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What is Non Destructive Testing

Non-Destructive Testing (NDT) is the use of technology to examine an object or material's structure, imperfections, composition or properties without destroying or compromising the object or material's future use.

NDT provides information about state of material that one cannot capture visually or would require a great deal of manual effort.

Used in every industry that relies on a piping infrastructure, results from NDT give the information necessary for informed decision-making.

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Why Companies Employ NDT

- To meet regulatory requirements
- To reduce manual evaluation time and save money related to planning and maintenance initiatives
- To ensure the mechanical integrity of their piping system
- To support evidence- based vs assumption-based decision making
- To keep their facilities safe

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NDT for the Ammonia Industry

While the ammonia industry has been using NDT for years to evaluate systems, testing is becoming recognized as a necessity for mechanical integrity compliance.

IIAR 6 recognizes there are integrity standards that cannot be met with visual inspection only, hence the addition of the ‘testing’ requirement.

Per the Standard, testing should be performed when the state of a component cannot be determined by visual inspection and at minimal timeframe intervals independent of visual inspection.

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NDT for the Ammonia Industry

Ammonia refrigeration owns a set of characteristics that differentiates it from other industries that use NDT:

+ Insulation is important to the process of refrigeration
+ Water trapped inside insulation causes *Corrosion Under Insulation* **(CUI)**
+ CUI, or pipe and vessel external **corrosion**, is the primary damage mechanism that affects the integrity of ammonia piping and vessels – and why piping fails.
+ The ammonia industry uses NDT to detect water or ice in insulation, the presence of corrosion, and the material wall thickness

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CUI – Corrosion Under Insulation

CUI is THE cause of failed piping in ammonia systems.

1. Water trapped in or under insulation in contact with the pipe.
2. Corrosion forms
3. Loss in pipe wall material (pitting)
4. *Pipe failure*

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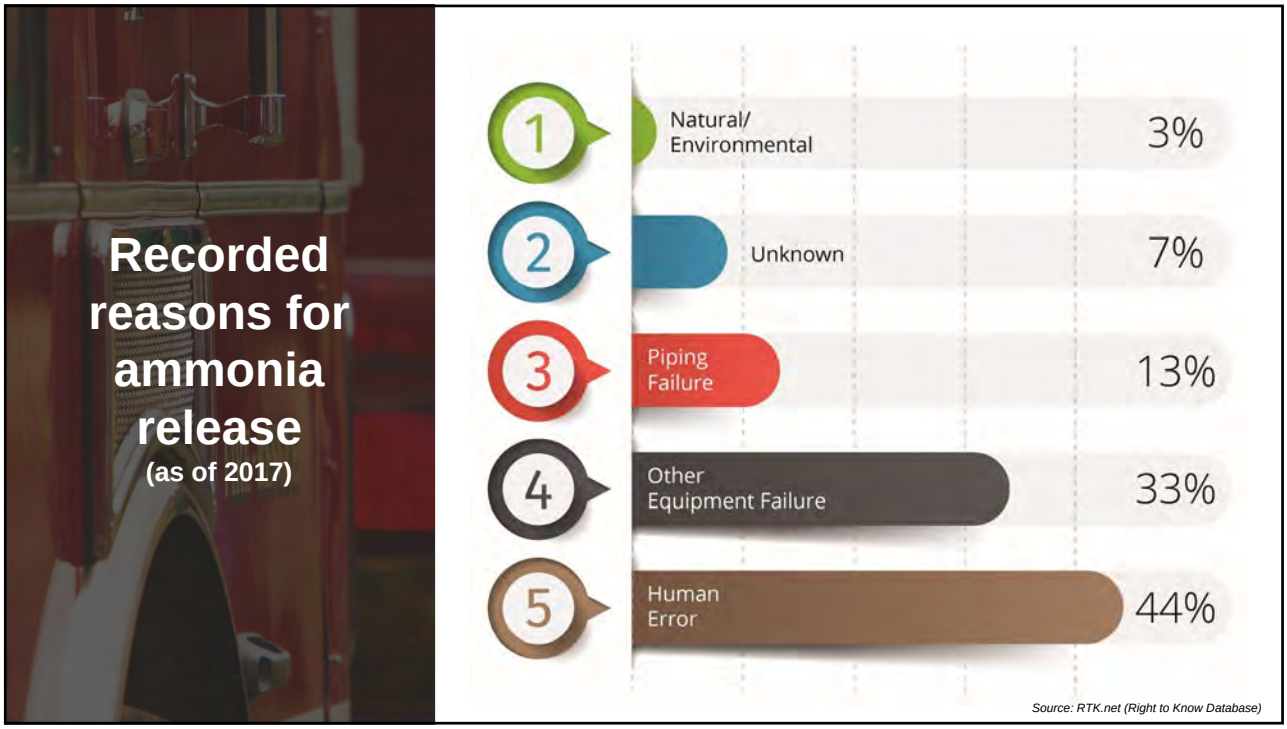

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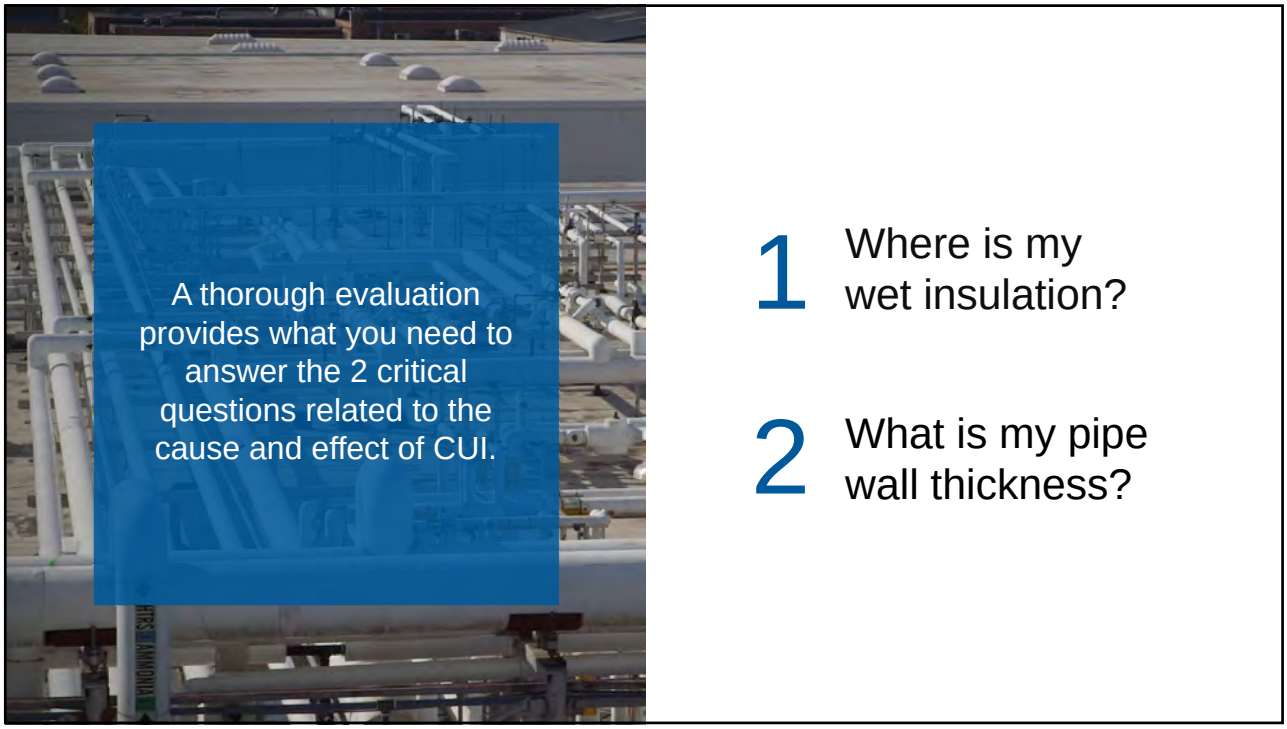

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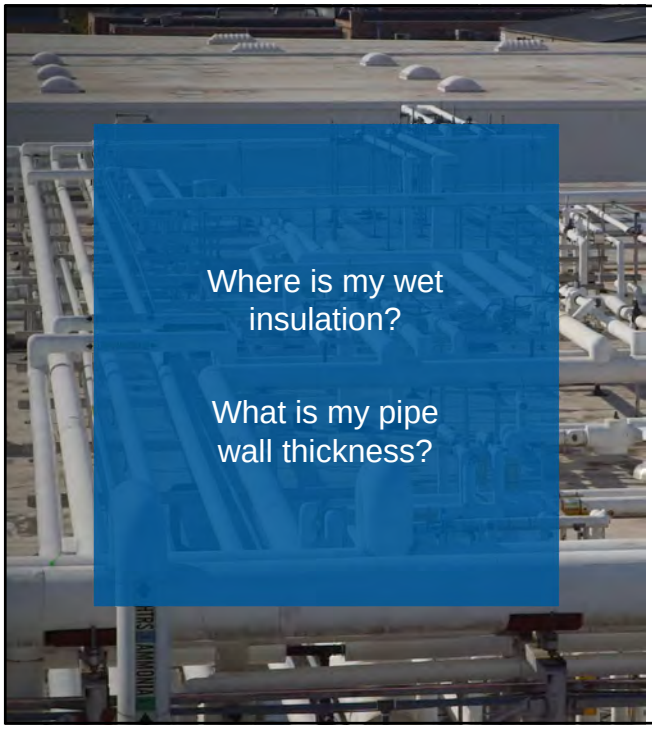

Considerations

1. **You don't want to create breaks** in the insulation vapor barrier.
2. **You can't rely on visual** to detect or measure anything under insulation.
3. **You need to measure pipe** to determine how much metal remains.
4. **You need all locations where damage is likely to occur checked** and not limited to areas indicated suspect as a result visual inspection or where it is most convenient to access.

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You don't want to create breaks in the insulation vapor barrier.

Atmospheric moisture enters the jacketing like snow through a coat sleeve – even the tiniest crack is vulnerable.

The most common entry point is at the joints…and then the moisture travels.

This moisture eventually forms water directly on your pipe, just as it does on your glass of iced tea on a hot summer day.

The water becomes trapped in the insulation.

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You can't rely on visual to detect or measure anything under insulation.

Capabilities of Visual Inspection

for Piping and Vessels

Conditions & Metrics	UNINSULATED		INSULATED	
	Detected	Undetected	Detected	Undetected
Damaged Jacketing	-	-	●	
Visible wet insulation	-	-	●	
Concealed wet insulation	-	-		●
Corrosion	●			●
Pipe wall thickness		●		●
Pipe size	●			●
Pipe schedule		●		●
P&ID verification		●		●

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The Truth About CUI

1. CUI is an inside > out process. Moisture accumulates inside the insulation before you can see it on the outside of the pipe.
2. By the time ice forms on the outside of the jacketing, the insulation is saturated and has been wet for a very long time.
3. Most of the water trapped in insulation is hidden under the jacketing – you can't see it.

Water trapped in insulation can look like this:

Though it usually looks like this:

100%

of the facilities we test have hidden water trapped in insulation.

30%

of piping in a facility has water trapped in insulation.

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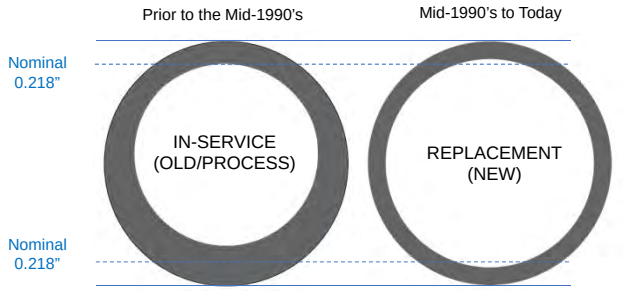
You need to measure pipe wall thickness to determine how much metal remains.

Pipe wall thickness is the critical metric – not age.

Pipe Manufacturing has Changed

Example: 2" Schedule 80



Actual wall thickness **0.250"**

Inconsistencies in the manufacturing process of seamless pipe resulted in a 'thin side' wall and 'thick side' wall

Actual wall thickness **0.189"**

The ability to stabilize the pipe and piercer results in more consistent, uniform wall thickness –extra wall material is no longer required to ensure the standard tolerance is met.

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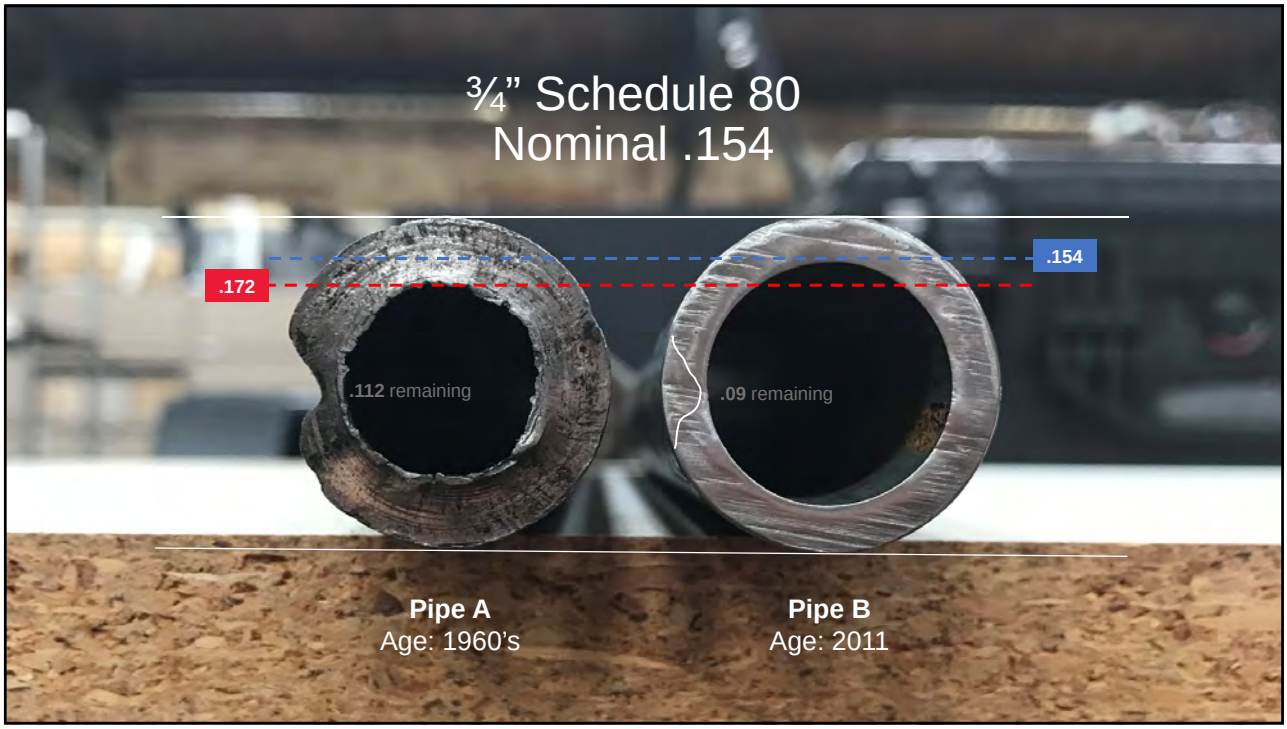

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You need all locations where damage is likely to occur checked and not limited to areas indicated suspect as a result visual inspection or where it is most convenient to access.

All insulated pipe - nested, suspended, vertical – is subject to CUI conditions.

Common Failure Points

- Elbows
- Tees
- Valve groups
- Terminations
- Sagging pipe sections
- Changes in pipe direction
- Low areas on long straight piping runs
- Periodically along long runs of pipe

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There are NDT methods that can address the challenges the ammonia industry faces, and help you do more than just meet regulatory requirements.

The most relevant (widely used today) NDT methods are:

1. Ultrasonic Thickness (UT or UTT)
2. Radiographic Testing (RT)
3. Real-Time Radiography (RTR)
4. Radiometric Profiling (RP)
5. Pulsed Eddy Current (PEC)

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ULTRASONIC THICKNESS TESTING (UT or UTT)

Wet Insulation	Wet insulation is detected with visual only after insulation is removed.
Pipe Wall Thickness	Measures pipe wall thickness after surface is prepared (cleaned). Results are based on assumptions, estimates and interpretation. Prone to erroneous results on pitted or freezing pipe.
Locations	Can interrogate all piping.
Vapor Barrier	Breaches the vapor barrier. Requires removal of or holes in insulation to measure pipe.

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INDUSTRIAL RADIOGRAPHY (RT)

Wet Insulation	Can identify water or ice in insulation.
Pipe Wall Thickness	Measures pipe wall thickness. Results are based on assumptions, estimates and interpretation. Accuracy of indications and measurements are dependent/ sensitive to orientation of film and radiation.
Locations	Cannot interrogate all piping.
Vapor Barrier	Does not breach the vapor barrier, insulation remains intact.

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REAL-TIME RADIOGRAPHY (RTR)

Wet Insulation	Can identify water or ice in insulation.
Pipe Wall Thickness	Cannot measure pipe wall thickness. View of outside diameter (OD) of pipe only.
Locations	Cannot interrogate all piping.
Vapor Barrier	Does not breach the vapor barrier, insulation remains intact.

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RADIOMETRIC PROFILING (RP)

Wet Insulation	Can detect wet insulation.
Pipe Wall Thickness	Can measure pipe wall thickness (up to 24” diameter).
Locations	Can interrogate all piping.
Vapor Barrier	Does not breach the vapor barrier, insulation remains intact.

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PULSED EDDY CURRENT (PEC)

Wet Insulation	Cannot detect wet insulation.
Pipe Wall Thickness	Cannot measure pipe wall thickness on pipe on small diameter (ammonia) piping.
Locations	Cannot interrogate all piping. Proximity of nearby (congested) piping can interfere with accuracy.
Vapor Barrier	Does not breach the vapor barrier, insulation remains intact.

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The Benefits of NDT

- Regulatory compliance (OSHA, EPA, PSM/RMP, IIAR 6)
- Operational compliance (Mechanical Integrity)
- Identification of threats or system failure sources for maintenance
- Budgeting and cost savings
- P&ID clarification / confirmation

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The #3 leading cause of ammonia release is piping failure.

CUI is the leading cause of piping failure.

Wet insulation is not visible to the naked eye. The chance your facility has water trapped in insulation is 100%.

Remaining pipe wall thickness is what matters.

NDT is a necessity for acquiring concrete evidence about the state of the piping and vessels in your system.

When possible, select a testing technique that does not compromise the insulation and jacketing, or breach the vapor barrier.

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Questions?

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