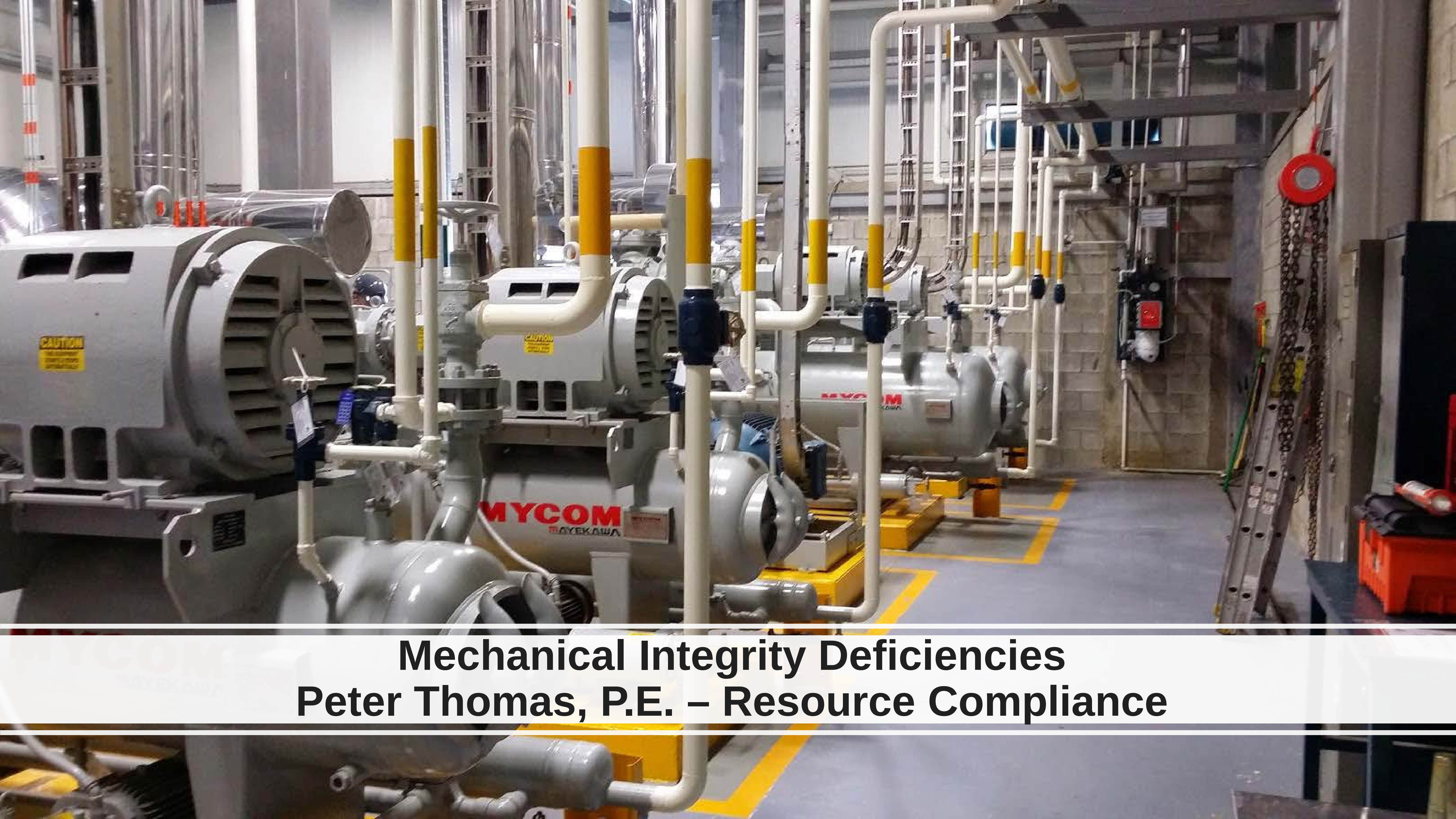
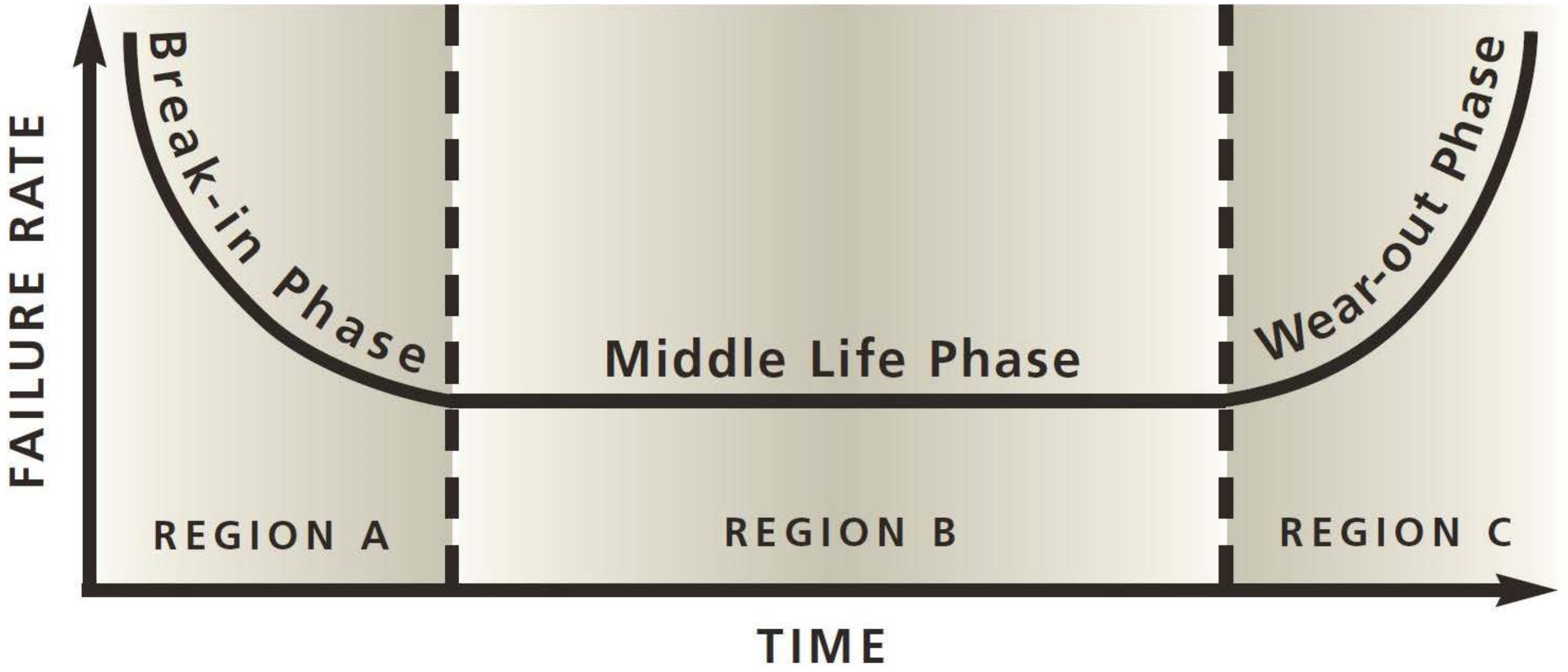


Mechanical Integrity Deficiencies

Peter Thomas, P.E. – Resource Compliance

Equipment Life Cycle



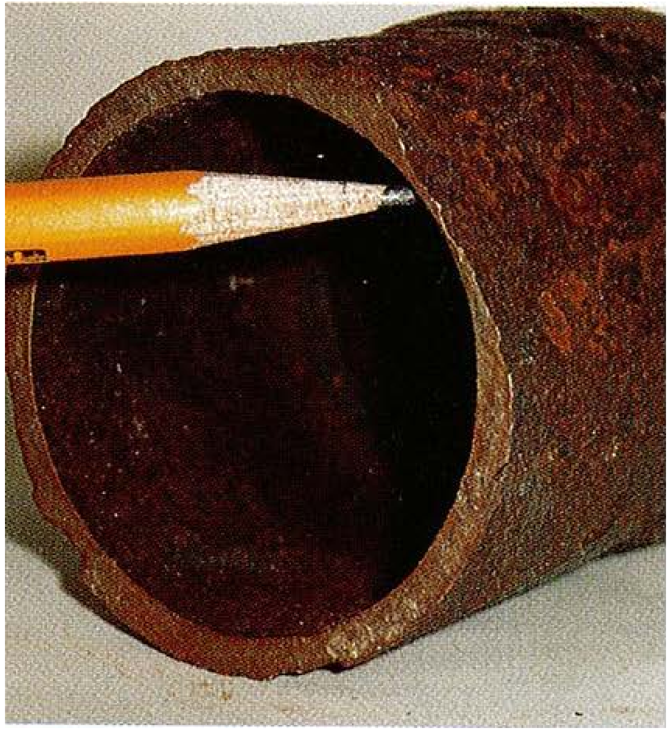
Corrosion

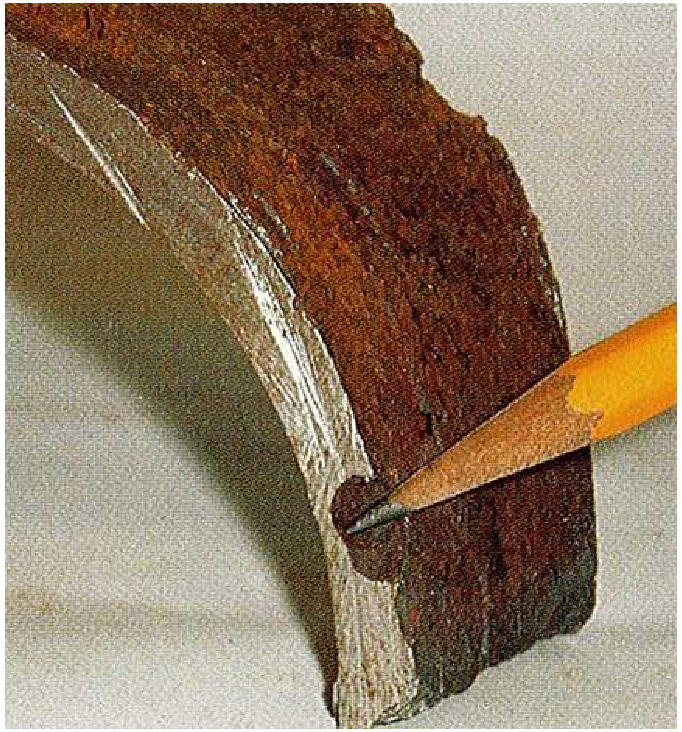

HENRY
LI-50

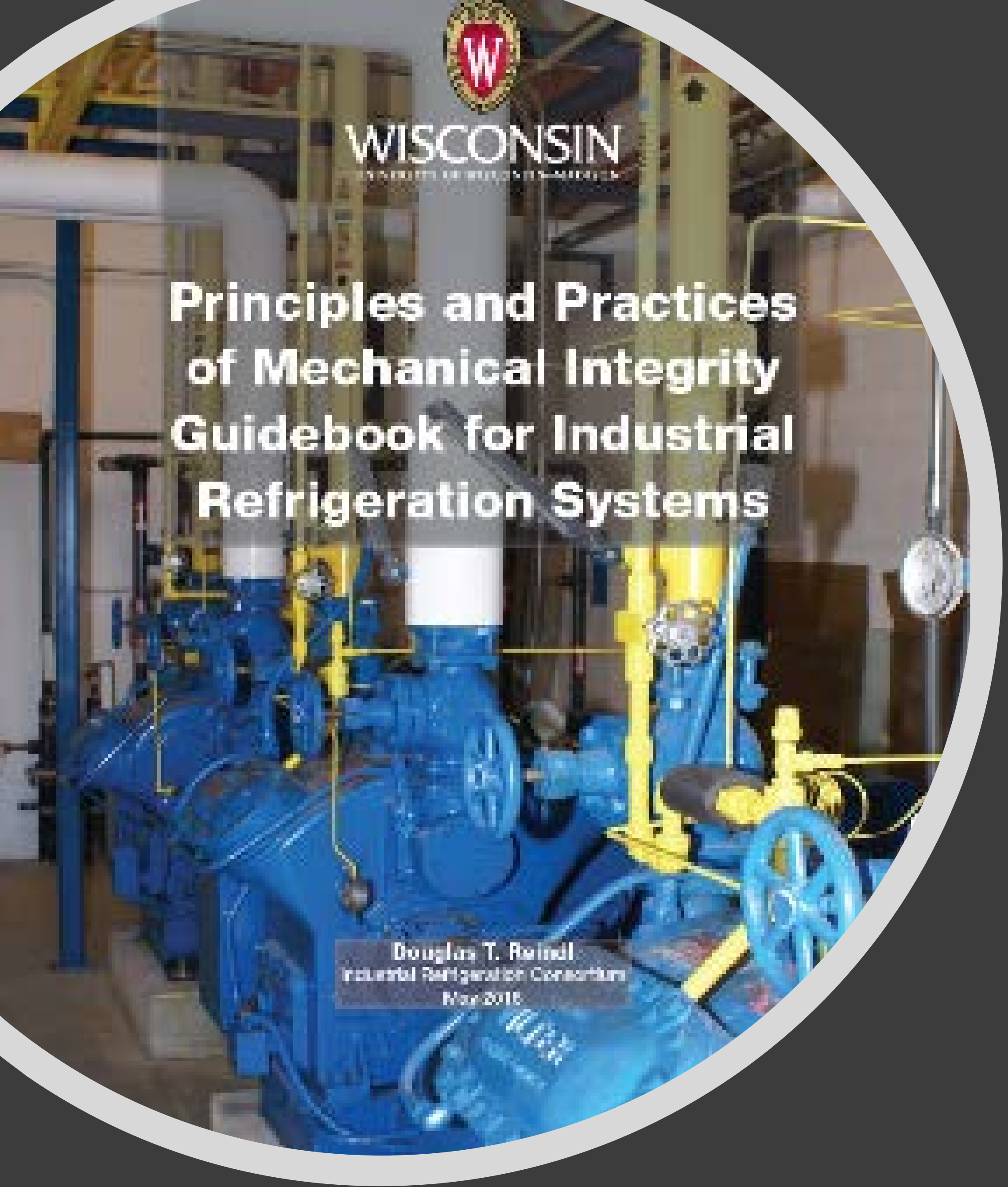

FS03
CH01


G.A.L. GAGE CO.
269-465-5750
1/8" POR
1/16" SCALE


MMONIA
AMMONIA
AMMONIA







IRC MI Guidebook

Table 4-5: Piping mechanical integrity action summary (adapted from Section 11.1.5 of RP 574).

Nominal Size (in)	Sch	Outside Diameter (in)	Nom. Wall Thickness (in)	Min Nom. Wall Thickness (in)	Wall thickness deviation from nominal (%)	Alert Wall Thickness (in)	Wall thickness deviation from nominal (%)	Replace Wall Thickness (in)	Wall thickness deviation from nominal (%)
1/2"	80	0.840	0.147	0.129	(12.5)	0.080	(45.6)	0.044	(70.0)
	160		0.294	0.257	(12.5)	0.080	(72.8)	0.080	(72.8)
3/4"	80	1.050	0.154	0.135	(12.5)	0.080	(48.1)	0.046	(70.0)
	160		0.308	0.270	(12.5)	0.080	(74.0)	0.080	(74.0)
1"	80	1.315	0.179	0.157	(12.5)	0.080	(55.3)	0.054	(70.0)
1-1/4"	80	1.660	0.191	0.167	(12.5)	0.080	(58.1)	0.057	(70.0)
1-1/2"	80	0.200	0.200	0.175	(12.5)	0.090	(55.0)	0.060	(70.0)
2"	40	2.375	0.154	0.135	(12.5)	0.100	(35.1)	0.046	(70.0)
	80		0.218	0.191	(12.5)	0.100	(54.1)	0.065	(70.0)
2-1/2"	40	2.875	0.203	0.178	(12.5)	0.100	(50.7)	0.061	(70.0)
3"	40	3.500	0.216	0.189	(12.5)	0.110	(49.1)	0.065	(70.0)
4"	40	4.500	0.237	0.207	(12.5)	0.120	(49.4)	0.071	(70.0)
5"	40	5.563	0.258	0.226	(12.5)	0.120	(53.5)	0.077	(70.0)
6"	40	6.325	0.280	0.245	(12.5)	0.130	(53.6)	0.084	(70.0)
8"	40	8.625	0.322	0.282	(12.5)	0.130	(59.6)	Requires evaluation of minimum thickess to satisfy piping design pressure	
10"	40	10.75	0.365	0.319	(12.5)	0.136	(62.6)		
12"	ST	12.75	0.375	0.328	(12.5)	0.162	(56.9)		
14"	30	14.0	0.375	0.328	(12.5)	0.178	(52.6)		
16"	30	16.0	0.375	0.328	(12.5)	0.203	(45.9)		
18"	ST	18.0	0.375	0.328	(12.5)	0.228	(39.1)		

Min Nom. Wall Thickness (in)	Wall thickness deviation from nominal (%)	Alert Wall Thickness (in)	Wall thickness deviation from nominal (%)	Replace Wall Thickness (in)	Wall thickness deviation from nominal (%)
0.129	(12.5)	0.080	(45.6)	0.044	(70.0)
0.257	(12.5)	0.080	(72.8)	0.080	(72.8)
0.135	(12.5)	0.080	(48.1)	0.046	(70.0)
0.270	(12.5)	0.080	(74.0)	0.080	(74.0)
0.157	(12.5)	0.080	(55.3)	0.054	(70.0)
0.167	(12.5)	0.080	(58.1)	0.057	(70.0)
0.175	(12.5)	0.090	(55.0)	0.060	(70.0)
0.135	(12.5)	0.100	(35.1)	0.046	(70.0)
0.191	(12.5)	0.100	(54.1)	0.065	(70.0)
0.178	(12.5)	0.100	(50.7)	0.061	(70.0)
0.189	(12.5)	0.110	(49.1)	0.065	(70.0)
0.207	(12.5)	0.120	(49.4)	0.071	(70.0)
0.226	(12.5)	0.120	(53.5)	0.077	(70.0)
0.245	(12.5)	0.130	(53.6)	0.084	(70.0)
0.282	(12.5)	0.130	(59.6)	Requires evaluation of minimum thickess to satisfy piping design pressure	
0.319	(12.5)	0.136	(62.6)		
0.328	(12.5)	0.162	(56.9)		
0.328	(12.5)	0.178	(52.6)		
0.328	(12.5)	0.203	(45.9)		
0.328	(12.5)	0.228	(39.1)		

Table 4-6: Piping inspection concern level summary for given values of wall thickness, t.

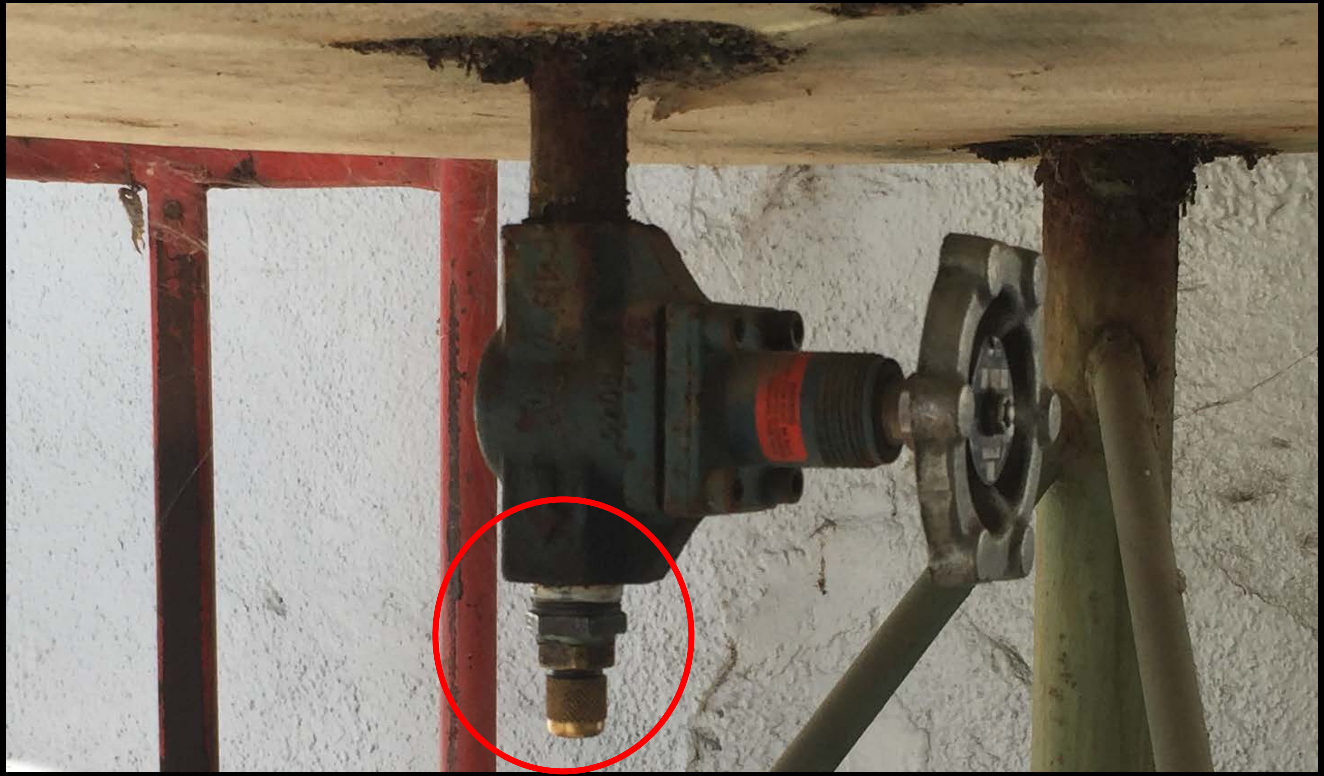
Level	Criteria	Flag	Action Required/Comments	Reference
1	$t \leq 0.3 * t_{nom}$		Piping at this wall thickness must be repaired or replaced unless an engineering analysis shows it is fit for continued operation. If the engineering analysis concludes that the piping is fit for continued operation, all active surface corrosion must be arrested and the surface coating restored without delay.	Gerber et al (1992)
2	$0.3 * t_{nom} \leq t < t_{alert}$		Piping below the alert wall thickness requires a more detailed engineering analysis to determine t_{min} for the portion of the piping system in question as a basis for evaluating its fitness for continued operation. If the measured wall thickness, t, at any location is less than the minimum allowable wall thickness ($t < t_{min}$), the pipe is not fit for continued operation and must be replaced promptly. If the pipe wall is above the minimum wall thickness, all active corrosion must be arrested/converted and the surface restored as soon as possible.	API RP 574 (2009) & ASME B31.5 (2013)
3	$t_{alert} \leq t < 0.875 * t_{nom}$		If the measured wall thickness, t, is less than nominal minus the mill tolerance but greater than t_{alert}, the piping can continue operation. As the wall thickness approaches t_{alert}, consider increased inspection frequency.	API RP 574 (2009) & ASME B31.5 (2013)
4	$t \geq 0.875 * t_{nom}$		Piping at this wall thickness is fit for continued operation. Ensure that any active surface corrosion is arrested and the surface restored in a timely manner.	Original design per ASME B31.5 (2013)


A
B

Condensers


BAC
HC01 HYBRID CONDENSER


Compatibility



Pipe Supports

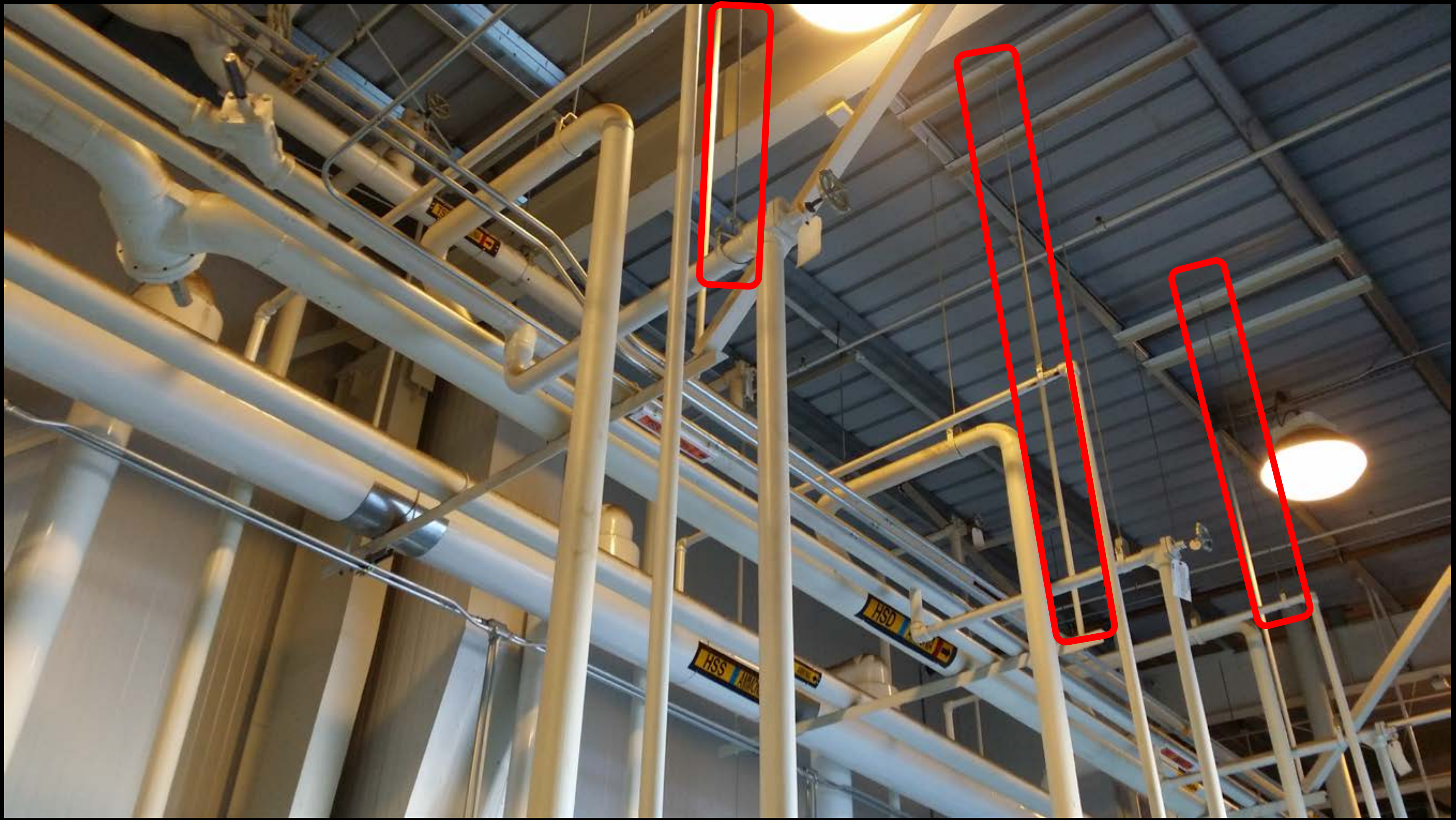
Practical Guide to SEISMIC RESTRAINT

Second Edition

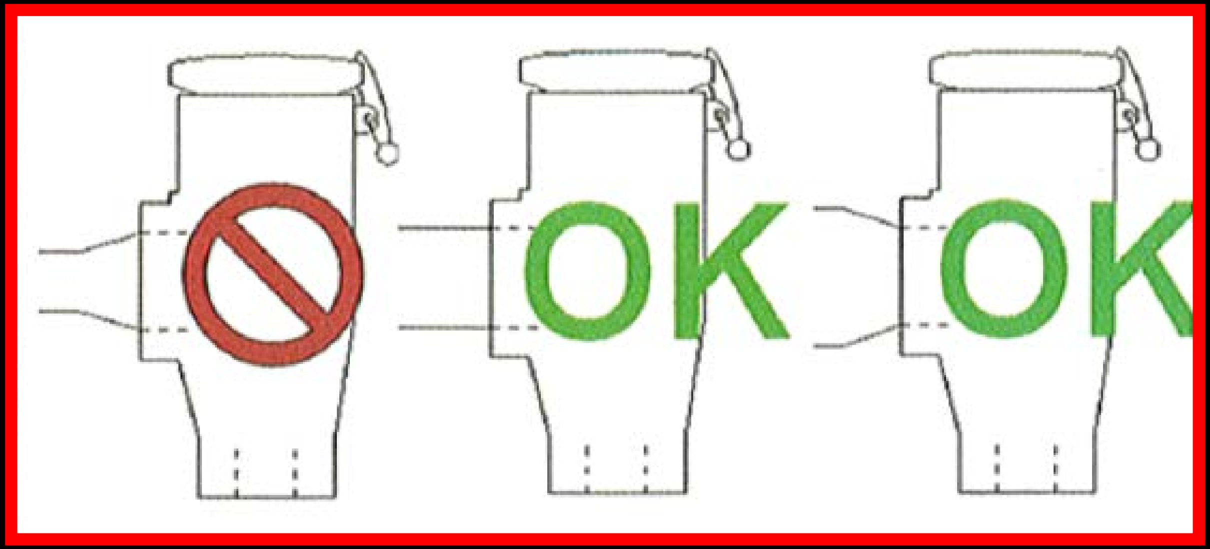
James R. Tauby
Richard Lloyd

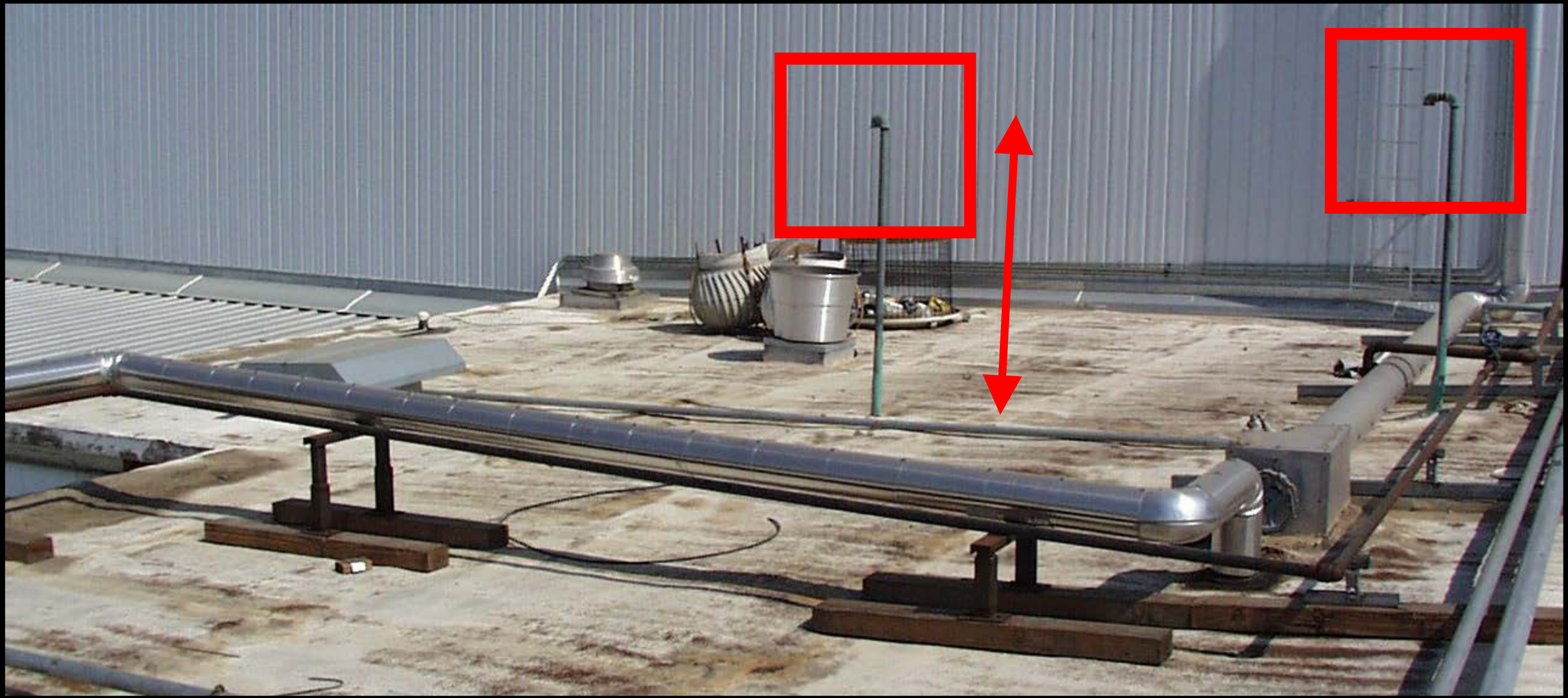
ASHRAE

INTERNATIONAL CODE COUNCIL

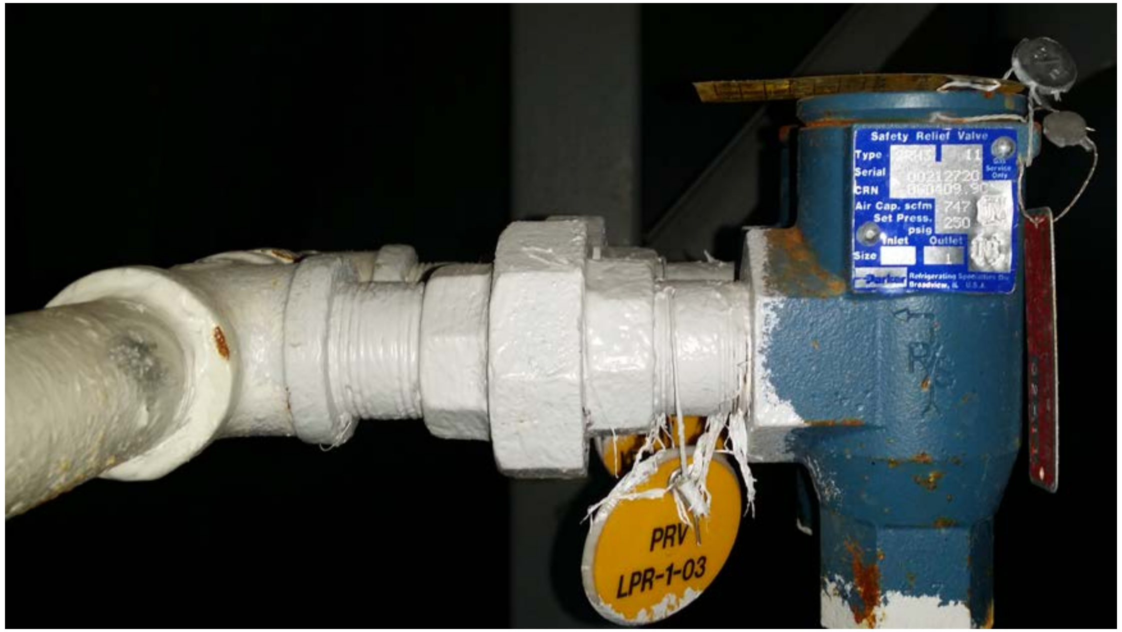

HSD
HSS

Relief Valves


OK
OK

OK
OK




Safety Relief Valve
Type
11
Gas Service Only
Serial
00212720
CRN
Air Cap. scfm
747
Set Press. psig
250
Inlet
Outlet
Size
1
Parker
Refrigerating Specialties Div.
Broadview, IL U.S.A.


PRV
LPR-1-03

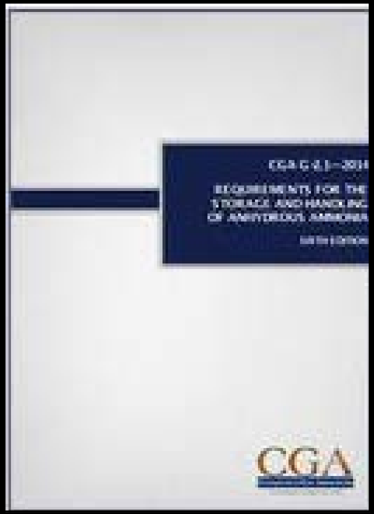

POCKET ROCKET™
The Fast and Easy Way
To Measure Diameters!
HOW TO USE:
READ HERE
INCH DIA.
PIPE SIZE
PATENT PENDING


Set Pressure (psig)	Length (ft)	Nominal Pipe Size, NPS, DN										
		½	¾	1	1¼	1½	2	2½	3	4	5	6
		15	20	25	32	40	50	65	80	100	125	150
250	*2*	16.5	30.4	50.7	89.9	124	207	298	463	803	1268	1836
250	*3*	15.5	28.8	48.6	87.2	121	203	293	457	796	1260	1826
250	*4*	14.6	27.5	46.9	84.7	118	199	289	452	789	1251	1815
250	*5*	13.8	26.4	45.2	82.4	115	196	284	446	782	1243	1805
250	*6*	13.2	25.4	43.8	80.3	113	192	280	441	775	1234	1795
250	*8*	12.2	23.6	41.3	76.6	108	186	273	431	762	1219	1776
250	*10*	11.3	22.2	39.1	73.3	104	180	265	422	750	1203	1757
250	*15*	9.8	19.6	35	66.7	95.4	168	250	401	721	1167	1713
250	*20*	8.8	17.7	31.9	61.5	88.7	158	237	383	696	1135	1672
250	*25*	8	16.3	29.5	57.5	83.3	150	226	368	673	1104	1634
250	*30*	7.4	15.1	27.6	54.1	78.7	143	216	354	652	1076	1598
250	*40*	6.5	13.4	24.7	48.8	71.5	131	200	330	616	1026	1533
250	*60*	5.4	11.3	20.9	41.7	61.5	114	176	294	558	944	1423
250	*100*	4.3	8.9	16.6	33.6	49.9	93.7	146	248	479	826	1261
250	*160*	3.4	7.1	13.4	27.2	40.6	76.8	121	207	406	710	1096
250	*250*	2.7	5.8	10.8	22.1	33	62.9	99.2	171	340	602	937

$$L = \frac{0.2146d^5(P_0^2 - P_2^2)}{fC_r^2} - \frac{d \times ln(P_0/P_2)}{6f}$$

Comparing RAGAGEPs

- **Refrigeration RAGAGEP**: ANSI/IIAR 2-2014 *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*
- **Fertilizer Storage RAGAGEP**: CGA G-2.1 – 2014 *Requirements for the Storage and Handling of Anhydrous Ammonia*



IIAR 2-2014

- ANSI/IIAR 2-2014 §15.3.7.2.1 Overpressure Due to External Fire
- The required discharge capacity of a pressure relief device for each pressure vessel shall be determined by the following equation:

  - $C = f \cdot D \cdot L$ (lb/min)
- Where
- C = required discharge capacity of the relief device, lb air/min
- f = capacity factor of the relief device, which is 0.5 for ammonia
- D = outside diameter of vessel, ft
- L = length of vessel, ft

CGA G-2.1 - 2014

- CGA G-2.1 – 2014 §5.8.6
- Pressure relief valves for excessive heat or fire protection used on containers covered by Sections 6, 11, and 12 shall be constructed to discharge at not less than the rates required in Appendix A before the pressure is in excess of 121 % of the MAWP of the container. Relief protection for any other reason shall use ASME UG-125, UG-126, UG-127, UG-128, UG-129, UG-130, UG-131, UG-132, UG-133, UG-134, UG-135, and UG-136.

CGA G-2.1 - 2014

- CGA G-2.1 – 2014 Appendix A
    - Flow rate ft^3/min air = $22.11 \times A^{0.82}$
- Where:
- A = outside surface area of the container in square feet
- Cylindrical container with hemispherical heads
- Area = overall length (ft) x OD (ft) x 3.1416

Example

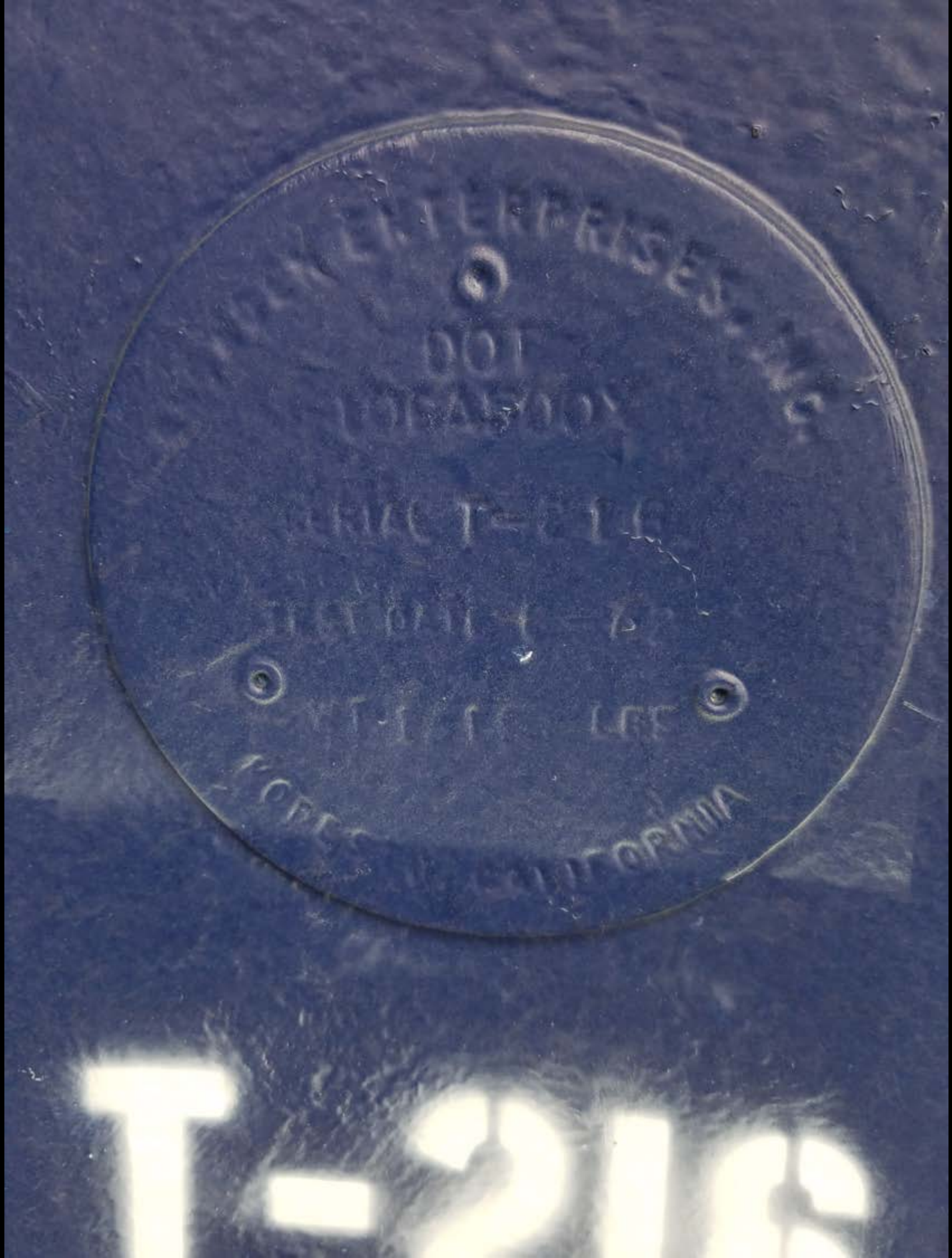
- **Vessel Dimensions**: 8’-0” Diameter x 40’-0” Long

Comparison

- Same vessel, same chemical:
- **IIAR 2**: 2,094.24 cfm_{air}
- **CGA G-2.1**: 6,404.36 cfm_{air}

Ton Containers


SNOWDEN ENTERPRISES, INC.
INHALATION HAZARD
2
CORROSIVE
8
FRESNO, CA (559) 237-5546
SULFUR DIOXIDE
UN 1079
T-216
5


ENTERPRISES
DOT

7.9.3

Connections to the ton container should be by means of a yoke and adapter (see figure 13) or by use of a union adapter connected directly to the valve. The yoke and adapter is recommended. Unloading should be through a flexible coil of copper tubing of 3/8-inch (9.52-mm) inside diameter or through a braided flexible hose of approved manufacture.

Ventilation


Frick


EXTECH
926
897
EXTECH


ON
DANGER
OFF
EXHAUST FAN #2

AMMONIA
DISCH. AMMONIA
AMMONIA


FD AMMONIA
FD AMMONIA
FIRE DEPARTMENT
Emergency Ventilation
Anhydrous Ammonia
Control Box
Keys in Knox Box

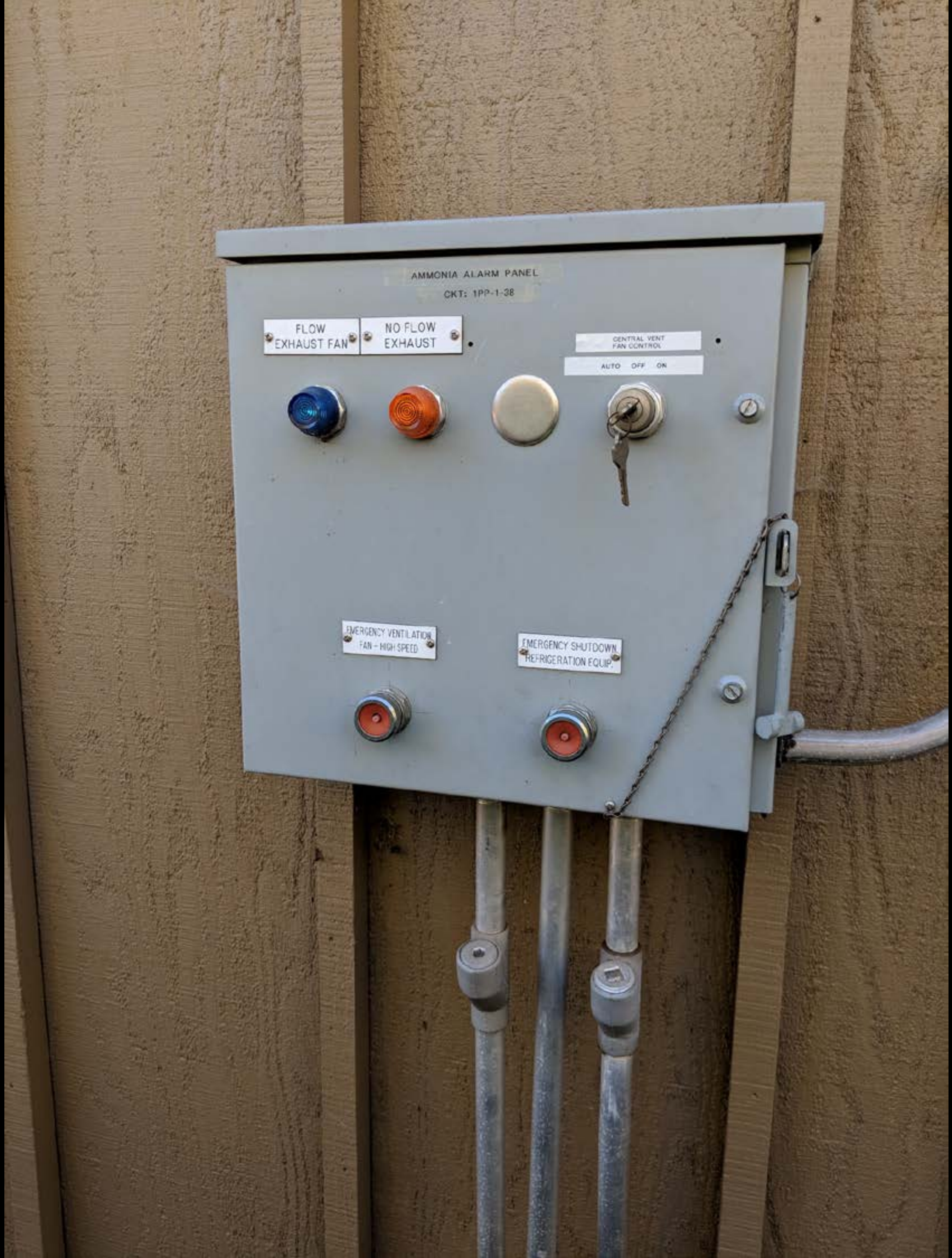

HANSEN
Gas Sensor

RIGHT TO KNOW
COMPLIANCE CENTER
BRADY
SAFETY DATA SHEETS
GHS
LTRS
AMMONIA
5 1 2 3 4
-100


COOLER

CONTROL POWER
EVAPERATIVE COOLER
EXHAUST FAN
ALARM
ADSORBSION ALARM
HIGH LEVEL FLOAT
COND #1 WATER PUMP
COND #1 FAN
HAND OFF AUTO
HAND OFF AUTO
QUICKPANEL jr.
REFRIGERATION MAIN SCREEN
ROOM CONTROL
PRECOOL #1
PC1 TUNNELS
COND CONTROL


GP 01



AMMONIA ALARM PANEL
CKT: 1PP-1-38
FLOW EXHAUST FAN
NO FLOW EXHAUST
CENTRAL VENT FAN CONTROL
AUTO OFF ON
EMERGENCY VENTILATION FAN - HIGH SPEED
EMERGENCY SHUTDOWN REFRIGERATION EQUIP.

Air-Cooling Evaporators

Detection


CLASS I GR CD CLASS II GR EFG CLASS III
USE ONLY ON C-H GUB 4P35
AS02/IR


GasGuard VL2-NH3
AMMONIA SENSOR
Calibration Technologies Inc.
Specialists in Gas Detection
866-394-5861
Factory Cal May, 2017
Due November, 2017
Calibration Technologies Inc.

Current Step	6	Alarm
Step #1	CompRm #1	1000
Step #2	CompRm #2	1000
Step #3	CompRm #3	1000
Step #4	CompRm #4	1000
Step #5	Pre-cool #8	50
Step #6	Pre-cool #9	50

Heat Exchangers

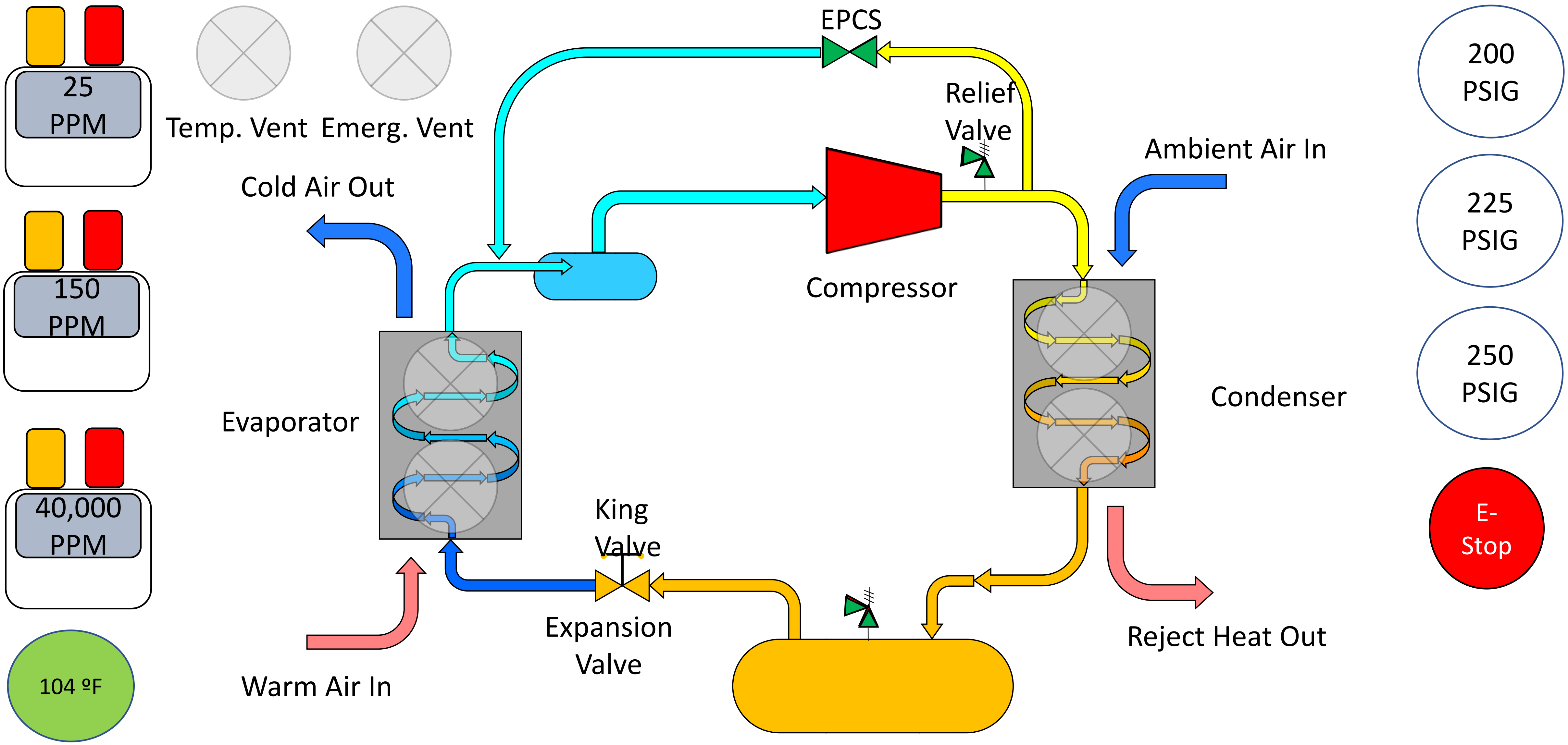
Housekeeping

Physical Protection


EV10

Questions?

pthomas@resourcecompliance.com


25 PPM
150 PPM
40,000 PPM
104 ºF
Temp. Vent
Emerg. Vent
Cold Air Out
Evaporator
Warm Air In
EPCS
Relief Valve
Compressor
King Valve
Expansion Valve
Ambient Air In
Condenser
Reject Heat Out
200 PSIG
225 PSIG
250 PSIG
E-Stop