least 30 minutes) preferably at a part load condition once the inhibitor has been installed

Adding Inhibitors

ADVAGuard 750:

- ADVAGuard 750 is broken into two separate parts, 750A & 750B. These two components will only work together if the alkalinity of the solution is in a certain range value. This value becomes important when maintaining solution chemistry
- If at anytime lithium hydroxide requires adjustment, always do this first before adding 750A or 750B
- When adding any of the above three components, withdraw between 20-30 gallons (76-114 liters) of solution out of the unit

Adding Inhibitors

ADVAGuard 750A:

- If needed, make the adjustments to the alkalinity first
- The ADVAGuard 750A is a yellow liquid that is strong in acidity, be careful when opening the container
- Pull 20-30 gallons of solution out of unit into a plastic container
- Slowly, at a rate of .25 liter per minute, pour the ADVAGuard 750A into your bromide solution while mixing with plastic rod
- If the 750A is added too fast, the solution will turn blue to greenish-blue. Stop mixing and suck this solution back into the machine. Start over again by pulling more solution out of the unit and mixing the remainder of the ADVAGuard 750A

Adding Inhibitors

ADVAGuard 750B:

- If needed, make the necessary adjustments to the alkalinity first
- The ADVAGuard 750B is a white/grayish powder that is very hydroscopic. Keep the container closed as much as possible to avoid contact with the surrounding air
- Once the ADVAGuard 750B container is open it will have a very minimal shelf life. Therefore, it is best to only to buy what is necessary to bring the solution chemistry back to it's recommended range
- Pull 20-30 gallons of solution out of unit into a plastic container
- Mix the 750B in the solution and stir well for about 15 minutes
- Suck this solution mixture back into the machine as before

Chemical Sampling

- Test Kit
- Extracting solution using Refrigerant Recovery Vessel
- Preventing air from entering the system
- Solution Chemical Maintenance
- Reading chemistry reports

Reading Chemistry Reports

- When you receive a solution analysis report, the report will show the amounts of various substances found in the solution you sent to the lab
- Some of the substances we are concerned about are:
  1. **Type of inhibitor**
  2. **Amount of inhibitor**
  3. **Solution Alkalinity (lithium hydroxide)**
  4. **Dissolved Copper (not to be confused with copper particulate or suspended copper)**
  5. **Ammonia**
  6. **Inhibitor corrections**

Solution Analysis Reports

ParaFlow™
Solution Analysis Report

Customer Name	Conant High School	**Sample Drawn**	Sep 1,2005
Unit Model No.	YPCFN14SC46CSC	**Report Date**	Sep 6,2005
Unit Serial No.	UMMM012725	**Report Number**	R7997
Sample Received	Sep 2,2005	**PO Number**	1-614676708

Inhibitor Type: **ADVAGuard™ 750**

- Nitrate
- Molybdate

	Sample Data			Converted Data (Sample data converted to 53%)	
Sample Concentration	**46.86**	% LiBr		**53.00**	% LiBr
Sample Specific Gravity	**1.478**	at 75°F		**1.580**	at 75°F
ADVAGuard™ 750A	**66**	mg/l	**120-300**	**80**	mg/l
ADVAGuard™ 750B	**4**	mg/l	**80-210**	**5**	mg/l
Alkalinity (Lithium Hydroxide)	**0.058**	N	**0.065-0.075**	**0.070**	N
Dissolved Copper	**0**	mg/l	**0-50**	**0**	mg/l
Ammonia	**5**	mg/l	**0-100**	**6**	mg/l

Corrections Necessary

ADVAGuard™ 750A	Add .000131 gals. of ADVAGuard™ 750A solution per lb. of solution in the
ADVAGuard™ 750B	Add 0.175 grams of ADVAGuard™ 750B per lb. of solution in the unit.
Lithium Hydroxide	Add .000262 lbs. of LiOH per lb. of solution in the unit.
Copper Removal	No
Ammonia Removal	No
Solution Charge (gallons)	**360**
Chemical Calculation	Based on a solution capacity of 360 gallons, add 0.62 gals. ADVAGuard™ 750A solution, 834 grams ADVAGuard™ 750B, and 1.25 lbs. lithium hydroxide monohydrate to the unit.

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Solution Analysis Reports

ParaFlow™
Solution Analysis Report

Customer Name	Conant High School	**Sample Drawn**	Sep 1,2005
Unit Model No.	YPCFN14SC46CSC	**Report Date**	Sep 6,2005
Unit Serial No.	UMMM012725	**Report Number**	R7997
Sample Received	Sep 2,2005	**PO Number**	1-614676708

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- Nitrate
- Molybdate

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Solution Analysis Report

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Sample Received	Sep 2,2005	**PO Number**	1-614676708

Inhibitor Type: **ADVAGuard™ 750**

- Nitrate
- Molybdate

	Sample Data		Converted Data (Sample data converted to 53%)
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Sample Received	Sep 2,2005	**PO Number**	1-614676708

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- Molybdate

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Solution Analysis Report

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Solution Analysis Report

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Ammonia	**5**	mg/l	**0-100**	**6**	mg/l

Corrections Necessary 0.005

0.1119 Add LiOH

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ADVAGuard™ 750B	0.1752685	Add 0.175 grams of ADVAGuard™ 750B per lb. of solution in the unit.
Lithium Hydroxide	0.0002623	Add .000262 lbs. of LiOH per lb. of solution in the unit.
Copper Removal		No
Ammonia Removal		No

Solution Charge (gallons)	**360**
Chemical Calculation	Based on a solution capacity of 360 gallons, add 0.62 gals. ADVAGuard™ 750A solution, 834 grams ADVAGuard™ 750B, and 1.25 lbs. lithium hydroxide monohydrate to the unit.

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Refrigerant Contamination

- Checking refrigerant specific gravity
- Refrigerant blowdown
- Alcohol separation

Purge Trending

- An estimated 90% of all absorption problems can be directly attributed to non-condensables
- Monitoring the non-condensable production gives the operator an early warning that problems are about to develop in the machine
- An increase in the non-condensable production is indicative of a solution chemistry imbalance, an air leak, or a combination of the two
- Simply put, monitoring the non-condensable production and if necessary taking prompt corrective action, will extend the life of an absorption unit

Purge Trend Log Form

- Items tracked on purge form:
  - Date
  - Purge tank pressure
  - Pressure difference
  - Was purging performed?
  - What was the tank pressure at the end of purging?

Figure 5 - Completed Purge Log Form

YORK INTERNATIONAL CORPORATION ParaFlow™ Purge Log Form

(TO BE FILLED OUT BY OPERATOR DAILY)

Job Name: York International Corporation

Unit Model Number: YPC-FN-13SC Unit Serial Number: HFBM100000

Two Weeks Ending (Insert Date): 7/12/97 Average Load (%): 95% Average Ambient Temp: 85°F

Day	Purge Tank Press. (mmHg)	Pressure Difference (mmHg)*	Purging Performed?	If so, purged down to (mmHg)	Operators Initials
Sunday	30	--			RWN
Monday	33	3			RWN
Tuesday	41	6			BH
Wednesday	46	5			RWN
Thursday	50	4			BH
Friday	55	5			RWN
Saturday	61	6	Yes	30	RWN
Sunday	35	5			JAB
Monday	39	4			BH
Tuesday	45	6			RWN
Wednesday	51	6			RWN
Thursday	57	6			BH
Friday	62	5	Yes	30	BH
Saturday	35	5			BH

The purge tank pressure [illegible] must be monitored on a daily basis. Take the readings at the same time each day. Purging is [illegible]

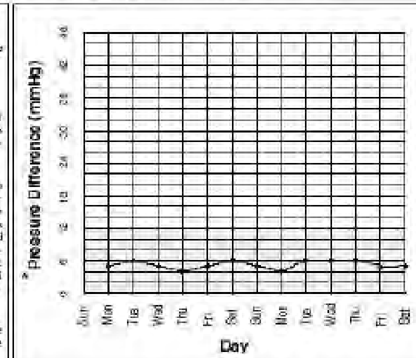
Note: * The pressure difference column is the difference between today's pressure reading and yesterday's reading. It is this value that should be plotted in the graph below. [illegible]

Plotting The Pressure Difference Trend

1. [illegible]

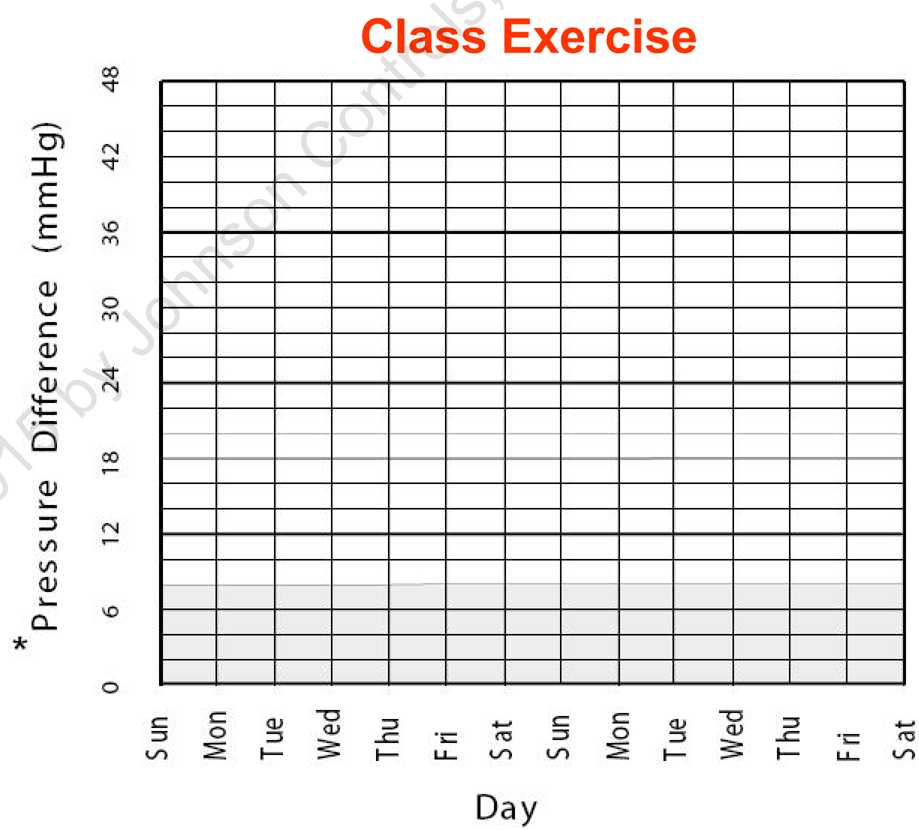
2. [illegible]

[illegible]

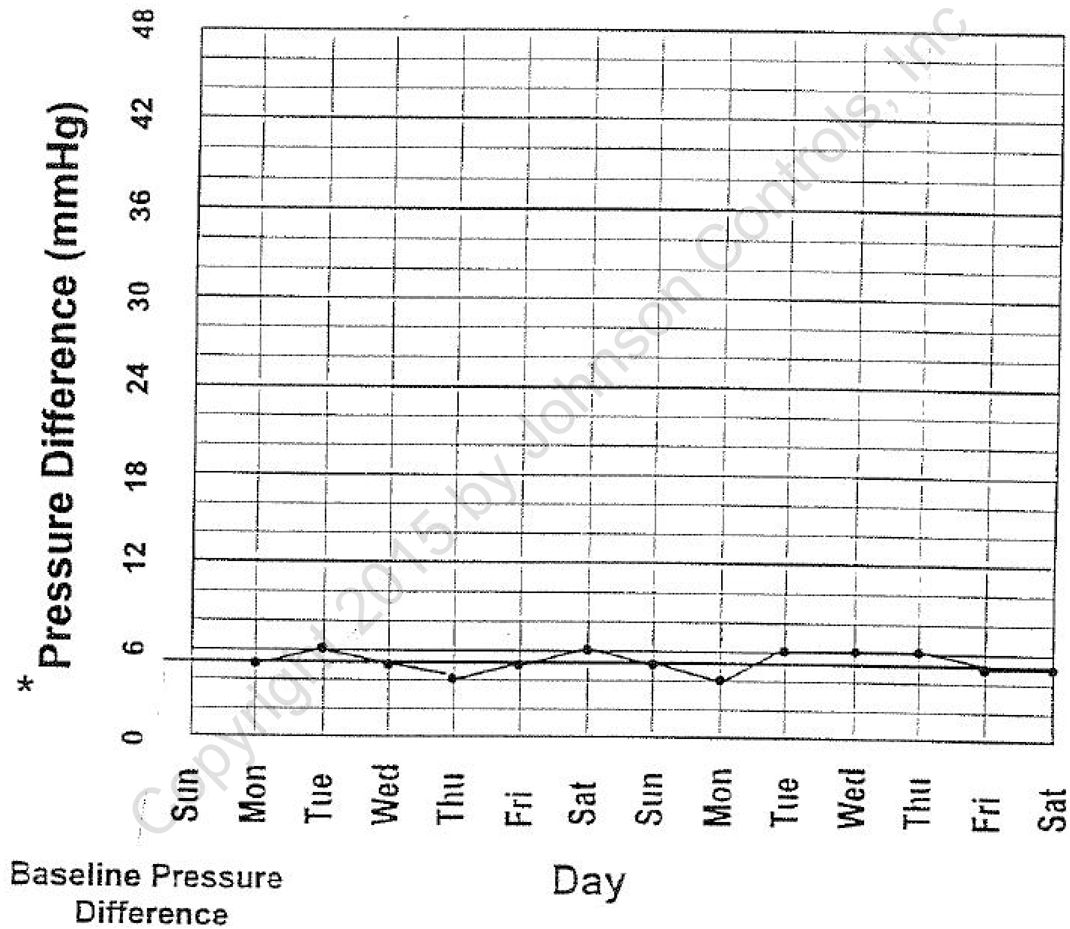


Purge Baseline

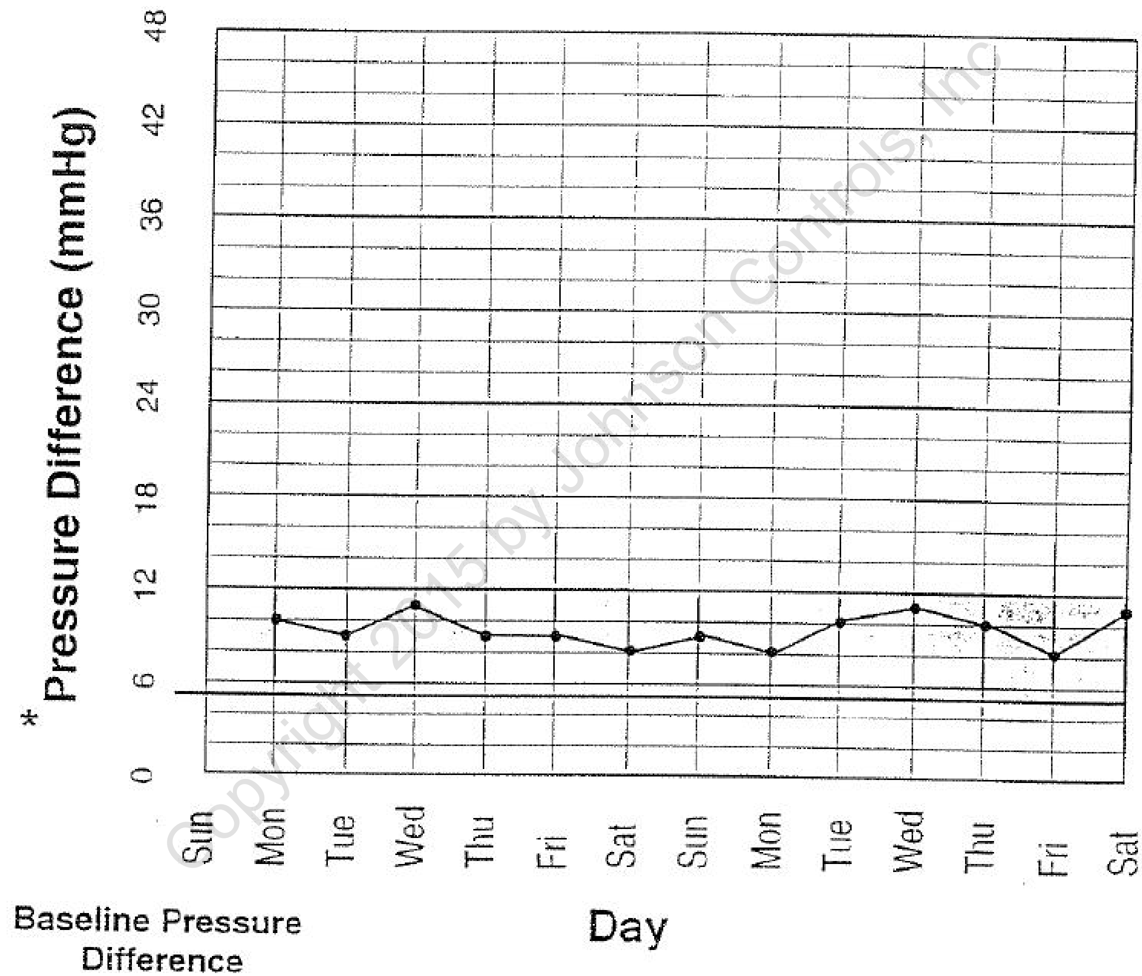
- Plot readings on graph using two weeks worth of data
- Decipher the Data



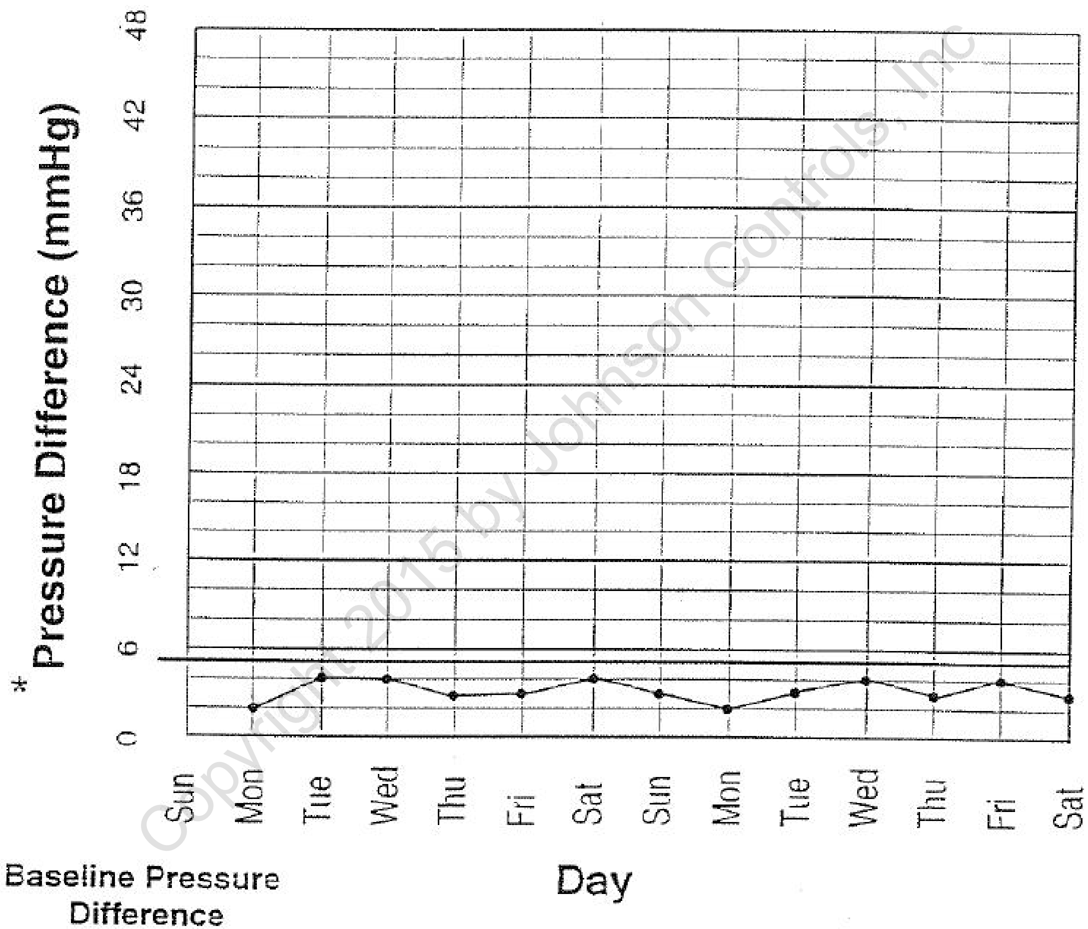
Normal Non-condensable Trend



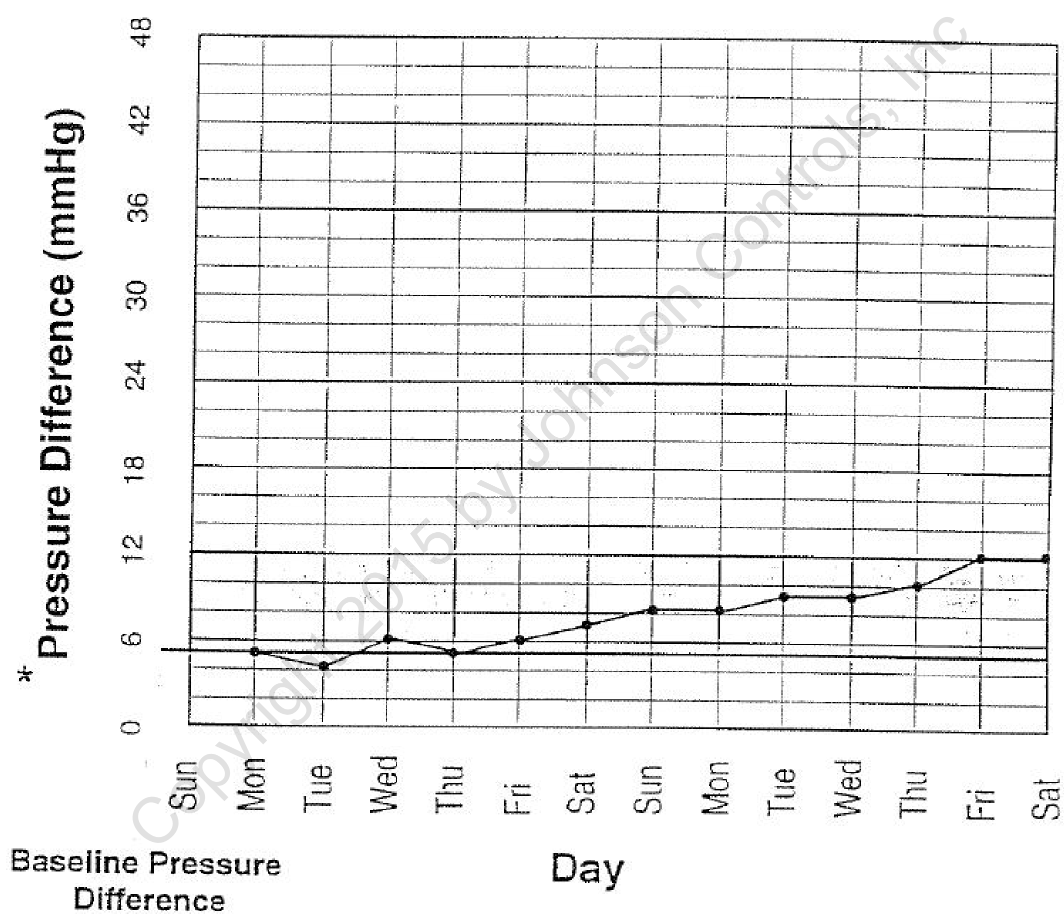
Flat Trend Above Baseline



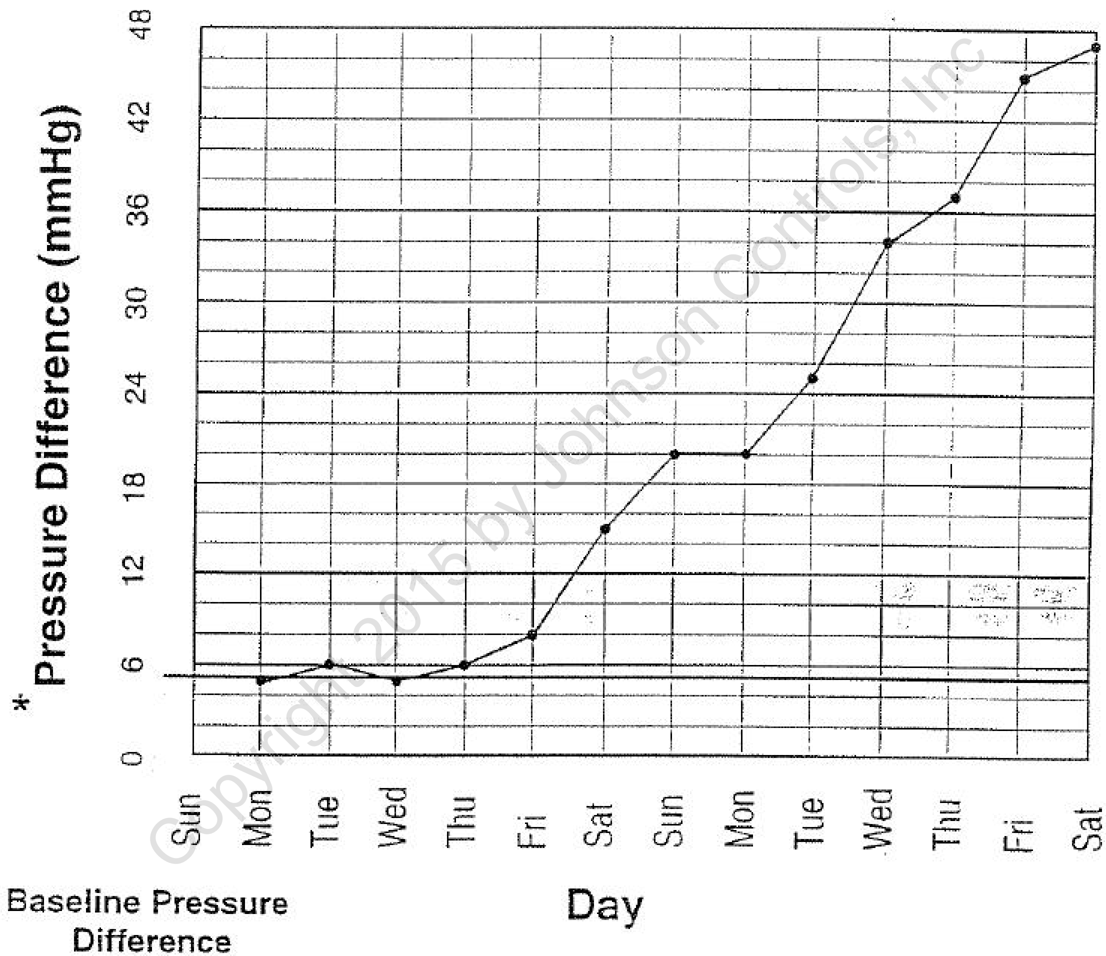
Trend Below Baseline



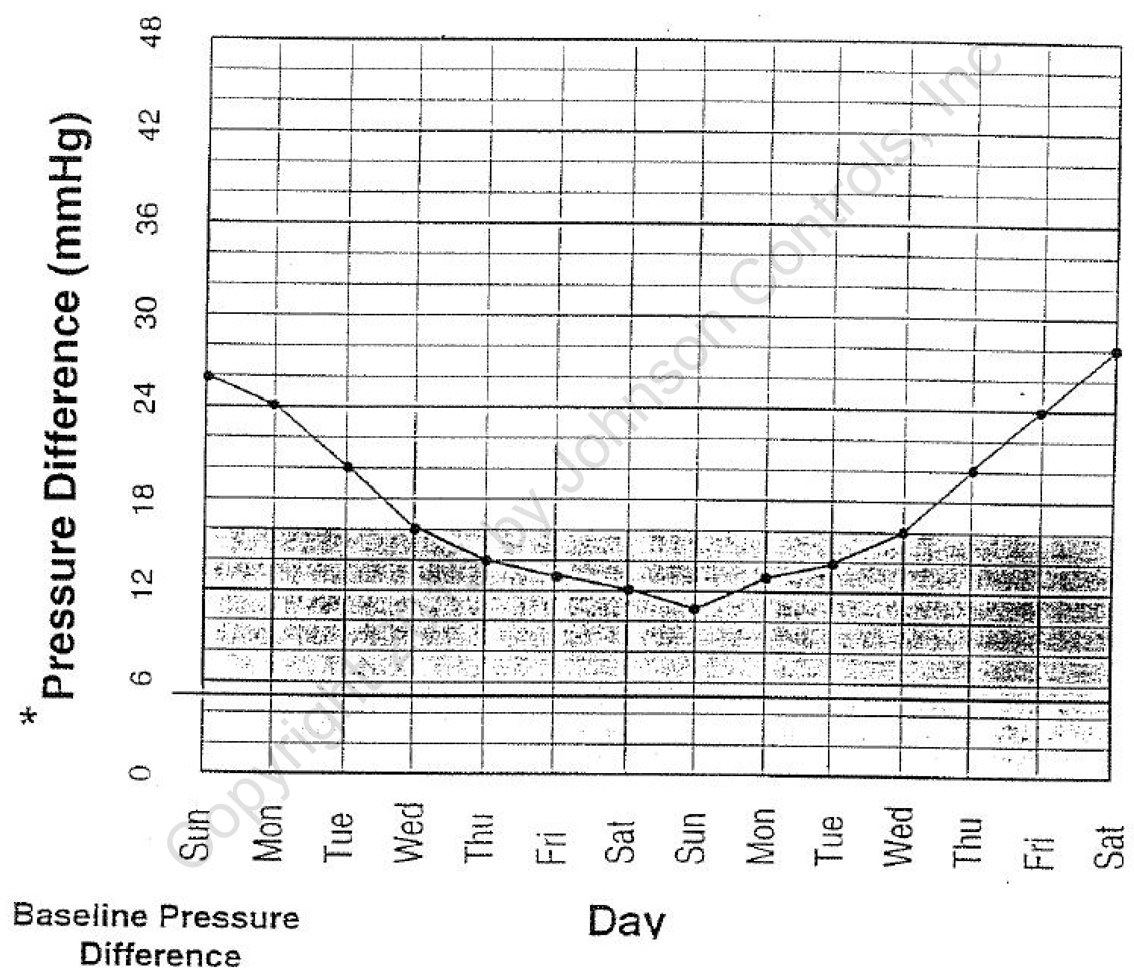
Gradually Increasing Trend



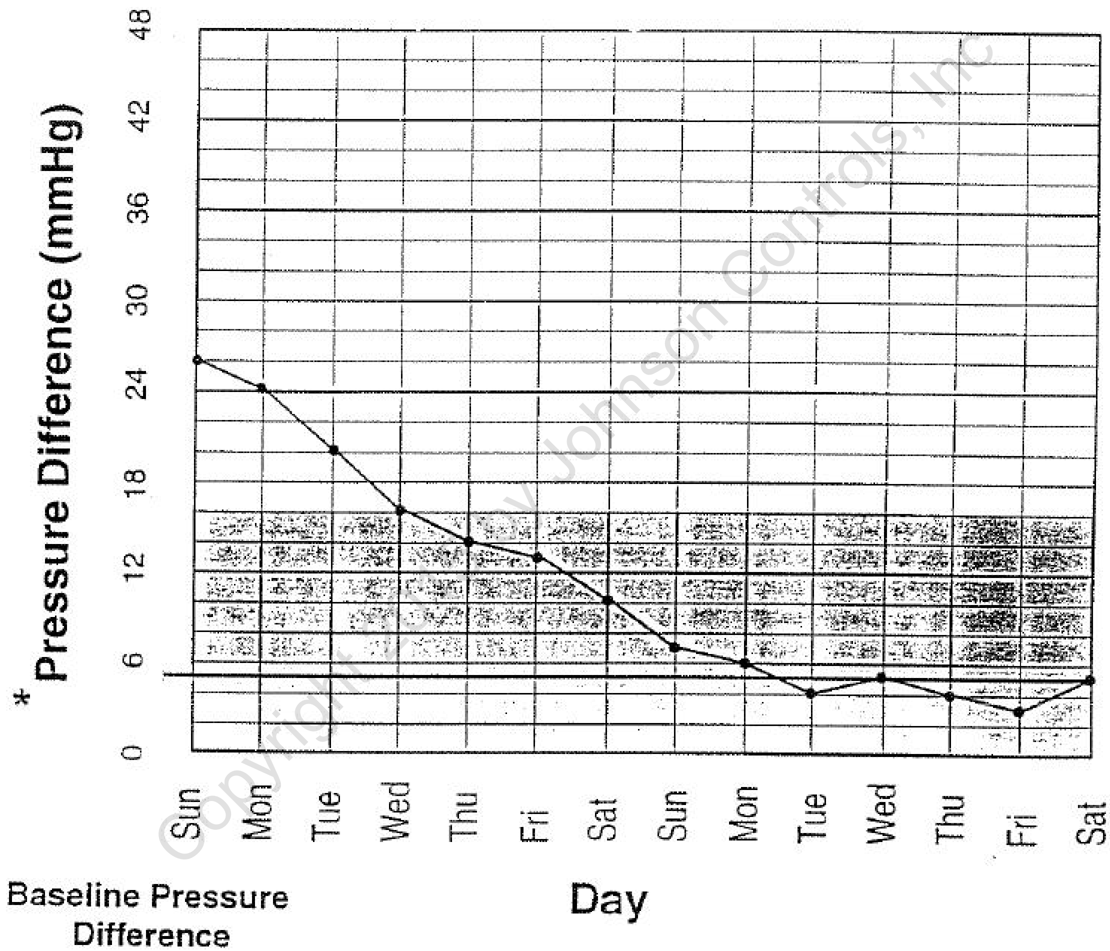
Rapidly Increasing Trend



Trend Reduction with Increase



Trend Reduction Down to Baseline

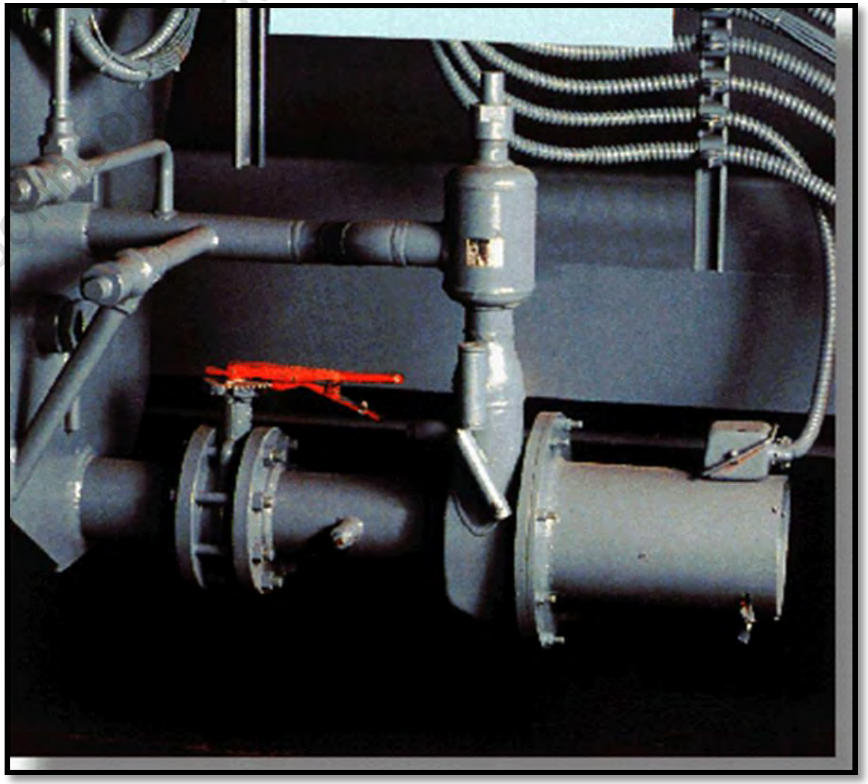


Operation & Maintenance

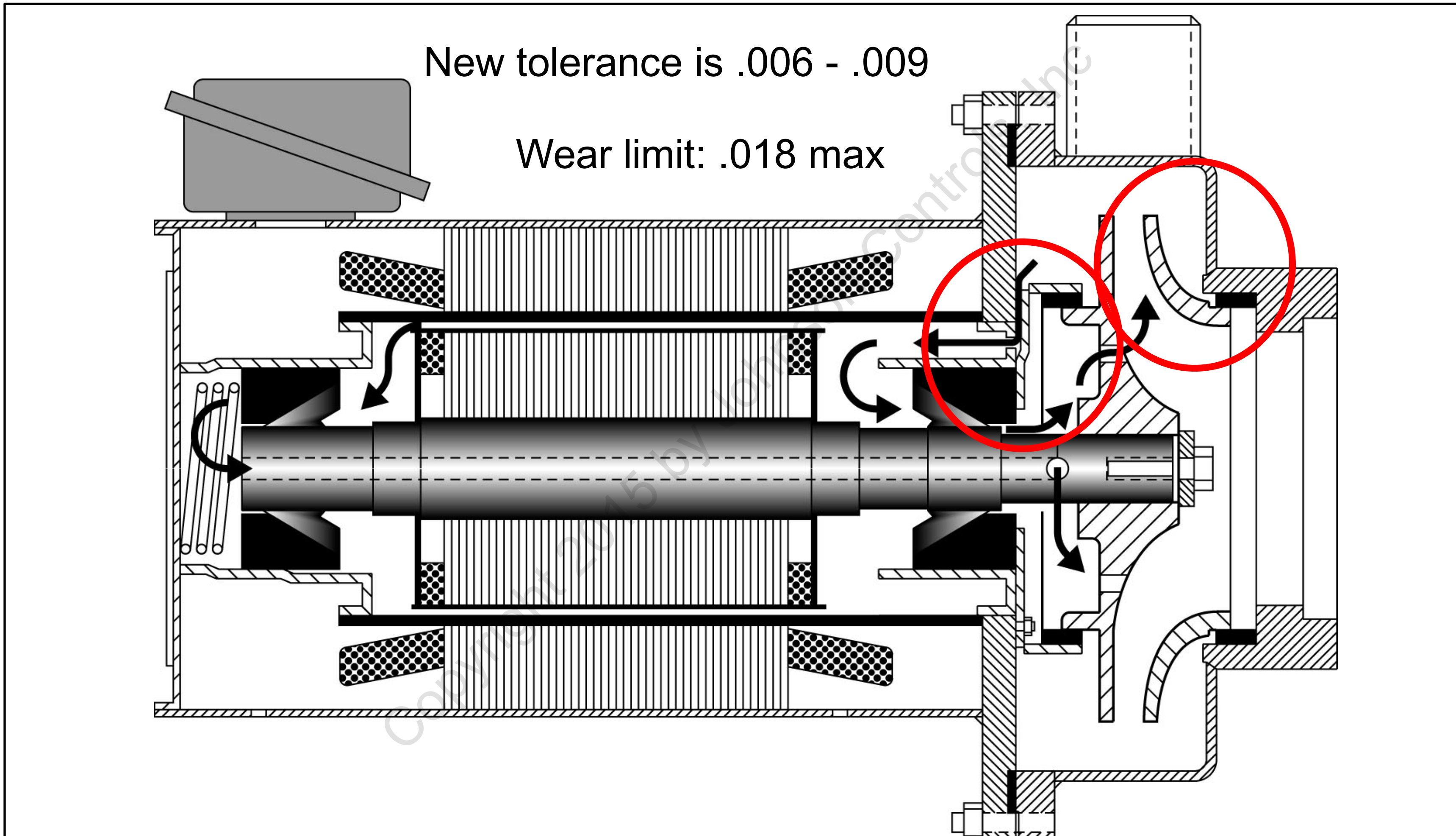
- Simultaneous Heating/Cooling and Changeovers
- Pump Maintenance

Buffalo Pump

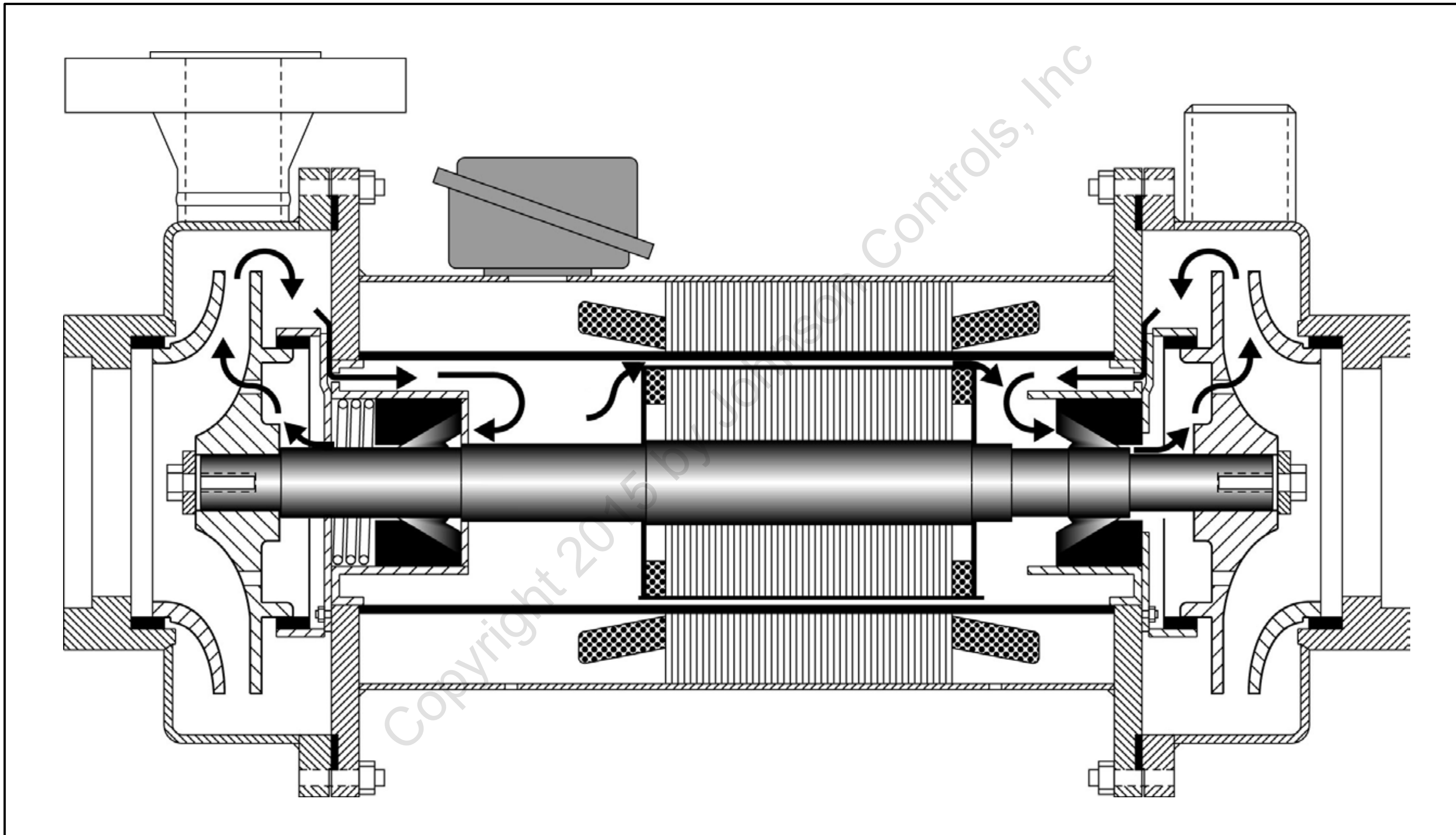
- Advantages
  - 50-60k hours maintenance interval vs 9k for Nikeso
  - Conical bearing design



Single Buffalo Pump

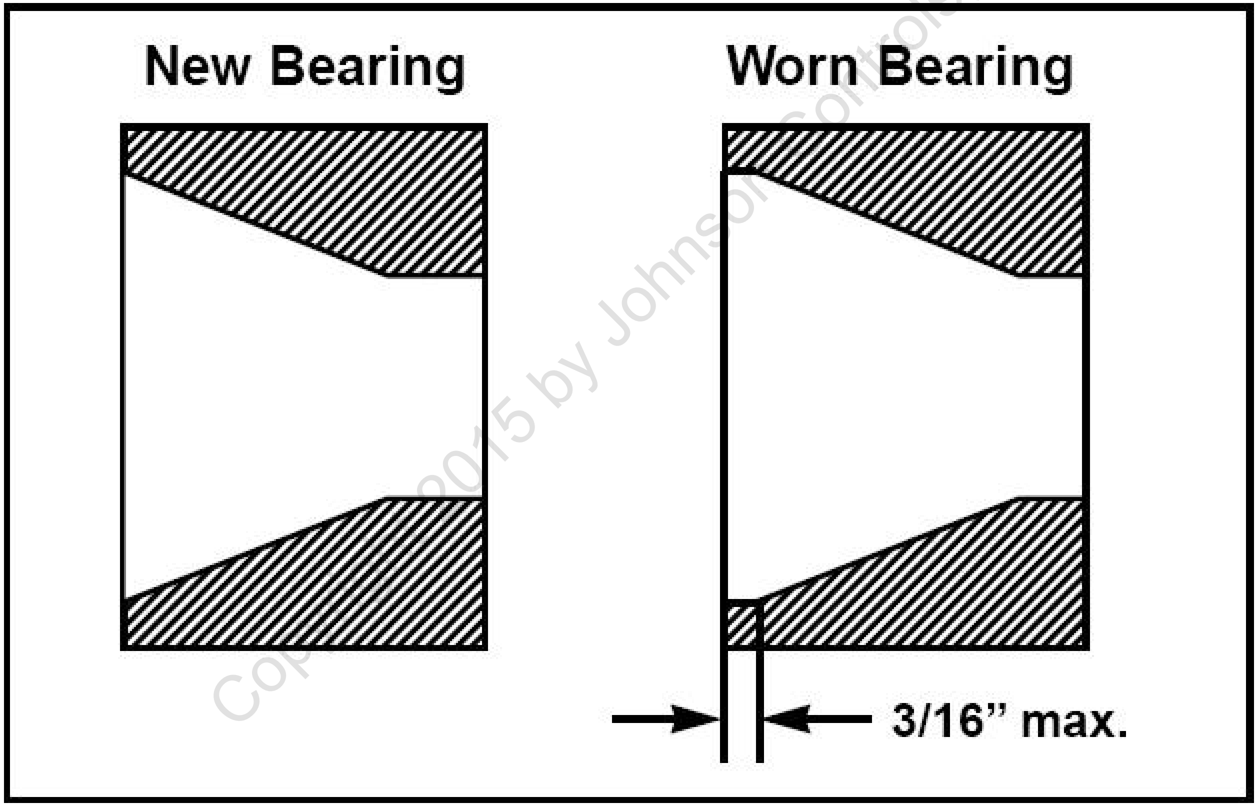


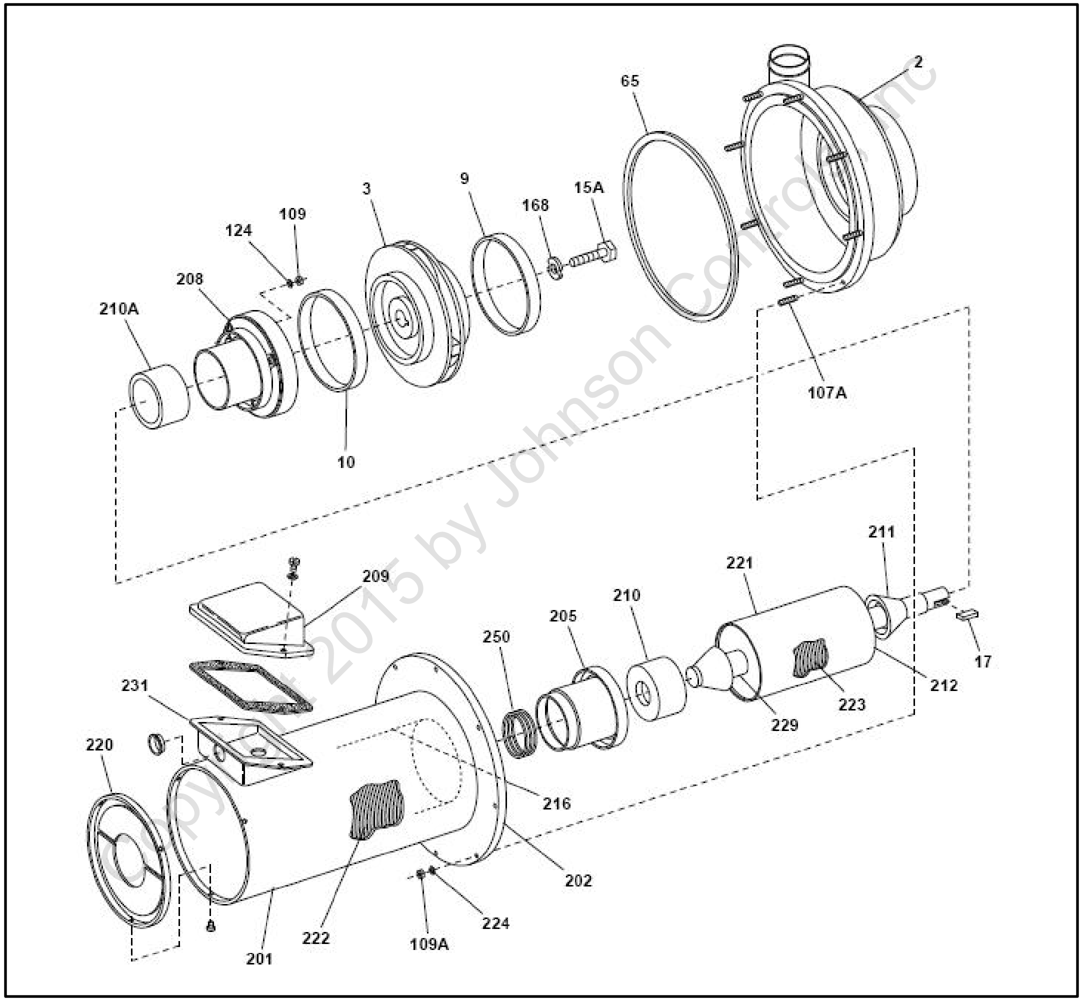
Double Ended Buffalo Pump



Pump Maintenance

ParaFlow Maintenance Manual: Pumps

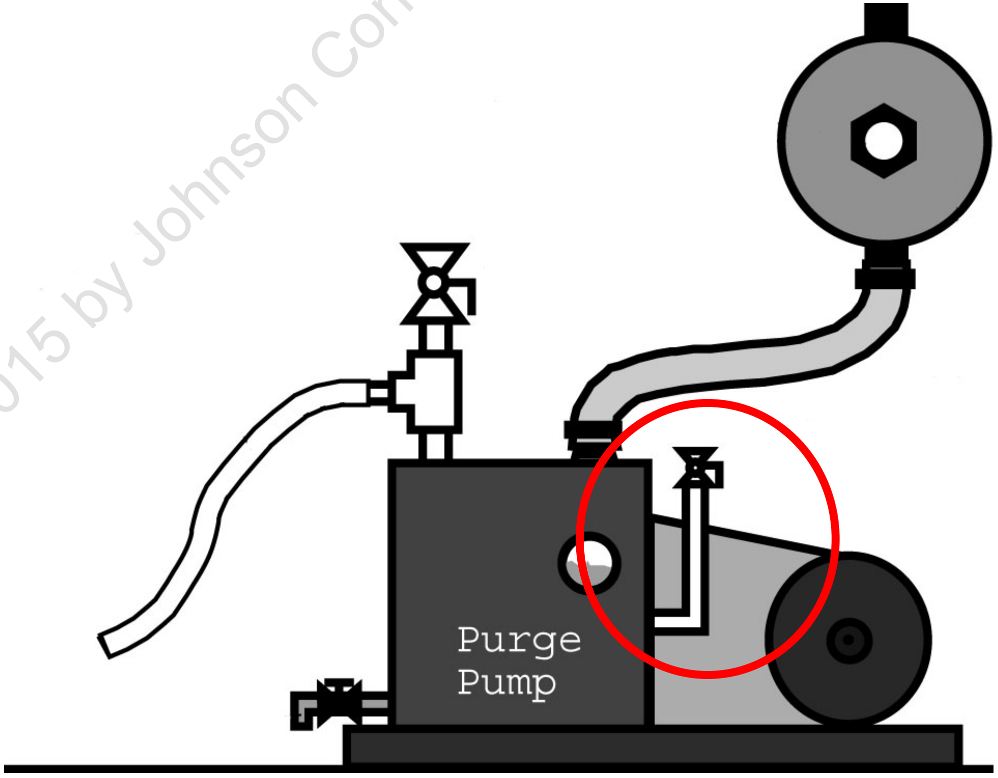



2
65
9
168
15A
3
109
124
208
210A
10
107A
209
211
221
210
205
250
17
212
223
229
231
220
216
202
224
222
109A
201

Purge Pump Maintenance

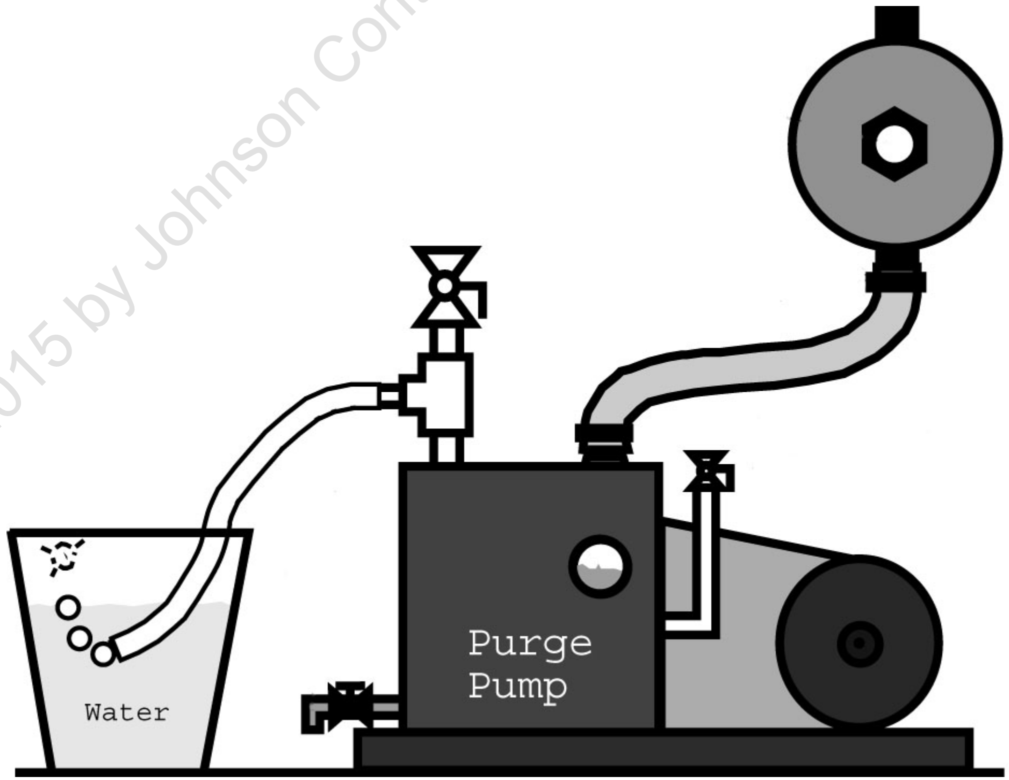
Principle of Gas Ballast

- Condensation in the 2nd stage of the pump
- Due to a high ratio of initial pressure and end pressure
- Air introduced in the 2nd stage, reduces the volume of the mixture condensation is therefore avoided



Oil Contamination

- How do you know? How to eliminate it?



Purge Pump Maintenance

- Change the oil
- Flushing the pump
- Belt condition/tension

Operation & Maintenance

- Simultaneous Heating/Cooling and Changeovers
- Pump Maintenance
- Tube Maintenance
- Water Treatment
- Valve Maintenance

Questions

Section 7: Troubleshooting

Leak Testing

Why leak test?

Leaks effect absorption chillers in many ways:

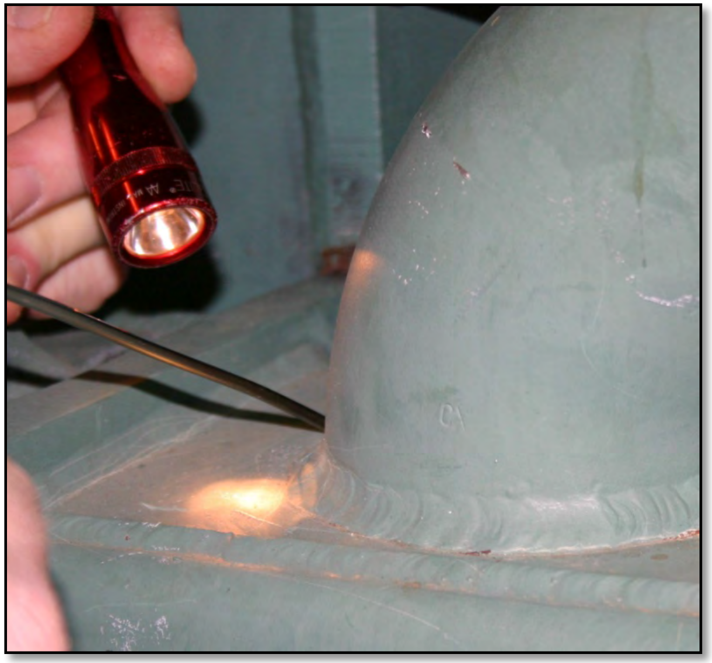
1. Decrease unit performance.
2. Prematurely deplete inhibitors.
3. Increase internal corrosion rates.
4. Shorten the unit’s life.

Sources of Leaks

Imperfect joints or seals by which various parts are assembled to form the finished product most commonly cause leaks.

On absorption machines these may include:

- Welded joints
- O-rings, gaskets, or elastomers
- Threaded Joints
- Flanged joints
- Valve packings
- Component leaks (such as transducers)



How to Determine if there is a Leak

- Leaks can be determined by monitoring the non-condensable production in the unit. Do this by:
  - Tracking unit bubble rate
  - Checking for hydrogen
  - Monitoring purge tank pressure (trending)
  - Counting the number of purges
- If it is determined the non-condensable rate is high:
  - Take a solution sample for lab analysis
  - Add inhibitors per analysis report
    - If molybdate unit, bring nitrate up to 75 mg/L (SI0044)
  - Monitor non-condensable rate again
    - If non-condensable production has decreased and returned to normal; non-condensable issue was due to a chemistry problem

Leak Criteria

Leak Characteristics

- Size of Leak
- Does the leak get worse when the machine heats up, cools down?
- Does the leak effect unit capacity?
- Does the leak cause the unit to trip on high pressure?
- Does the refrigerant level increase over time?
- Does the unit only leak when it’s shutdown?
- Is refrigerant contaminated and difficult to clean up?

Leak Test Methods

- Visual
- Soap bubble test
- Refrigerant leak test
- Helium leak detection

Leak Test Methods

Visual Inspection

- Only very large leaks can be found in comparison with the other three methods

Leak Testing Techniques

Visual Inspection

- This method is great for finding leaks under the liquid levels or determining if a tube leak is present
- Using a small flashlight, look for bubbles in sight glasses, wet spots under the chiller or seepage from joints
- A tube leak may cause a rising refrigerant level in tank
- Best if insulation is removed when looking for air leaks

Leak Test Methods

Soap bubble test

- Accurate to a leak rate of 1.0×10^{-4} atm cc/sec

Leak Testing Techniques

Soap Bubble Test

Unit is charged with dry nitrogen, argon or any inert gas. Keep the charge pressure 3 psig BELOW the pressure rating of the rupture disk

- If rupture disk is removed or blanked off DO NOT go over 12.0 PSIG. (shell design is 15.0 psig)
- Remove solution to check areas under the solution level
- In some cases, additional valves may have to be added to the unit for complete drainage or isolation
- Liquid soap is brushed or sprayed onto various joints and observed for bubbles

Leak Test Methods

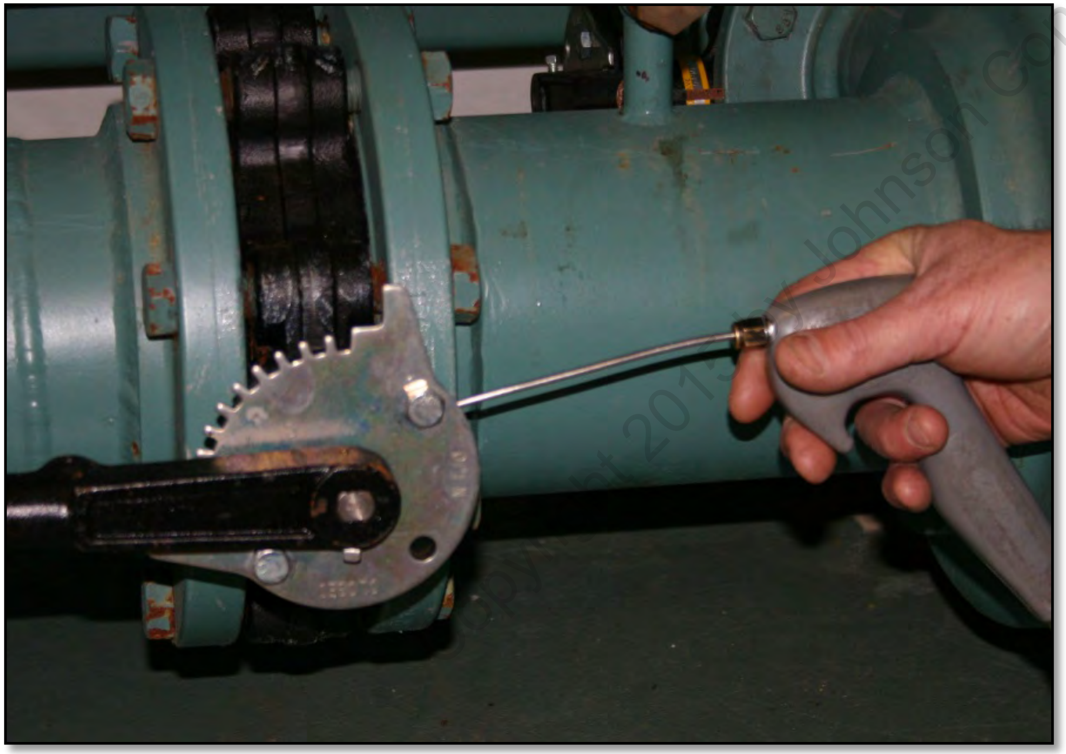
Refrigerant leak test

- Accurate to a leak rate of 1.0×10^{-5} atm cc/sec

Leak Test Methods

Helium leak detection

- Accurate to a leak rate of 1 x 10^{-9} atm cc/sec



Leak Testing Techniques

Detector-probe, “Sniff” or “inside-out” method

- This method can follow the soap bubble test if no leak was found
- Unit is set-up in the same fashion as the soap bubble test
- A small amount (~5 lbs) of “tracer” gas, usually R-22, is added to the inert gas and charged into the unit. The “detector probe” on an electronic halide leak detection device (such as a G.E. model H2) is used to “sniff” for R-22 as the tracer gas mixture leaks out of the unit

Leak Testing Techniques (Cont'd.)

- For a more precise test, install bags (3-4 mil poly film duct taped) around components on the unit
- Allow time for the R-22 within the unit to "seep out" of the possible leak area to fill the bag
- Stick the probe into the bag to sense for R-22
- Please note, some additional valves may have to be added to the unit for complete unit drainage or isolation

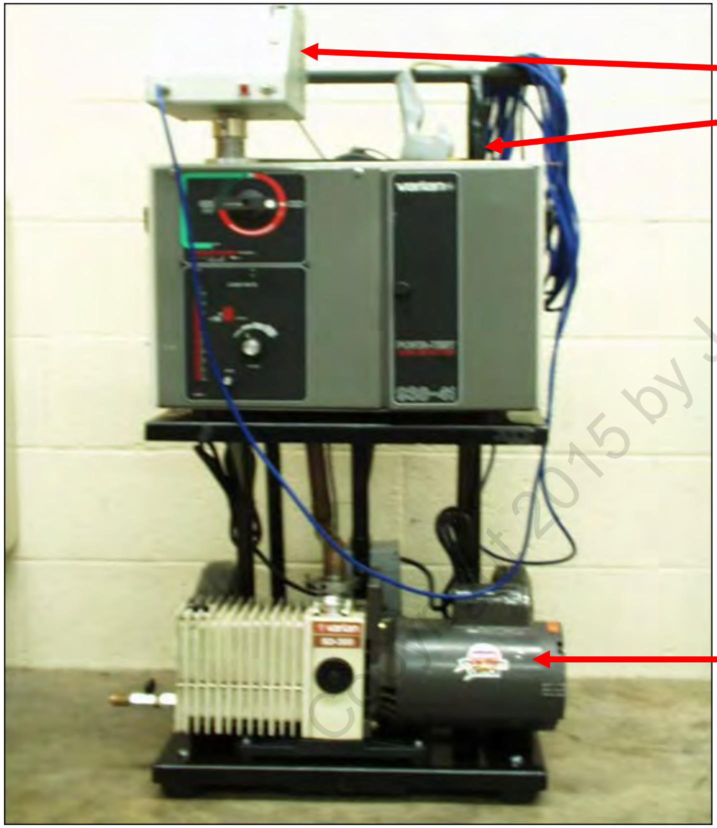
Leak Testing Techniques

Helium, detector-probe, sniff or inside-out method

- Performed in the same manner as the detector-probe, “sniff” or “inside-out” test, except
- 100% helium is charged into the unit as the tracer gas
- A helium mass spectrometer (HMS) and roughing pump is used instead of a halide leak detector
- Bags are installed around various unit components in the same manner as the “tracer-probe or sniff test
- The helium will escape through the leak area and accumulate in the bag
- Insert the HMS detector probe into the bag to sense if helium is present

Leak Testing Techniques

Helium, detector-probe or inside-out leak test



Sniffer probe attachment

Vacuum roughing pump

Leak Testing Hints

- Allow time for the tracer gas or helium to accumulate into the bags. On very small leaks this could take overnight
- Remember, the unit may have more than one leak. Keep leak checking until the complete unit is checked
- When a leak is detected, either repair it immediately or isolate it from the remainder of the unit
- After repairing the leak(s), go back and verify it’s fixed!

Leak Testing Hints

- The detector-probe, “sniff” or “inside-out” test is most effective if ALL solution and refrigerant is drained from the unit. Additional valves may have to be added to the unit to accomplish this – especially in the heat exchanger area
- Sometimes it is advantageous to isolate the high side of unit from the low side if leak is suspected in one or the other. However, not all units will have all the valves necessary to do this
- If the rupture disk is removed don’t forget to re-check the disk seal after the new disk is installed
- metallic rupture disks are ONE TIME use only!

Leak Testing Techniques

Helium, Tracer-Probe or “outside-in” leak test method

- This is the only leak test method that can be accomplished while the unit is in operation
- This is a great advantage if the chiller cannot be shut down
- A helium tracer gas is sprayed on the outside of the unit in hopes that the leak will pull the helium into the unit
  (cont'd.)

Leak Testing Techniques (Cont'd.)

Helium, Tracer-Probe or "outside-in" leak test

- The helium mass spectrometer "HMS" unit is connected to where the manometer connection is on the purge piping. VP2 valve remains open while the unit mounted purge pump continuously purges from the purge tank
- A throttling needle valve is used to pull a sample of the non-condensable gases from the purge piping into a cold trap chamber
- The cold trap protects the HMS unit (this is the same HMS as used in the detector-probe test method) from contamination
- Moisture and alcohol vapor are frozen in the cold trap while the helium gas will continue through and into the HMS. The cold trap operates at a temperature of -148 deg F or -100 deg C and a pressure of < 10.0 millitorr

Leak Testing Techniques (Cont'd.)

Helium, Tracer-Probe or "outside-in" leak test

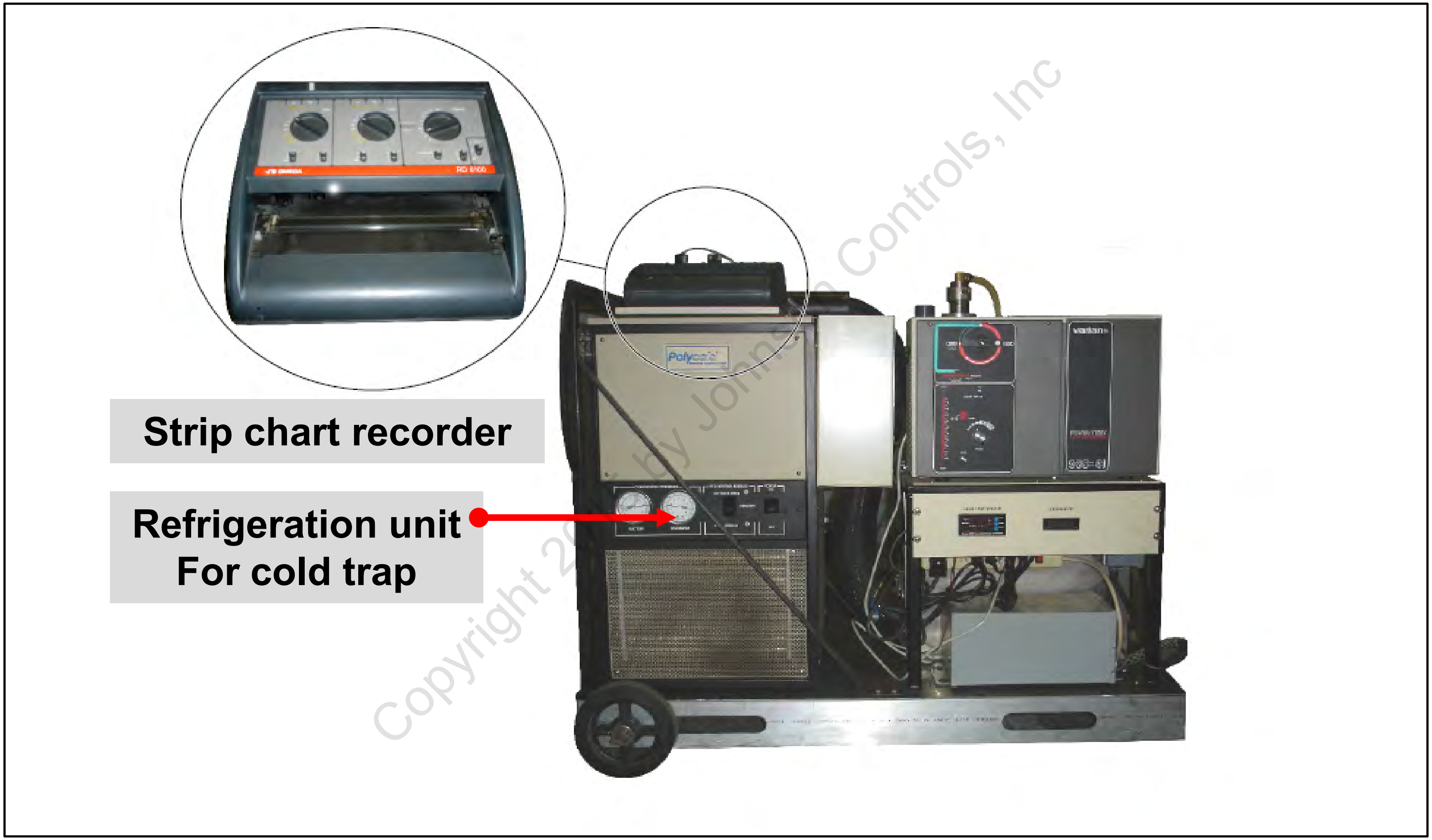
- If the HMS unit indicates helium, the operator will know that the last thing or area he sprayed is leaking
- Sometimes unit components are bagged in the same manner as the detector-probe test to aid in the testing

Leak Testing Techniques

Helium, Tracer-Probe or "outside-in" leak test drawbacks

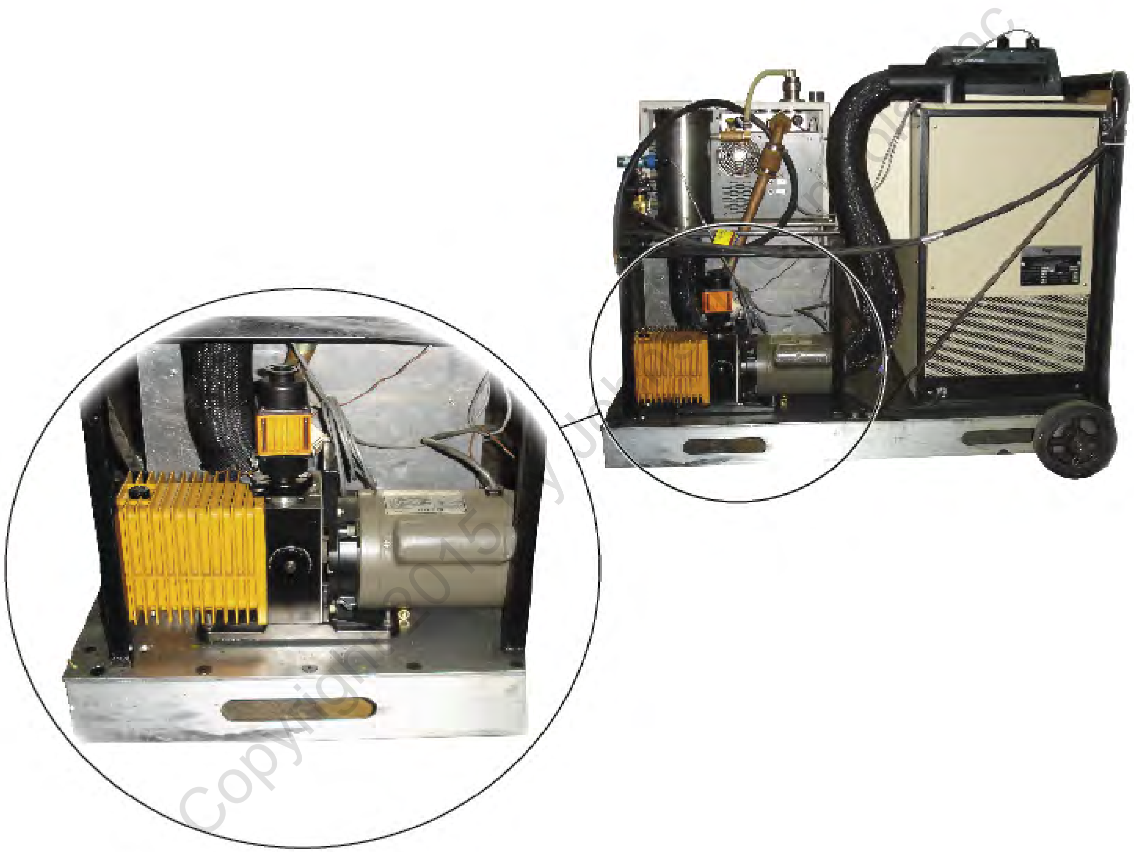
- Equipment sensitivity deteriorates during extended periods of leak checking. This lengthens the leak check time
- Some response times can be long which requires high operator skill and knowledge due to false-positive indications
- Equipment is specialized and therefore hard to obtain, maintenance costs are high, and it is not easy to transport and maneuver in tight equipment rooms

Helium, tracer-probe leak check unit




Mass Spectrometer Unit


Cold Trap

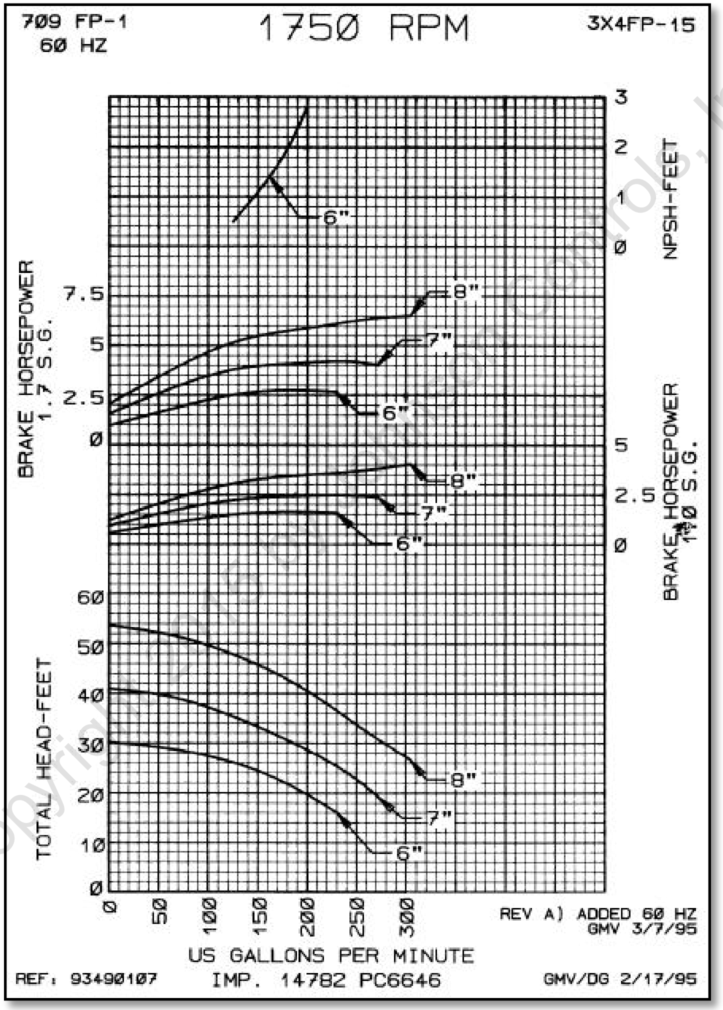


Roughing pump

Helium Leak Check Test Station in Durango, MX

Troubleshooting

- Micropanel faults
- High Generator Pressure/Temperature
- Low Refrigerant Temperature
- Low Absorber Levels
- Stubborn Crystallization Problems
- Stuck or Broken Floats
- Pumps: tripping on overloads or thermal protection
- Removing Dissolved Copper or Reducing Ammonia



709 FP-1
60 HZ
1750 RPM
3X4FP-15
BRAKE HORSEPOWER 1.7 S.G.
7.5
5
2.5
0
NPSH-FEET
3
2
1
0
6"
8"
7"
6"
BRAKE HORSEPOWER 1.0 S.G.
5
2.5
0
8"
7"
6"
TOTAL HEAD-FEET
60
50
40
30
20
10
0
8"
7"
6"
0
50
100
150
200
250
300
US GALLONS PER MINUTE
REV A) ADDED 60 HZ GMV 3/7/95
REF: 93490107
IMP. 14782 PC6646
GMV/DG 2/17/95

Section 8: Repair

Section 8: Repair

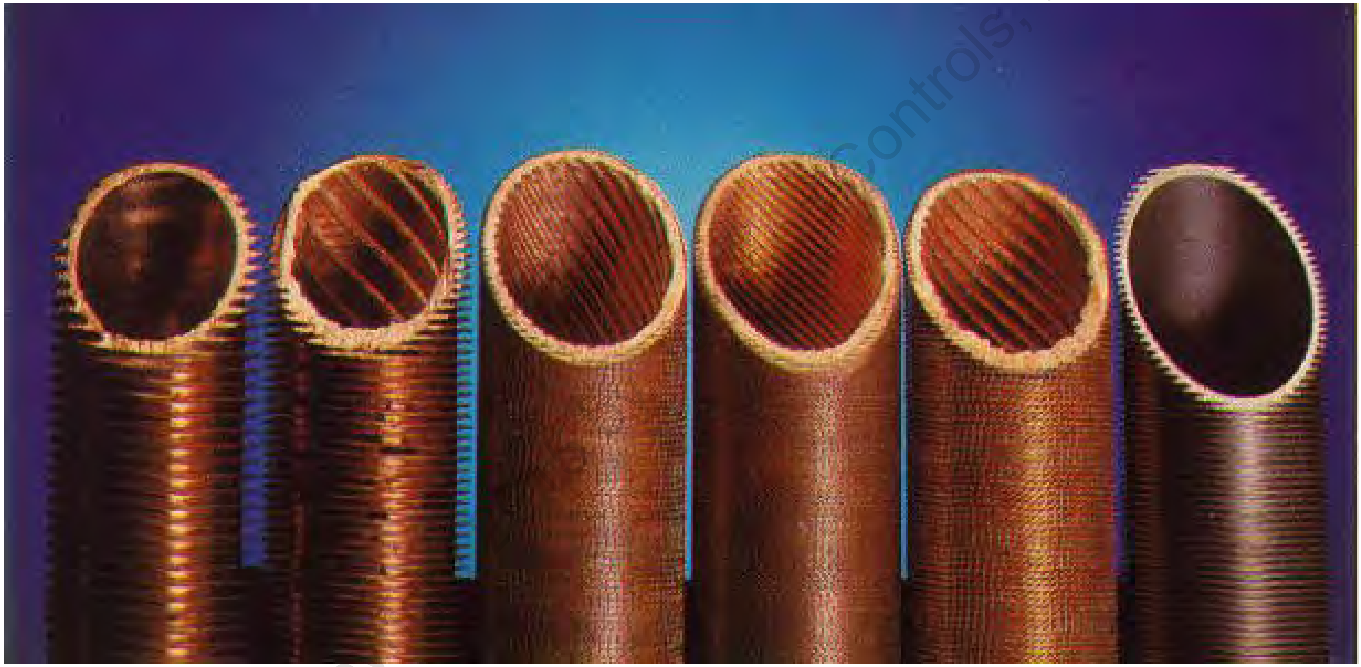
- Breaking Unit Vacuum
- Cutting and Welding
- Tube Replacement
- Steam Head Gasket Replacement
- Changing O-Rings and Diaphram
- Lithium Hydroxide Wash

Breaking Unit Vacuum

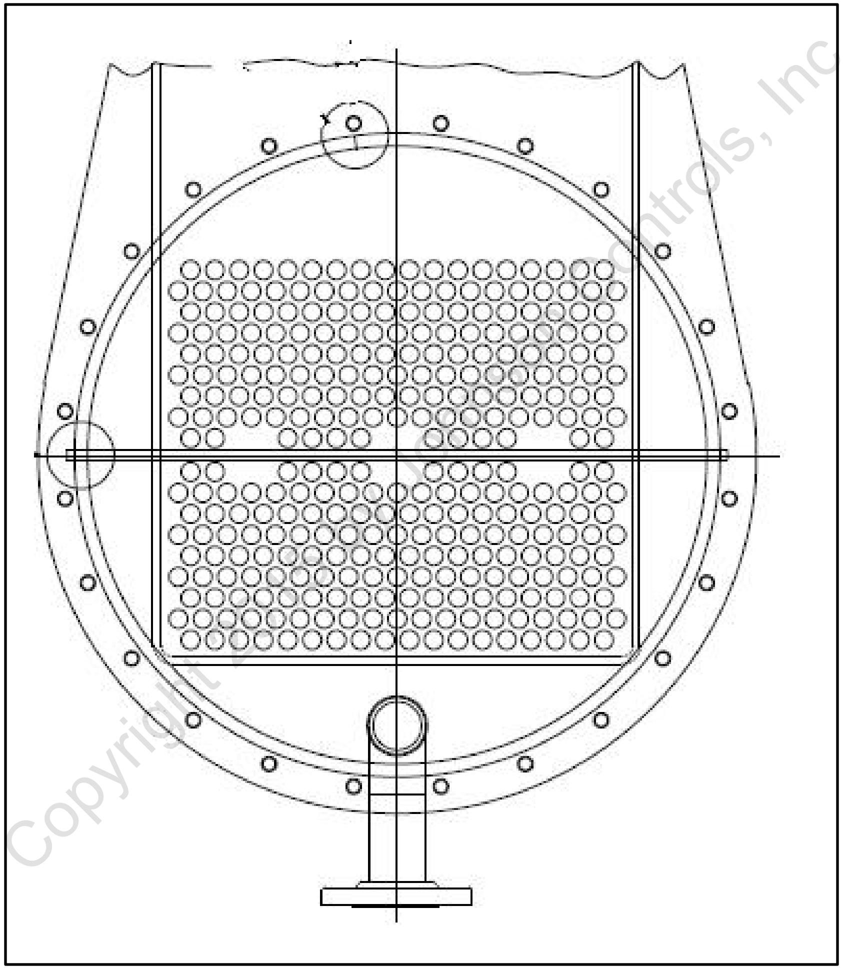
- Best Demonstrated Practice
  - Water-pumped Nitrogen
  - Valve positions
- Using Nitrogen
- Establishing Positive Pressure

Cutting and Welding

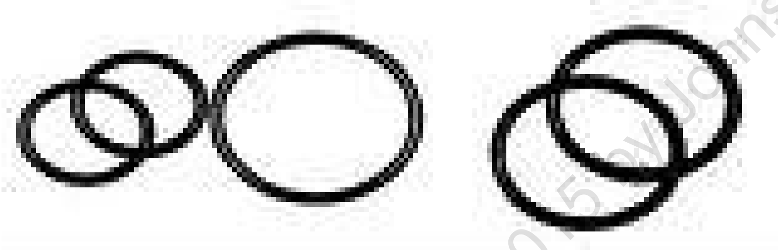
Tube Replacement



Steam Head Gasket Replacement



Changing O-Rings and Diaphram



Lithium Hydroxide Wash

Assessment

Please open up Eclicker on your iPad to take the Assessment

Resources

Review Exercise

Technical Documentation

Handouts

Scratch Pad

Review Exercises

Day 1 | Day 2 | Day 3 | Day 4 | **Resources**

7066 Review Questions

ARU Factory Order Form

Technical Documentation

Day 1 | Day 2 | Day 3 | Day 4 | **Resources**

155.16-EG3

155.16-M3.1

155.17-F1

155.16-OM1

155.16-M3

155.17-F2

155.21-OM1

155.16-RP3

155.17-F8

155.17-EG4

155.17-SU1

155.17-LS1

155.00-CH1

155.19-LS1

155.17-RA1

155.17-N1

Handouts/Paraflow Maintenance Manual

- SI0045
- Abs Proc Revealed
- C-Manual
- Flow Diagrams S Units DF
- Flow Diagrams G Units DF
- Power Flame Burner Spec Info
- Pressure Equivalents and Boiling Point Table
- Purge Log Form
- South Western Energy Drawing
- South Western Energy Factory Order Form without pricing
- South Western Energy Performance

Handouts/Paraflow Maintenance Manual (Cont'd.)

- YIA Cycle Color 1
- ISO Flow Unit Packing List
- YPC Cycle in Color
- YPC Warranty Startup Checklist
- Power Flame Burner Spec Sheet
- Refrigerant and Lithium Bromide Order
- Refrigerant and Lithium Bromide PO

Handouts/Paraflow Maintenance Manual (Cont'd.)

Burner	G Valves	Purge	Trending
Crystallization	Installation	S Unit Valves	Welding
Flow Diagrams S Units	Insulation	Solution Side	
Flow Diagrams G Units	Maint Proced	Startup	
G Unit ST Valves	Maint Sched YPC DF	Steam	
G Valve Settings	Pumps	S Valve Settings	

Scratch Pad

Scratch Pad

Scratch Pad

Scratch Pad