



**Safety
for life**



Material of Construction for Chemical Process Plants

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(Select document Information Tier)

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**ZERO HARM
POSITIVE IMPACT**



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Incident Description

A loss of primary containment event occurred from an analogue temperature indicator stub (threaded socket fitting) on an ammonium nitrate solution (ANS) storage tank. The leak was largely contained inside the bunded area, however due to the location of the stub, a portion of ANS sprayed onto adjacent soil surface. Immediate cleanup was conducted with the assistance of environmental specialists . Solidified ANS residue was collected and disposed of, in strict accordance with local legislation.



Corrosion
experienced by the
threaded socket

Incident Type	Process Safety – Release
Severity of Incident	Major (Tier 1)
Classification Basis	API 745 3 rd Ed
Factors of Influence	Release volume of material Environmental consequences Direct costs Failure mechanisms • Management (Process) • Equipment (Materials) • Mitigative (Bunding)

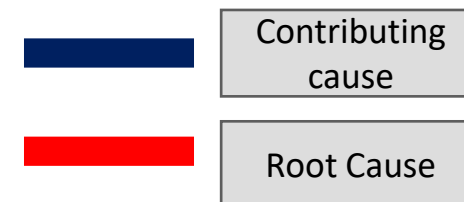
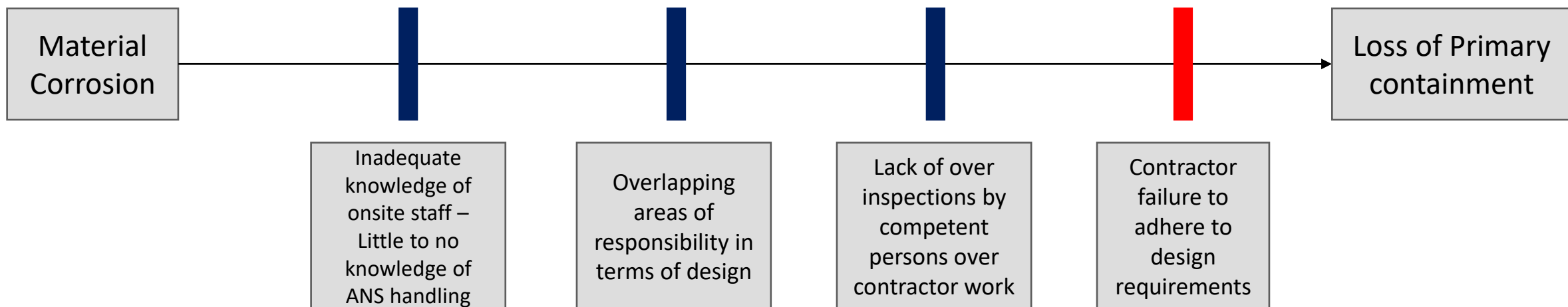
Immediate Actions Taken

- The eyewitness alerted the relevant persons of the leak and emergency protocol followed:
 - The Safety department was notified of the incident.
 - The access to the plant was closed off, only authorized persons were allowed to enter the area.
 - Residual ANS in affected tank was pumped out to another available tank.
 - The environmental spill response team was notified of the incident. Due to heavy snowfall and traffic authorities closing off highways, the response was delayed. Need to take environmental conditions into consideration when developing emergency procedures. .
 - When the area was declared safe to enter, engineering staff performed an inspection on all fittings used in the plant. The team found six additional fittings that were the incorrect type. These six fittings were ear marked to be changed out immediately after the environmental spillage was cleaned up.



Environmental
spill response in
progress

Swiss Cheese Model



Choosing the correct material for a Process – DESIGN/HAZOP

- During the **design phase of a process**, the process engineer must ensure that the design envelope of the plant is clearly defined. This operating envelope includes parameters like:-
 - Pressure
 - Temperature
 - Concentration of process fluids (including solids)
 - External corrosion factors
 - Fluid velocity (related to solids settling)
 - P&ID development
- These are key inputs into pipe classes for the project and these inform: -
 - Pipe material of construction
 - Gasket Material
 - Flange Rating
 - Bolting arrangements
 - Specification breaks
 - Pipe schedule
- The process engineer should make use of material of compatibility charts to ensure that the process fluid being handled must, across the design envelope, be compatible of material of construction.**
- During the HAZOP process (HAZOP III), a deviation guideword of material of compatibility for instrumentation, piping and equipment should be asked. **All “wetted parts” must be of a suitable material of construction.** If there is any doubt about the material of construction, a materials specialist should be consulted.
- Reference Material – Material compatibility charts
 - The following links are links to online material compatibility charts. These charts can be used to determine the compatibility with chemicals and material. Be aware, the factors like temperature and concentration may alter material selection
 - <https://www.coleparmer.com/chemical-resistance> - Chemical to Material and Chemical to Chemical
 - <https://www.graco.com/us/en/in-plant-manufacturing/support/tools/chemical-compatibility.html> - Chemical to Material
 - <https://tools.thermofisher.com/content/sfs/brochures/D20480.pdf> - Chemical to Material – Focus on plastic

Choosing the correct material for a Process – CONSTRUCTION

- The choice of materials for chemical process is part of the design process and is very important. This is supplemented by the joining of different metals in process piping or vessel manufacture. It is important to understand that bi-metallic corrosion is equally important as joining to incompatible materials can lead to structural integrity issues.

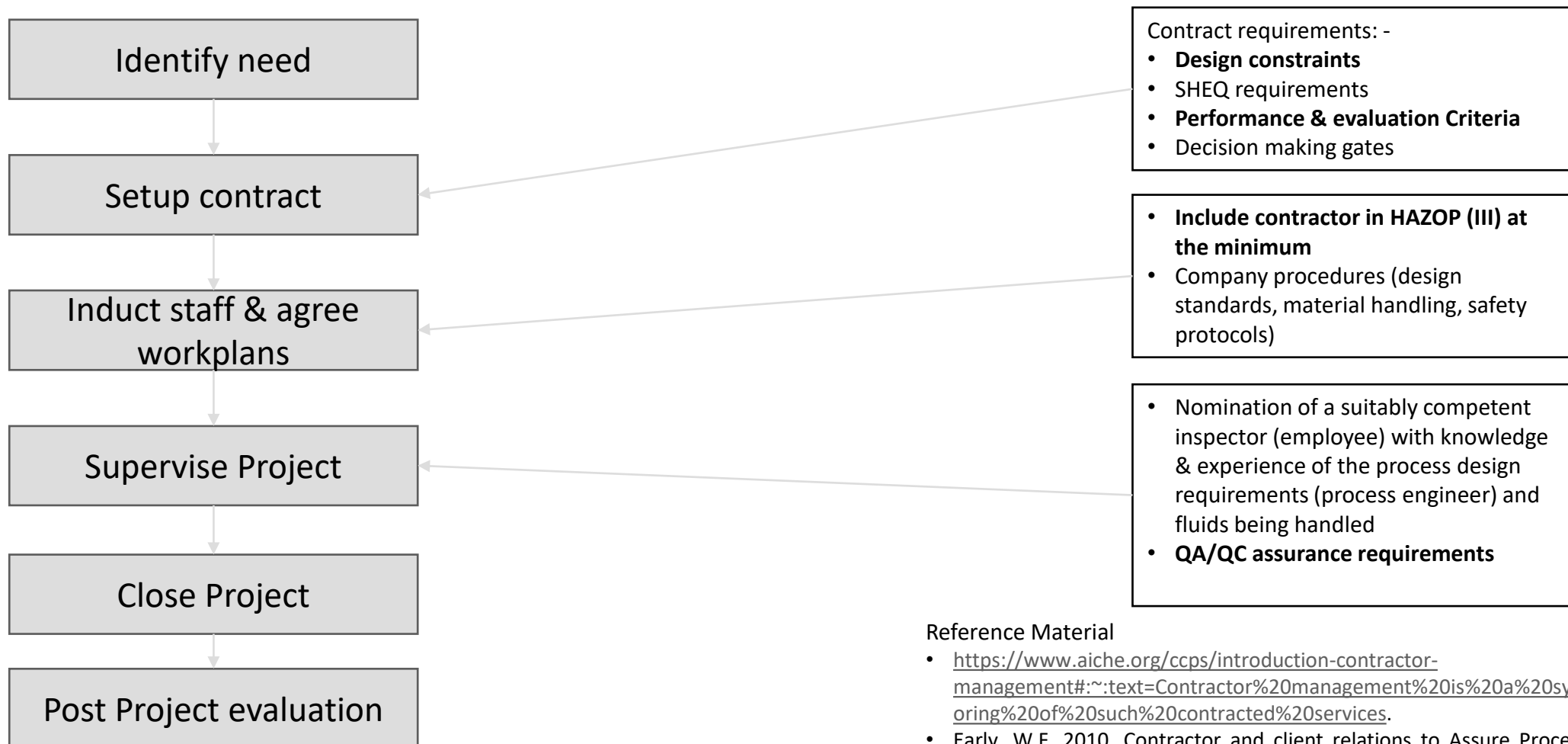
Metal in contact \ Metal being considered (a)	Magnesium	Zinc	Aluminium alloys	Carbon Steel	Cast iron	Lead	Tin	Austenitic Cast Iron	Brasses	Gunmetals/Tin Bronzes	Copper Nickel Alloys	Nickel Aluminium Bronze	Alloy 400/K-500	Low alloy stainless steel	Nickel-chrome moly alloys	Titanium	High Alloy Stainless Steel	Graphite
Magnesium																		
Zinc																		
Aluminium alloys																		
Carbon Steel																		
Cast iron																		
Lead																		
Tin																		
Austenitic Cast Iron																		
Brasses																		
Gunmetals/Tin Bronzes																		
Copper Nickel Alloys																		
Nickel Aluminium Bronze																		
Alloy 400/K-500																		
Low alloy stainless steel																		
Nickel-chrome moly alloys																		
Titanium																		
High Alloy Stainless Steel																		
Graphite																		



- <https://www.npl.co.uk/getattachment/research/electrochemistry/corrosion-guides/Corrosion-Guide-No-5.pdf.aspx?lang=en-GB>
- <https://industrialmetalservice.com/metal-university/avoid-long-term-problems-with-our-galvanic-corrosion-chart/>

Contractor Management – Life Cycle

Typical contractor management cycle



Reference Material

- <https://www.aiche.org/ccps/introduction-contractor-management#:~:text=Contractor%20management%20is%20a%20system,monitoring%20of%20such%20contracted%20services.>
- Early, W.F. 2010. Contractor and client relations to Assure Process safety. A CCPS concept book. Early Consulting. Houston – Texas.

Lessons learnt – Contractor Management

- Persons who are appointed to conduct over inspections of contractor work should be suitably experienced and competent in handling the specific material used in the process.
- Limit of responsibility – Limits of responsibility should be outlined in a project document and specific requirements must be stipulated. For example, consider two different entities, Entity A and Entity B had designed different parts of the plant, however, the different sections were not HAZOP's/Risk assessed as a whole. Fluctuations in one part of the process can affect the next part of the process and thus it is a fundamental requirement that a process plant be HAZOP'd end to end in totality.
- It is critical that when tender requirements are drawn up, the requirements of experience, in handling specific fluids be explicitly stipulated. That way, a suitably experienced contractor can be selected.
- Reference Material
 - <https://www.aiche.org/ccps/introduction-contractor-management#:~:text=Contractor%20management%20is%20a%20system,monitoring%20of%20such%20contracted%20services>.
 - Early, W.F. 2010. Contractor and client relations to Assure Process safety. A CCPS concept book. Early Consulting. Houston – Texas.



QUESTIONS?

