Corrosion Under Insulation

CUI

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Agenda

1. **Backgrounds *CUI***
   - Facts & figures
2. ***CUI* mitigation strategy**
   - ✓ Senior management
   - ✓ Design & Engineering
   - ✓ Inspection

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NCTI

Cini

HOGESCHOOL UTRECHT

NACE INTERNATIONAL
75th Anniversary 1943 - 2018

EFC
EUROPÄISCHE FÖDERATION KORROSION
EUROPEAN FEDERATION OF CORROSION
FEDERATION EUROPEENNE DE LA CORROSION

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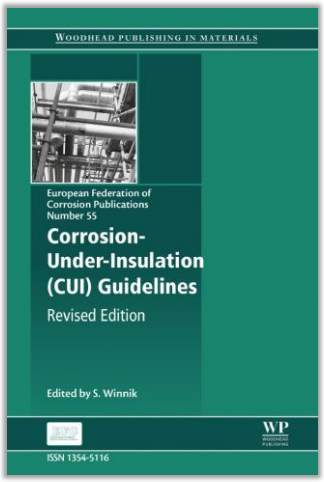
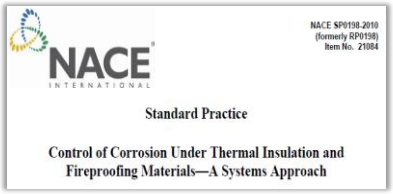
CUI System approach





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Senior Management Awareness

Senior management awareness

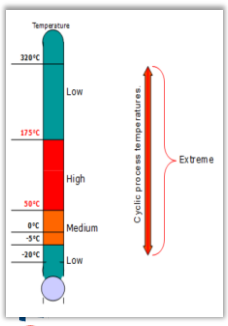
- ExxonMobile globaly spends 30 m$ on CUI inspections
- Netherlands: 4% GNP approx € 17,5 billion [1)]
- Dutch industry 10% maintenance budget related to CUI [2)]
- USA: Direct cost corrosion 2001: $ 276 billion (3.1% GNP)

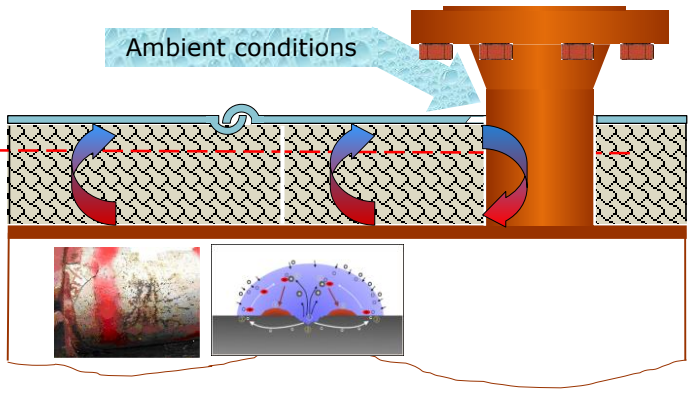
Source 1) Presentation Studiekern Corrosie March 2008
2) The Dutch Proces Industry Forum (NPI) 2004

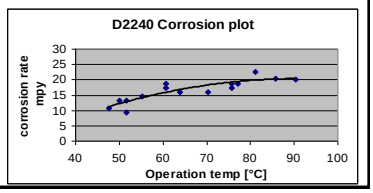
Starts with: Mission and Vision

1. We are committed to maintaining a safe work environment enriched by diversity and characterized by open communication, trust, and fair treatment. Above all other objectives, we are dedicated to running safe and environmentally responsible operations.
2. Safety is always our top priority. We aim to have zero fatalities and no incidents that harm people, or put our neighbours or facilities at risk.
3. We act in a responsible manner and support the Responsible Care initiatives. Economic considerations do not take priority over safety and health issues and environmental protection.
4. Values: Integrity, Respect for People, Protecting our Planet. Strategic Themes: Financial Discipline, Sustainability Performance Culture, Profitable Growth

CUI fundamental basics







CUI Facts

1. Onder alle type's isolatiemateriaal:

- ✓ Eisen specificeren:
  - Water absorption, Leachable chlorides
  - Afwaterend beplating
  - CINI versus bestaande situatie
  - Industrial Insulation Design

2. Equipment/piping design versus CUI

- ✓ Check en update eigen designpratices
- ✓ Implementeer "Leasons Learned"
  - Liftinglugs, trunions
  - Mangaten-davits
  - Nozzle collars
  - Check CINI

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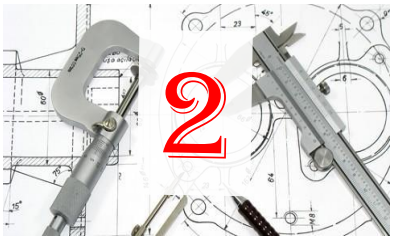
Question?

is *CUI* a



Technical problem

Organisation problem

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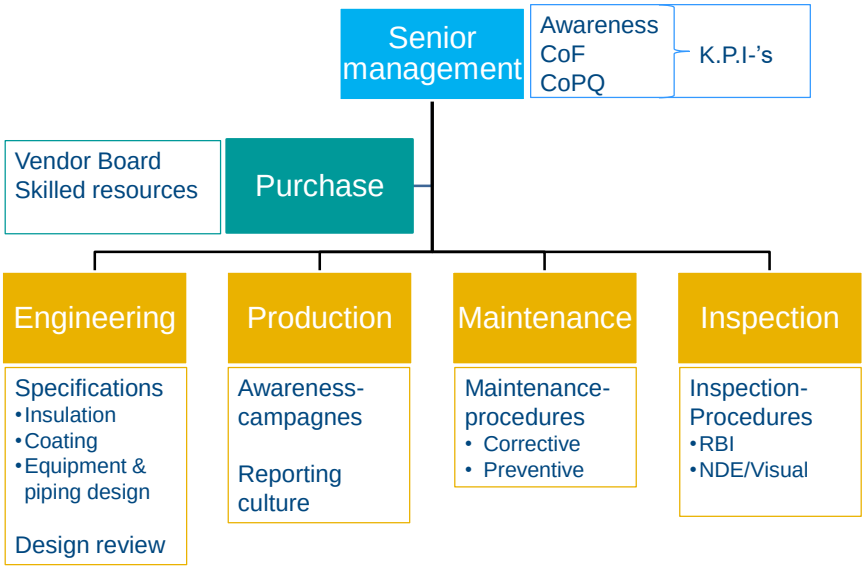

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Corrosion team

Maintenance manager

Sr. inspector

Engineering

Reliability eng.

Production manager

Contractor's Coating/Insulation

Integrity eng.

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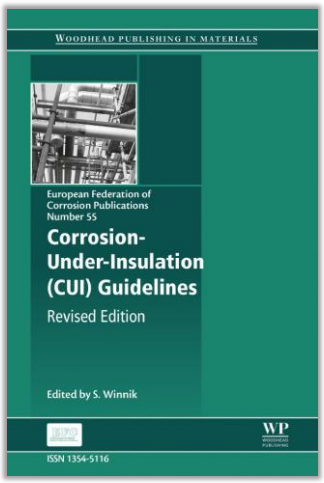
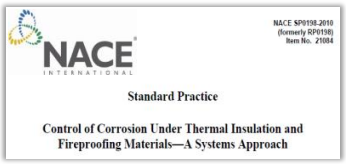
CUI System approach





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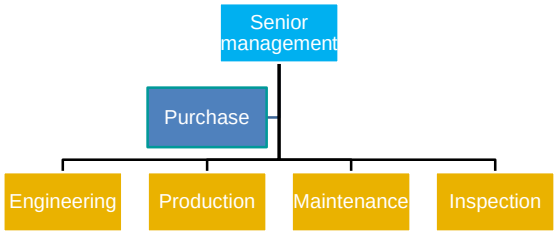
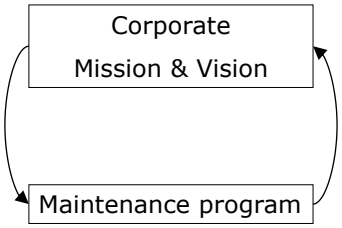
Good houskeeping

Official Legislation

1. **UK**: Pressure Equipment Directive
2. **D**: EU-Druckgeräterichtlinie
3. **NL**: Praktijk Richtlijnen voor Druk Apparaten
4. **Brzo 2015**
   Besluit Risico's Zware Ongevallen
   Ageing Assets => Audits
5. **Milieumonitor 15**
   Meet protocol lekverliezen
   Fugitive emmissions

1st step: Maintenance management

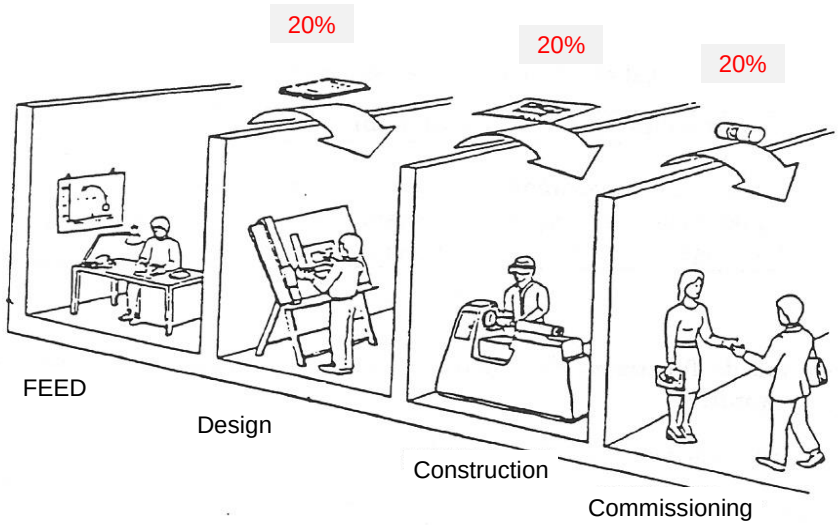




Technical KPI-'s:
1. Number of leaks due to CUI or external corrosion.
2. Number of repairs for CUI or external corrosion.
3. Number of CUI saves (capturing equipment & piping before wall loss becomes significant).
4. Reprioritisation of inspection due dates.

Financial KPI-'s:
1. LPO as a result of CUI or external corrosion.
2. Maintenance repair cost due to CUI or external corrosion.

2e step: Design & Engineering



Food for Thought

Moisture doesn't only cause:

1. Corrosion
2. Decreases life cycle insulation material
3. Increases thermal conductivity
4. Absorbs process energy

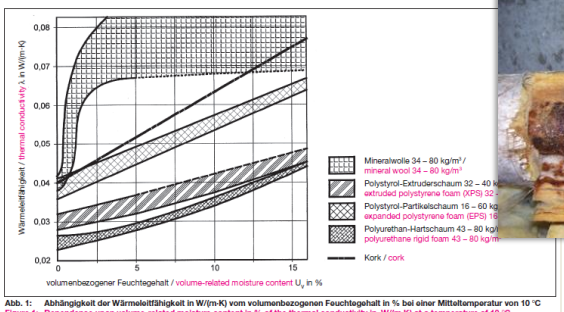


Abb. 1: Abhängigkeit der Wärmeleitfähigkeit in W/(m·K) vom volumenbezogenen Feuchtegehalt in % bei einer Mitteltemperatur von 10 °C
Figure 1: Dependence upon volume-related moisture content in % of the thermal conductivity in W/(m·K) at a temperature of 10 °C

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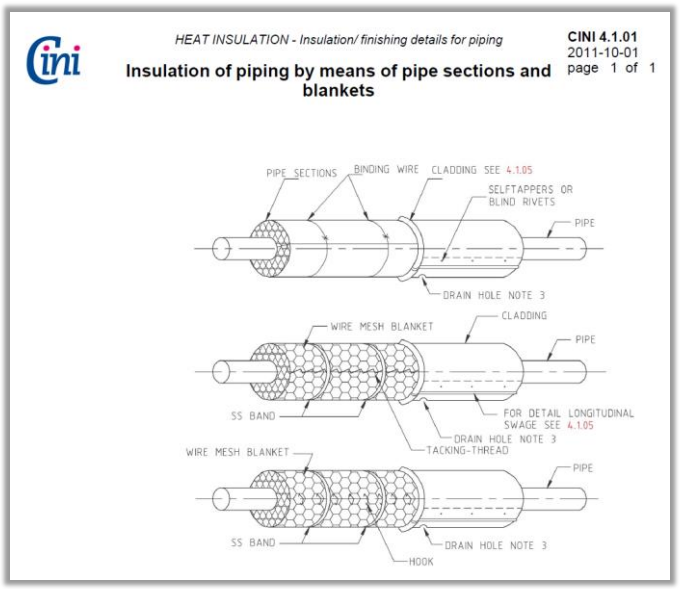
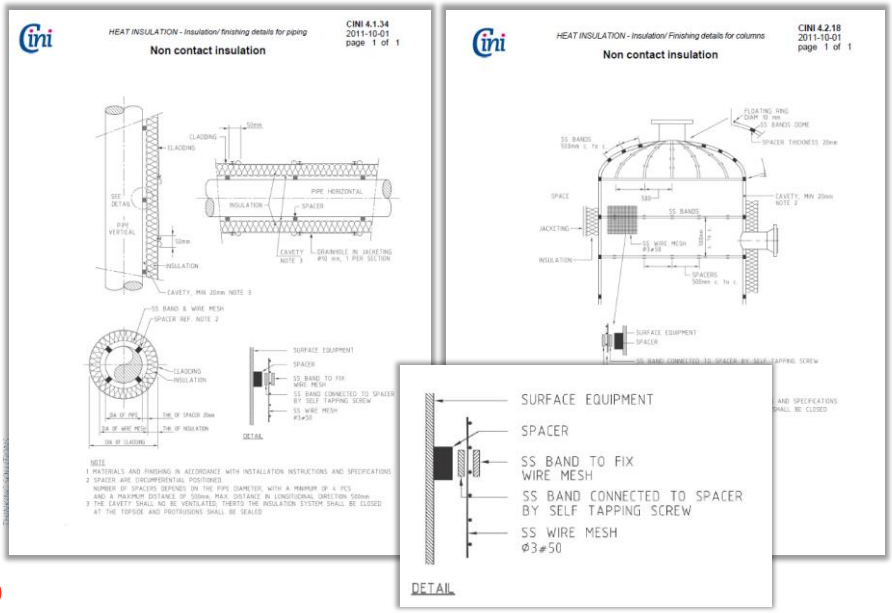
"Fit-For-Purpose" Insulation systems

1. Traditional system
2. Non-Contact insulation
3. Ventilated air cavity system

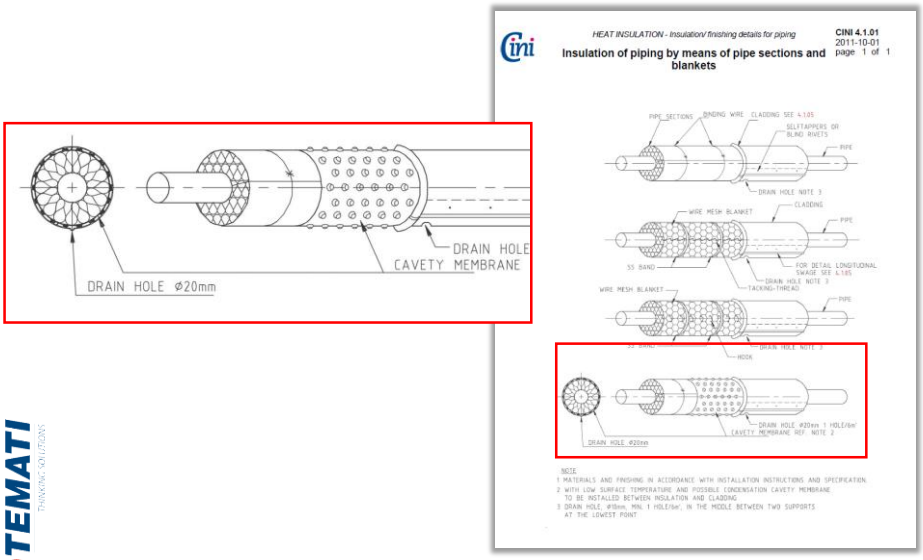
Traditional system

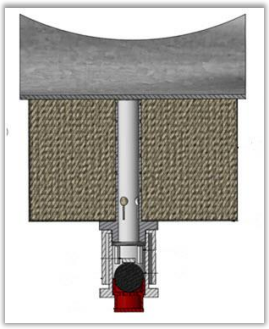


Non-Contact System



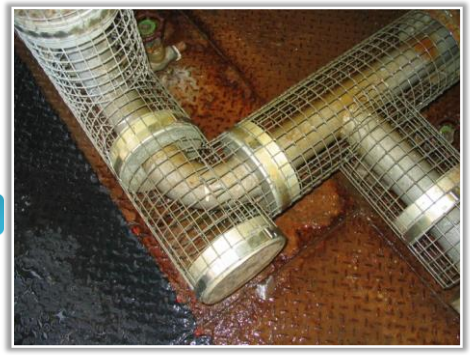
Air cavity outside





No Insulation !!??

- ✓ Challenge the need
- ✓ Personnel Protection
- ✓ Green Policy (EiiF)



TIC (Thermal Insulating Coating)

- Ceramic based
- Aerogel based
- High-Build Polysiloxane Matrix

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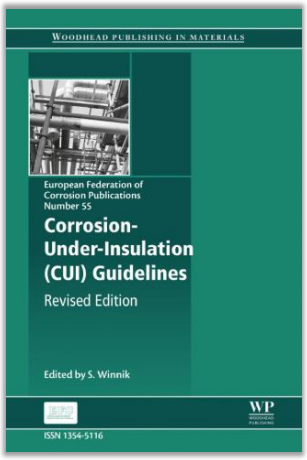
CUI inspectie strategie en technieken



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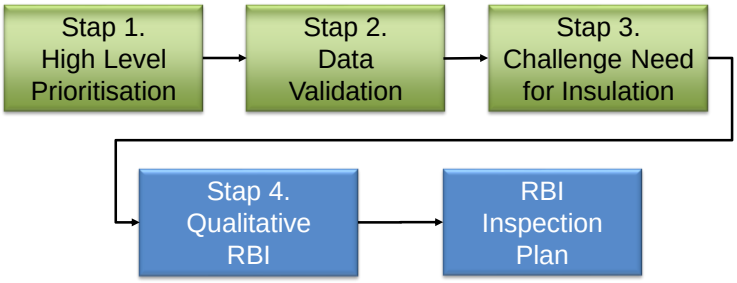
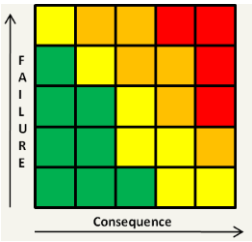
Risk Based Inspection R.B.I





Inspection Insulation Quality

Insulation Defect		
Equipment item; Line nr.:		
Insulation system	Hot / Cold / Ambient	
Insulation material		
Cladding material		
		Tick if applicable
Caulking or sealant that has hardened and separated		
Longitudinal cracks in glass-reinforced epoxy or glass-reinforced polymer jacketing		
Missing insulation (not reinstalled after maintenance activities)		
Missing insulation at flanges or valve boxes		
Missing self-tapers, rivets or stainless steel bands		
Rust stains and bulges in metal cladding		
Sagged insulation and cladding		
No termination at flanges or valves		
No termination in a vertical pipe or piece of equipment		
Water increase at penetration (e.g. nozzles)		

Purpose:

1. Root Cause Analysis CUI
   - Relation CUI susceptibility - probability?
2. Report to maintenance ERP system
   - Prioritizing
   - When it's broken fix it (good householding)

Inspection technique

Direct (with insulation dismantling)

1. Visual
2. Ultrasonic wall thickness measurements
3. Dye Penetrant Test

Indirect (without/partly insulation dismantling)

1. Guided Wave Ultrasonic
2. Pulsed Eddy Current.
3. Profile/ Flash Radiography.
4. Real-Time Radiography.
5. Infrared.
6. Neutron Backscatter.

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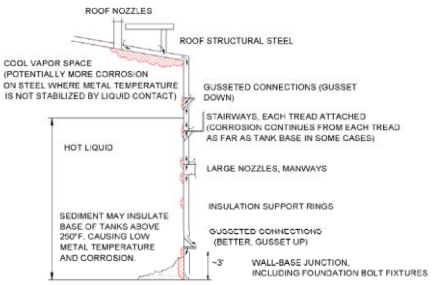
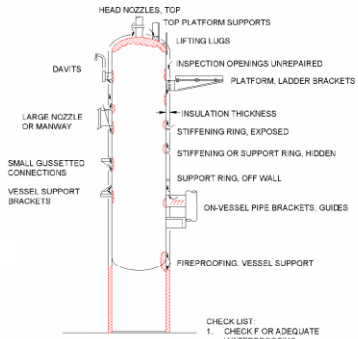
Scope inspection under insulation





GENERAL NOTES:

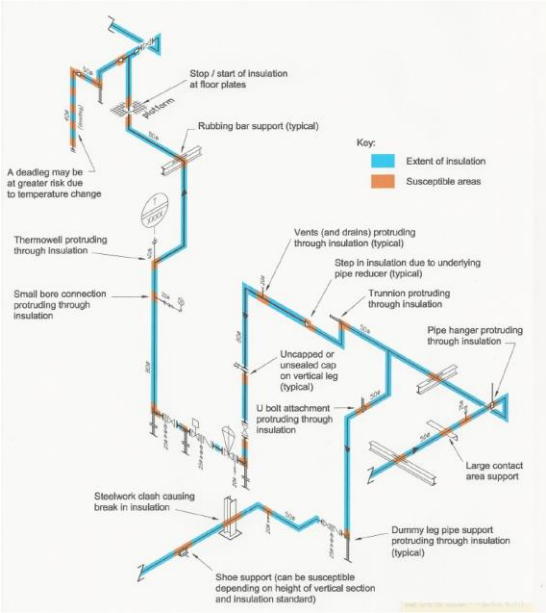
1. WATER ENTERING ROOF INSULATION CAN CAUSE SEVERE CORROSION OF WALLS AS WELL AS ROOF. WHERE IMPEDIMENT TO DRAINAGE EXISTS. SERIOUSLY DEFECTIVE ROOF WEATHERPROOFING CAN QUICKLY DESTROY A TANK IF METAL TEMPERATURES PERMIT.
2. PROLONGED FLOODING OF TANK AREA BASIN DUE TO ENVIRONMENTAL RESTRICTIONS ON DRAINING IS A CAUSE OF SEVERE CORROSION AROUND BASE OF TANK.
3. ROUTINELY INSPECT WEATHERPROOFING AND STEEL. REPAIR INSULATION DAMAGE RESULTING FROM INSPECTION.
4. WEATHERPROOFING AND DESIGN CORRECTIONS ARE ESSENTIALLY THE SAME AS FOR VESSELS, EXCEPT FOR ROOF/WALL JOINT.

TRAPPED WATER
WATER ENTRY POINT
IMPEDIMENT TO DRAINAGE
POTENTIAL WICK ACTION
PROBABLE CORROSION ZONE

CHECK LIST:

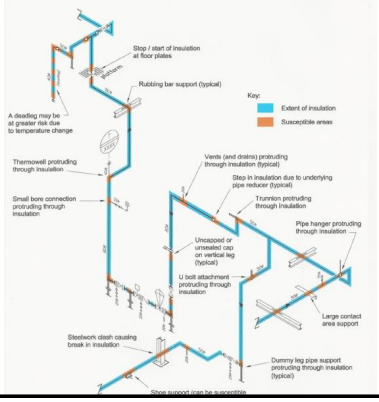
1. CHECK F OR ADEQUATE WATERPROOFING.
2. AS REQUIRED, REMOVE INSULATION TO INSPECT FOR CORROSION.
3. LOOK FOR SOURCES OF WATER:
   1. COOLING TOWER DRIFT
   2. SEAWARD SIDE
   3. STEAM TRAPS AND VENTS
4. CHECK CONDITION OF METAL JACKETING.
5. CHECK VESSEL METAL TEMPERATURES TOP TO BOTTOM OR HOT END TO COLD END.
6. USE METAL TEMPERATURES, SOURCES OF WATER AND WEATHERPROOFING HISTORY TO GUIDE SELECTION OF CANDIDATE DETAILS FOR INSULATION REMOVAL.
7. REPAIR ALL OPENINGS MADE FOR INSPECTION.
8. EXPOSED STIFFENING RINGS SHOULD BE WEATHERPROOFED ASAP.
9. THE TOP HALF OF HORIZONTAL VESSEL AND THE TOP OF A TOWER EXPERIENCE SIMILAR CORROSION PROBLEMS.

Scope inspection under insulation



Meten is weten

- ISO 19277
  Qualification testing and acceptance criteria for protective coating systems under insulation
- SwRI CUI JIP
  Evaluation of protective coatings used for corrosion under insulation.
- Follow the Water
  Proposal stage



Thank you for your attention

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