THE ARROW
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TECHNICAL ARTICLE

Circuitization: A Technique for Increasing Inspection Efficiency

The oil and gas industry is constantly looking for ways to reduce the maintenance costs of their assets. Once an asset is put into service, one major expense is the management of corrosion through inspection programs.

Circuitization aims to reduce overhead inspection costs through the thoughtful break down of a system into smaller sections. These smaller sections can be easily inspected, and from those inspections useful data can be collected. Done correctly, circuitization lowers inspection costs and makes information gathered by inspectors more valuable to the engineers managing the asset.

The process of circuitization involves three general steps:

1. Conduct a Risk-Based Assessment (RBA) to outline corrosion loops within the system
2. Determine the Criticality of Failure
3. Divide into Piping Circuits

This process will be discussed more in the following sections.

Risk-Based Assessment

Risk-based assessment (RBA) is an organized procedure for developing inspection programs based on identifying the corrosion threats deemed most plausible and monitoring those deemed most critical. The foundation of RBA is a breakdown of the system into sections which all house the same type of fluid, known as corrosion loops.

Some examples of corrosion loops are:

- Wet Oil
- Dry Oil
- Utility Seawater
- Methanol

Once corrosion loops are established, inspection programs can assign condition monitoring locations (CMLs) to piping and vessels throughout the facility based on criticality. Figure 1 contains a sample of corrosion loops.

CL1 - WET OIL
CL2 - DRY OIL
CL3 - WET GAS
CL4 - PRODUCED/OILY WATER
CL5 - RELIEF SYSTEM
CL6 - DRY GAS/FUEL GAS
CL12 - CHEMICAL INJECTION
CL20 - LUBE OIL

Figure 1: A Sample of Common Corrosion Loops

Criticality

Criticality is a semi-quantitative rating which combines the piping's susceptibility to failure (StF) with the consequences of that failure. Criticality ratings allow engineers to rank the risks posed by corrosion to every pipe in the system.

The StF is determined by a comparison of the corrosion rate used to estimate the overall piping design to its actual corrosion rate. The consequence of failure is best determined by a multidisciplinary team who review and evaluate possible failure scenarios (pinhole leak, large leak, total pipe separation, etc.). This analysis is completed for each degradation mechanism the piping could possibly face, and the highest criticality rating awarded to the piping is identified.

Figure 2 shows a standard criticality assessment chart. The y-axis shows the probability of failure (risk), and the x-axis shows the consequence of that failure; the spot where the two intersect is the criticality rating.

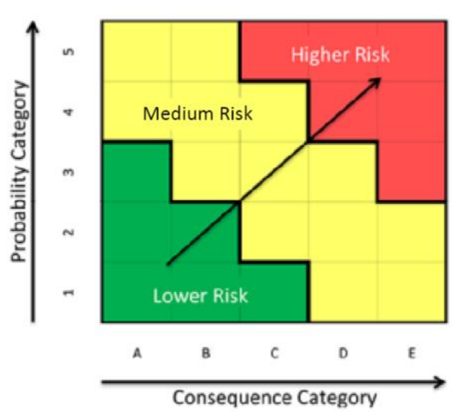

Figure 2: Criticality Assessment Chart

A Step Further: Piping Circuits

Corrosion loops are further divided into piping circuits. Piping circuits are partitioned from the rest of their corrosion loop based on their operating variables (pressure, temperature, material type, etc.), meaning that the piping in each circuit faces similar corrosion mechanisms and is likely to fail in the same way. This also means that the piping within a circuit will have the same criticality rating, and all pieces of that circuit will share that rating for the same reasons. These similarities require all the piping within a circuit to be inspected in a similar manner and on a similar schedule.

Once a criticality rating has been assigned to these circuits, those parts of the system requiring the most attention can be determined. Figure 3 shows an example of a piping circuit within a corrosion loop.

Increased Efficiency: Offshore & in the Office

Significant overhead costs are associated with getting inspectors to offshore facilities, and individual corrosion loops are too large to be quickly inspected. Circuitization increases the bang received for each buck spent. Piping circuits are relatively small and usually connected, so inspectors will not have to traverse the entire facility to locate disjointed piping spools in order to complete their inspections. This will allow them to spend less of their limited time offshore searching for piping and setting up/taking down their equipment and more of it performing and completing inspections.

Circuitization also increases the efficiency of the inspection team. Once circuitization has been completed, CMLs can be managed from the circuit level, rather than the line-number level. Since conditions are consistent within a circuit, the same level of analysis is completed with many fewer man-hours spent. Looking at the system from this slightly broader vantage point also makes it easier to identify dead-legs and other areas with potentially higher corrosion rates and corresponding higher risks.

Conclusion

A good inspection plan focuses most of its resources on the operation-critical components of a system while giving just enough attention to the rest of the system to ensure that nothing unexpected is going on. Circuitization helps the asset owner/operators more easily decide which segments are mission-critical, so that they can focus their limited resources appropriately.

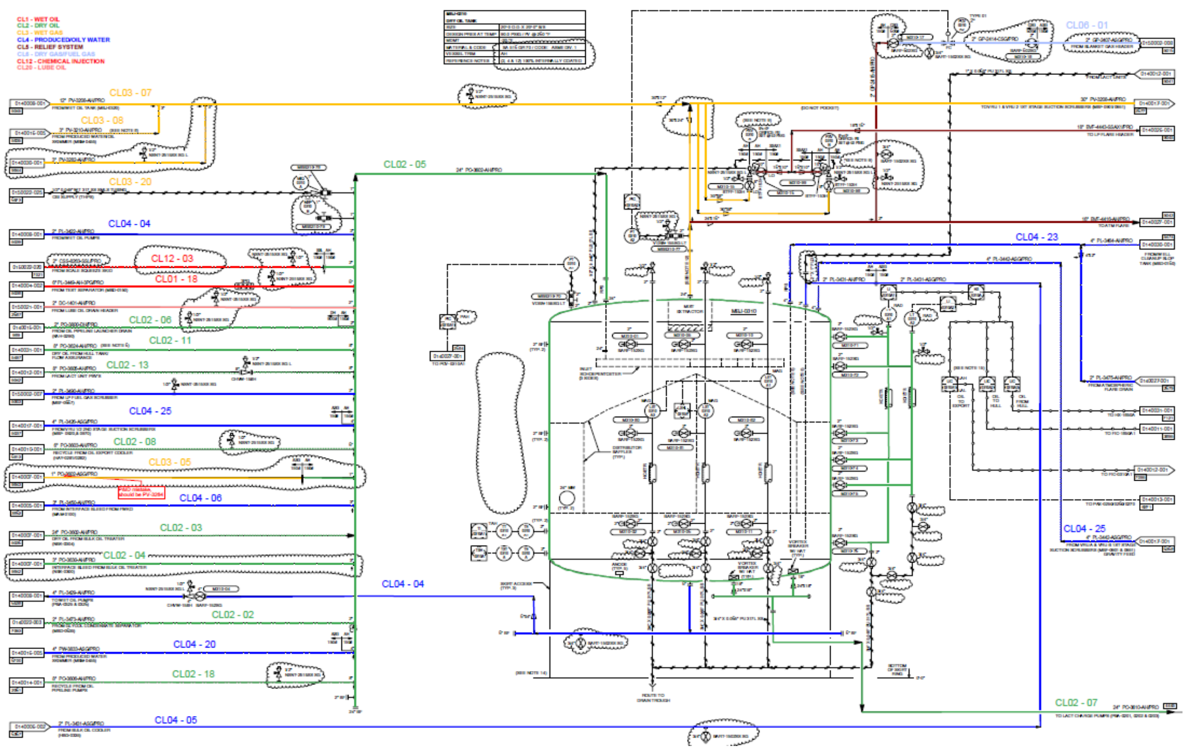

Figure 3: Corrosion Loop and Piping Circuit Example