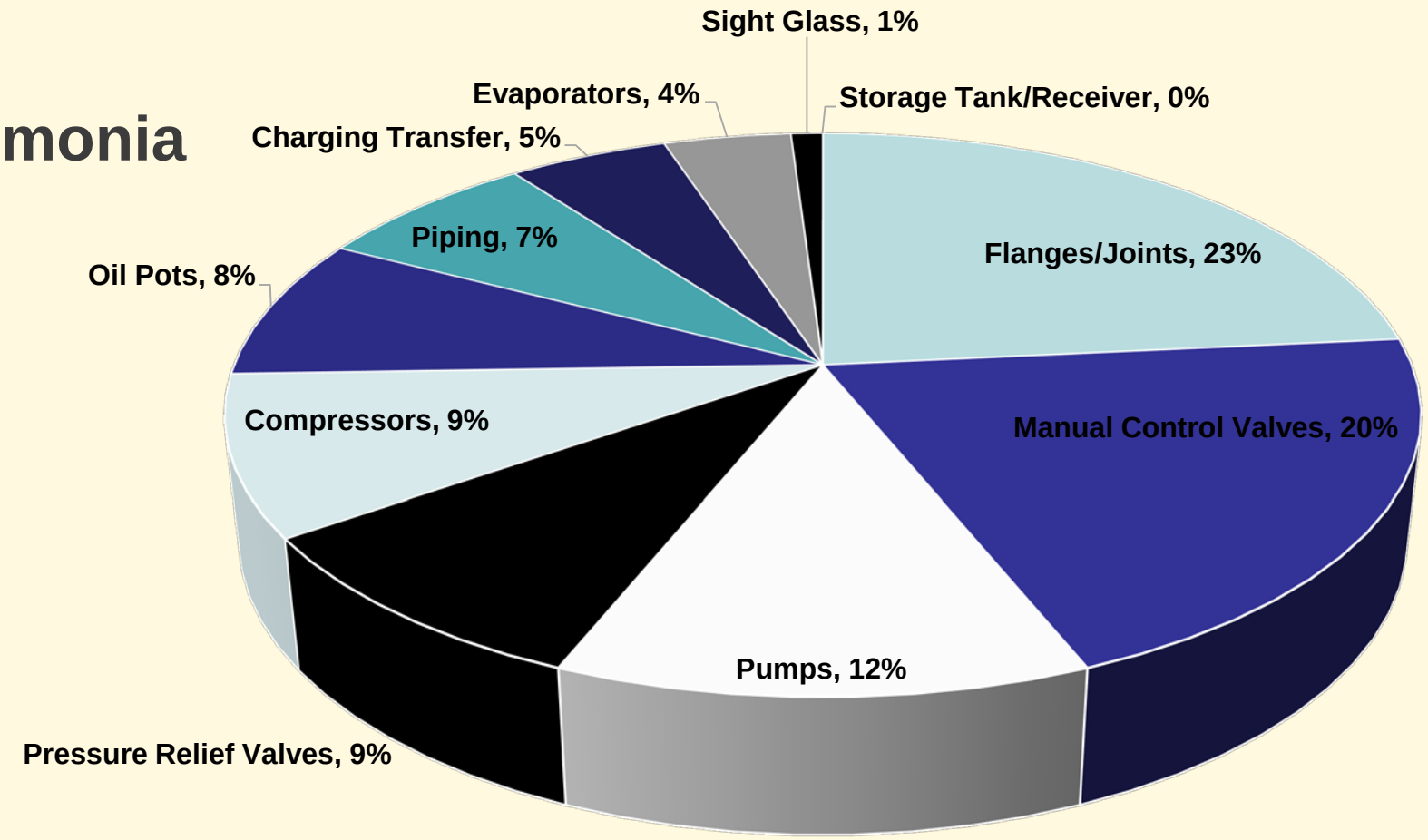
Mechanical Integrity

Common Findings and Recommendations

Peter Thomas, P.E., CSP – Resource Compliance, Inc.

IIAR Survey

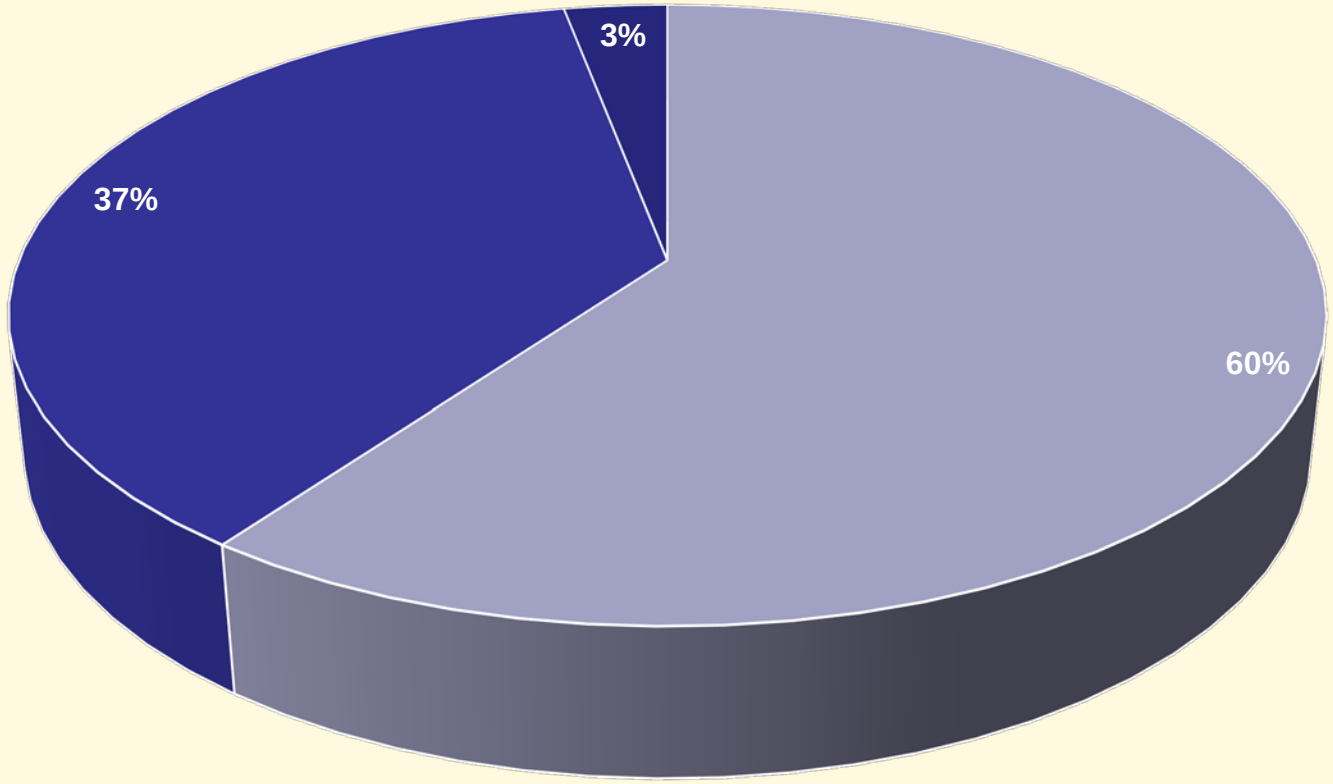
Where do most ammonia releases occur?



IIAR Survey

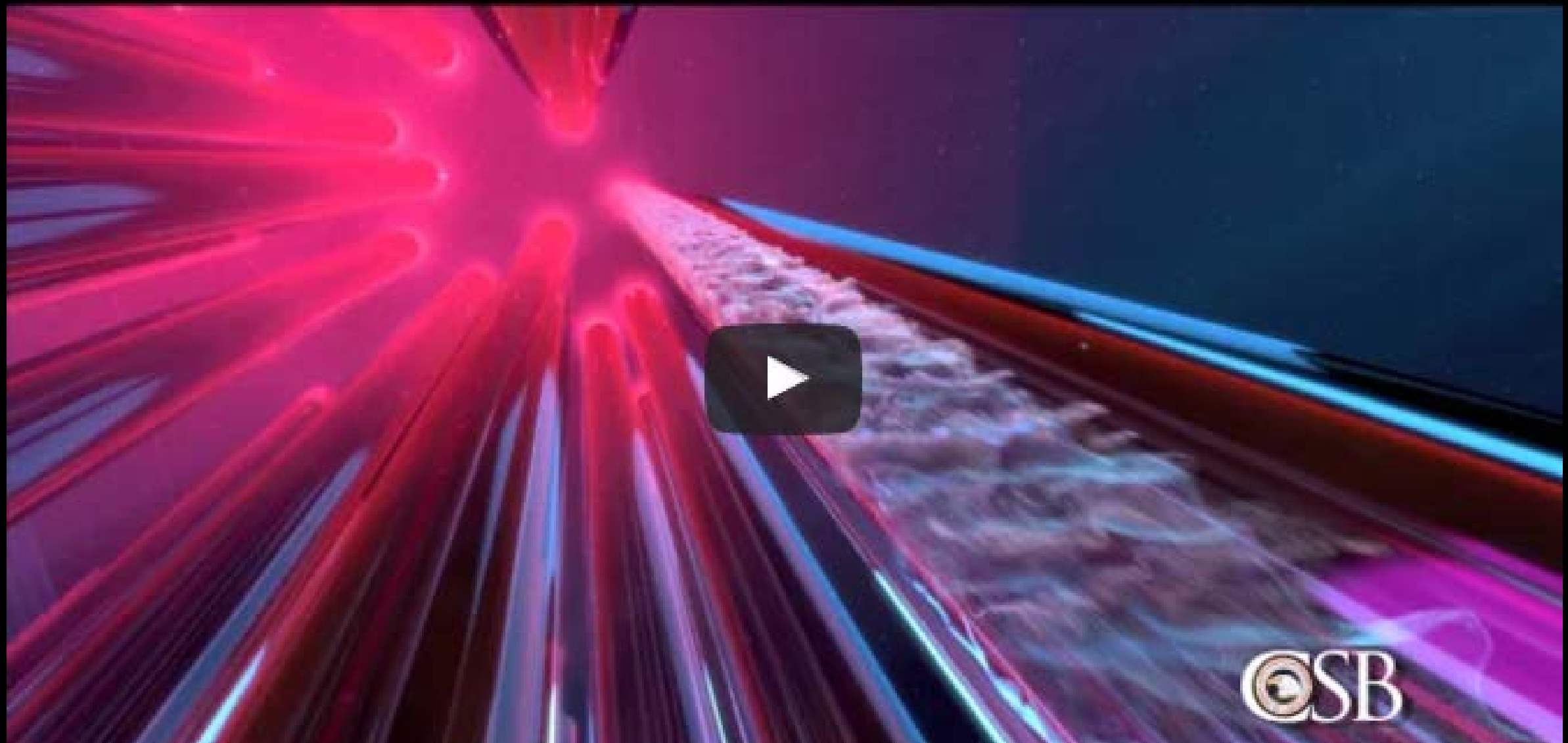
Why do most ammonia releases occur?

- Human Error
- Mechanical Failure
- Other (Natural Disaster, Fire, Ammonia Theft, etc.)




WHITLEY AVE

Shock to the System




MECHANICAL ROOM
REFRIGERATION
MACHINERY ROOM
AUTHORIZED PERSONNEL ONLY
CAUTION
AMMONIA
R-717
CAUTION
EYE AND EAR
PROTECTION REQUIRED
IN THIS AREA
3
3
0


NOTICE
EMPLOYEES
ONLY
DANGER
ANHYDROUS
AMMONIA


TENNANT


REFRIGERATION
MACHINERY ROOM
AUTHORIZED PERSONNEL ONLY
CAUTION
AMMONIA
R-717
CAUTION
3
3
0


Dräger
Polytron TX
Adj


CAUTION
BATTERY CHARGING
STATION
NO SMOKING
OR OPEN FLAMES
CAUTION
EYE PROTECTION
MUST BE WORN
IN THIS AREA


Gas Sensor
NH3 SENSOR
EC-F9-0/100-N1
Manning
Systems, Inc.


REFRIGERATION
AMMONIA
EMERGENCY STOP
EMERGENCY MECHANICAL ROOM VENTILATION
EXHAUST FAN FLOW
CENTRAL MECHANICAL ROOM VENTILATION
HAND
OFF
AUTO
SUCTION ACCUMULATOR HIGH LEVEL
EXHAUST FAN NO FLOW
ENGINE ROOM AMMONIA
ALARM SILENCE
ALARM RESET


EMERGENCY REFRIGERATION SWITCH BREAK GLASS
EMERGENCY VENTILATION SWITCH BREAK GLASS
Telemecanique

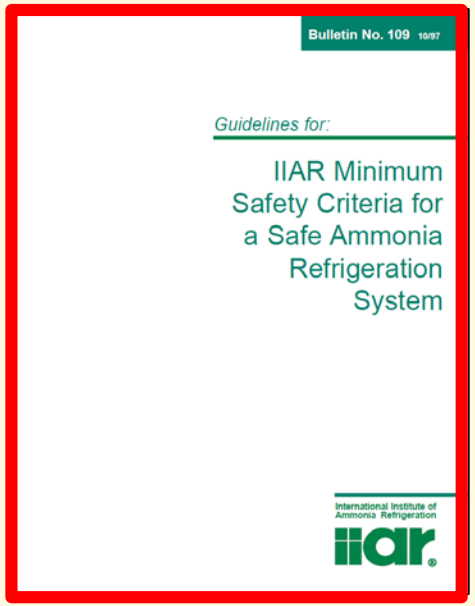

Safety Relief Valve
Type
Serial
Set Pressure
psig
Air Capacity
scfm
Inlet
Outlet
Size
Parker

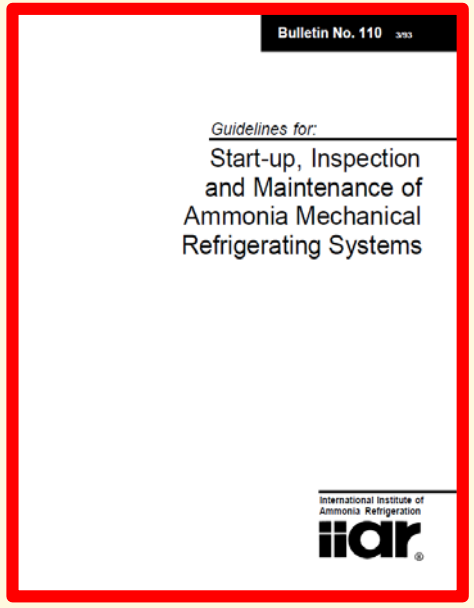

GLOBAL
globalindustrial.com

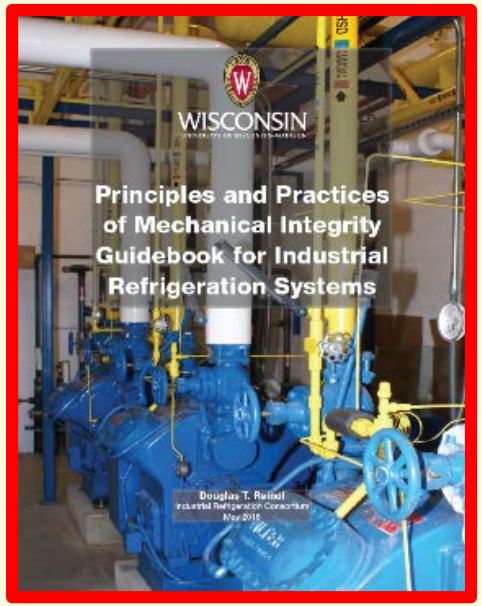

ASME SA53/SA106 GR.B/API 5L B PSL1/NACE MR 0175/
NDE/B.BLG 892/3.53 LBS/FT/IND'A.

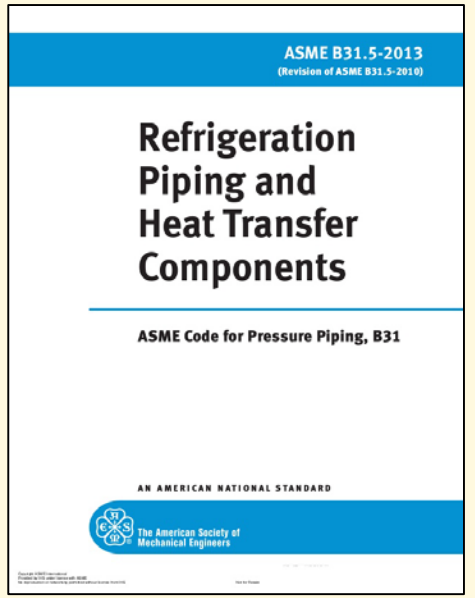
Pipe Wall Thickness

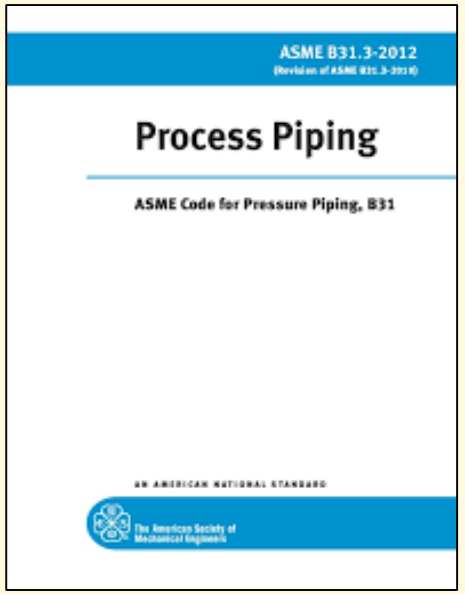
Key RAGAGEP documents











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)		

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

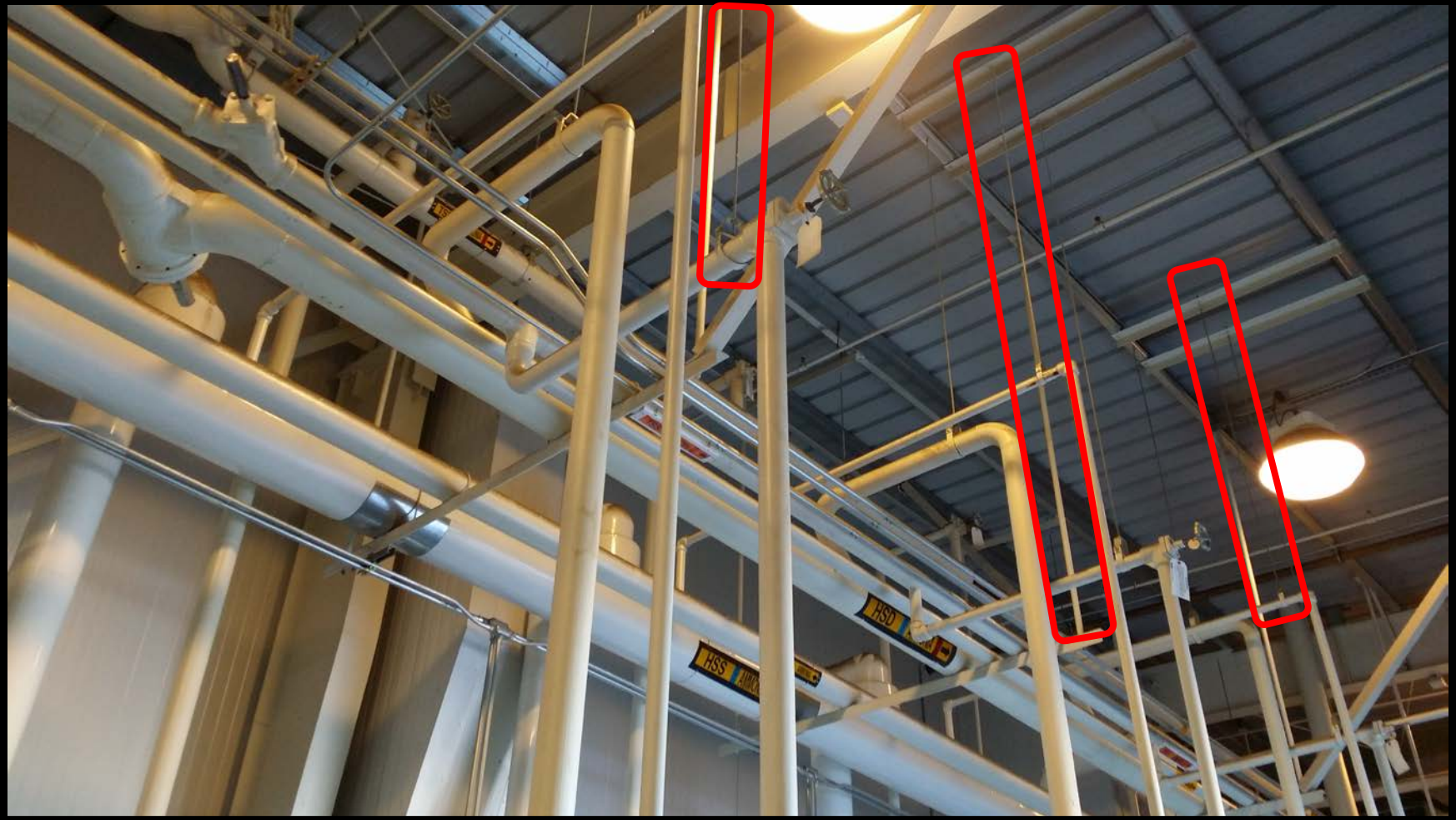
Level	Criteria	Flag	Action Required/Comments	Reference
1	$t \leq 0.3 * t_{nom}$		Piping at this wall thickness must be repaired or replaced unless an engineering analysis shows it is fit for continued operation. If the engineering analysis concludes that the piping is fit for continued operation, all 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)


AMMONIA

Pipe Supports

- ANSI/IIAR 2-2014 Appendix F

Nominal Pipe Size	Maximum Span	Minimum Rod Diameter
Up to 1	7	1/8
1-¼ - 1-1/2	9	3/8
2	10	3/8
2-1/2	10	1/2
3	12	1/2
4	14	5/8
5	16	5/8
6	17	3/4
8	19	7/8
10	22	7/8
12	23	7/8


HSS
HSD

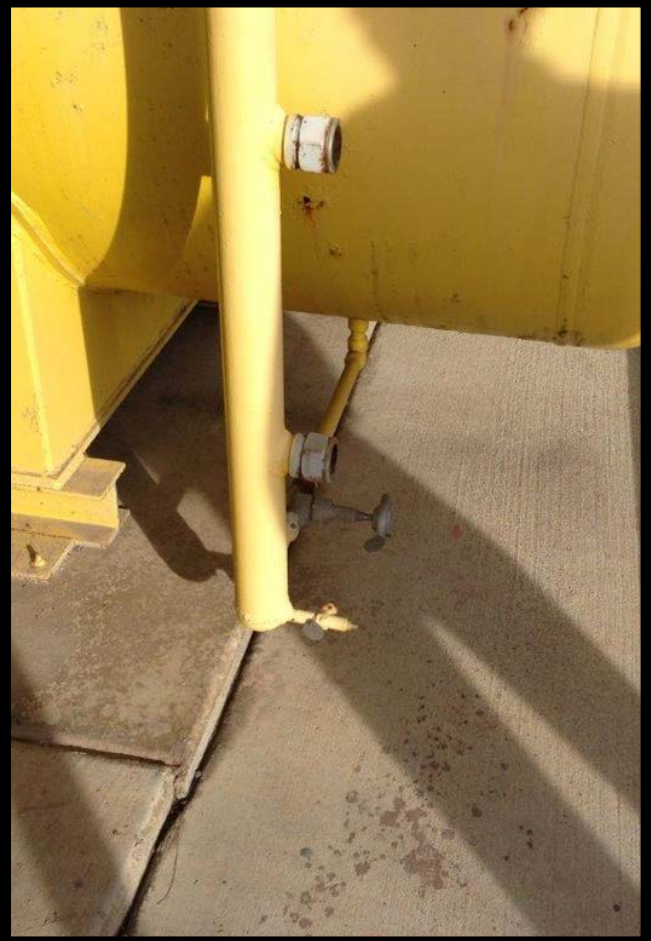

Frick

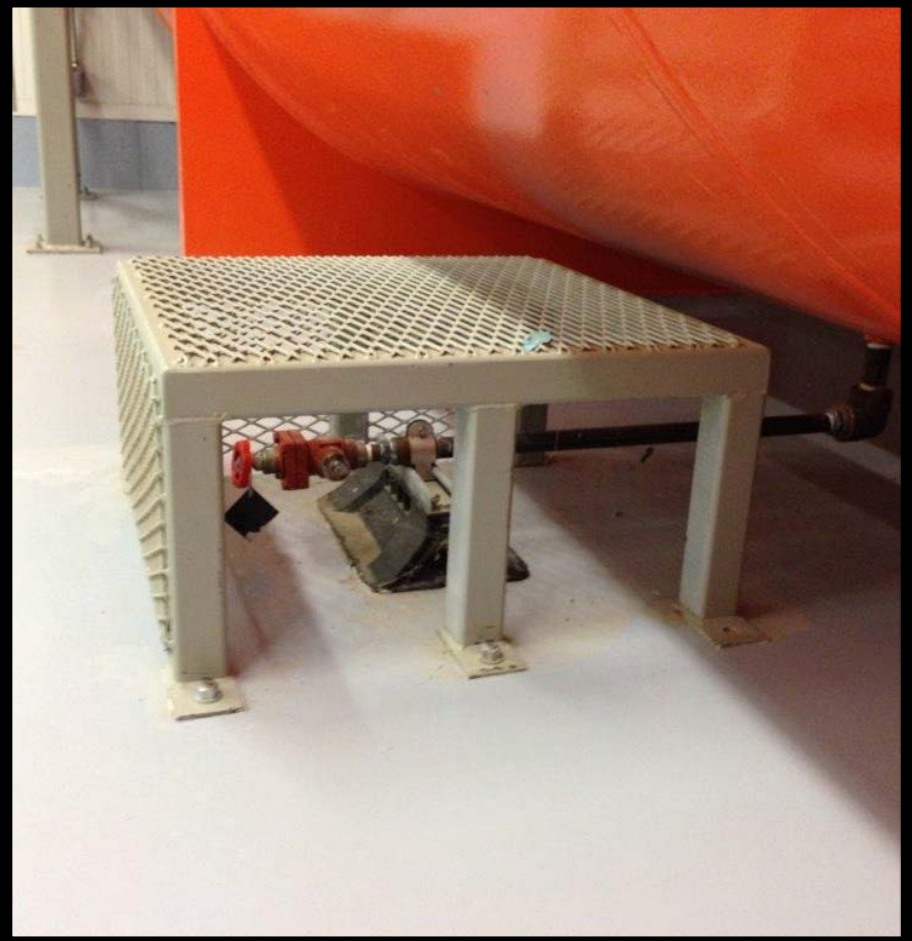
Service Provision

- **Maintenance Accommodation**
  - Equipment shall be accessible for maintenance, as required by the Mechanical Code. [ANSI/IIAR 2-2014 §5.12.1]
  - Shell and Tube Condenser [ANSI/IIAR 2-2014 §10.4.4]
  - Plate Heat Exchanger Condenser [ANSI/IIAR 2-2014 §10.5.4]
  - Double-Pipe Condenser [ANSI/IIAR 2-2014 §10.6.4.1]
  - Shell and Tube Evaporator [ANSI/IIAR 2-2014 §11.3.1.4, ANSI/IIAR 2-2014 §11.3.2.4]
  - Plate Heat Exchanger Evaporator [ANSI/IIAR 2-2014 §11.4.4]
  - Scraped Surface Heat Exchanger [ANSI/IIAR 2-2014 §11.5.4]
  - Pressure Vessels [ANSI/IIAR 2-2014 §12.6.1]

Safe Access

- **Valves**
  - Stop valves shall be readily accessible from the machinery room floor or a level platform [2013 CMC §1112.3]
  - Manually operated valves that are inaccessible from floor level shall be operable from portable platforms, fixed platforms, ladders, or shall be chain operated. [ANSI/IIAR 2-2014 §6.3.3.1]
  - Manually operated isolation valves identified as being part of the system emergency shutdown procedure shall be directly operable from the floor or chain operated from a permanent work surface. [ANSI/IIAR 2-2014 §6.3.3.2, §13.3.7]
  - Relief device arrangements shall be configured to allow access for inspection, maintenance, and repair. [ANSI/IIAR 2-2014 §15.2.3]
  - Similar requirement dating back to 1978






VILTER
SERIAL NO
MADE IN USA

Questions?

Peter Thomas, P.E.

(559) 994-0162

pthomas@resourcecompliance.com