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The Hidden Dangers Facing Maintenance & Engineering Managers with Buried Piping at Their Plant

Buried Piping at Your Plant – a Disaster Waiting to Happen?

I was at an Inspection Summit Meeting several years ago and attended a presentation by one of the OSHA inspectors. The topic of discussion was Mechanical Integrity; focus became piping and then drilled down to "buried piping", then the question on the table quickly became what does OSHA expect of a plant mechanical integrity program specifically associated with buried process piping.

Whoa such a silence, then the OSHA guy asked of the crowd, WELL?? What are you doing? One person in the crowd said:

> *"We don't do nothing about it that is why we buried it in the first place, so we don't have to look at it." The OSHA guy wanted his name and plant immediately; which for obvious reasons, were not forthcoming. The crowd went silent for a bit, joked around a bit, then moved on to another topic"*

There is a lot of attention currently centered on getting the inspection and monitoring program right for the above ground piping in our plants today. Witness the flurry of activity around this issue following the recent disaster at the Chevron Refinery in Richmond Washington. And there should be a lot of attention on it, we have a lot of work to do to make our process plants safe in the United States. We are averaging a disaster every few months, month before last it was the fertilizer plant in West Texas. Today it was the Williams Olefins plant in Geismar La. It will be somewhere else in a few months.

Piping is the Elephant in the Tent Relative to Mechanical Integrity

Well this paper asks the question posed above at the inspection summit, regarding buried piping.

Rhetorically of course; but nevertheless we are going to put it back on the table then provide you with a definition of the problem and the solution. Anyone familiar with the design requirements for modern refineries and chemical plants will tell you that some of the ground rules would be similar to the following, abstracted from a typical design basis document:

Typical Criteria for Buried Piping inside a Plant

- ***Keep buried piping to a minimum. Generally only sewer drain lines and fire mains are located below ground. In some cases due to Client or climate requirements, cooling water lines are also buried below the frost line.***
- ***With future maintenance in mind, buried lines should be located well clear of foundations, and if running side by side, well-spaced out. A minimum of 300 mm clearance is necessary between foundations and lines and between the lines themselves.***
- ***Above ground safe drain-tails will enter below ground drain line via a tundish (concentric reducer normally) or if a sealed system and cooling water lines by a flanged stub raised above ground.***
- ***Flanged connections should be a minimum of 300 mm above prevalent grade level. It is advantageous to set a common level for all these take offs at the outset of the job. When locating tie-in connections to***

underground systems, especially from elevated drain points, and adjacent to equipment plinths, ensure adequate clearance.

- ***All buried steel pipes should have applied a corrosion resistant coating and wrapping.***
- ***Deep valve boxes for buried lines should be designed with ample room inside the box for a maintenance man to bend over and use wrenches for tightening flanges of re-packing valves. Consideration should be given to the use of concrete pipe in lieu of square boxes.***
- ***The criteria for a good underground piping design should be ease of maintenance. Piping should be so spaced as to allow easy digging out and replacement of faulty sections; for this reason, never run underground piping under or through foundations.***

Good Design Criteria Right?

How many process Plant Owners, Engineering Managers, Maintenance Managers, Or Plant Operators (refinery, chemical, natural gas and other manufacturing) can say you have the assurance you need that your plants can meet these criteria?

Six Sure-Fire Signs That You've Got a Problem…

1. You don't have documentation in place to provide you the assurance you need that these criteria were met during the construction of the plant
2. You don't have the evidence to provide assurance that the piping within or outside your boundary limits are still within the plant design basis
3. You don't know how much buried "process piping" you have
4. You don't know where the buried process piping is
5. Your P&IDs and PFDs are not up-to-date
6. You or your inspection department haven't been asked the question:

WHAT ABOUT THE BURIED PIPING?

Even if you have no buried process piping; <u>all piping is in the plant for a reason</u>, even the utility and cooling water lines are there for helping you with your bottom line – and that is: your business is to make gasoline, diesel fuel, olefins, electricity, pharmaceuticals, or some other product that makes your company prosperous. Mechanical Integrity is not your primary business. However, it is required to ensure assets are safe and reliable.

- Can you honestly say you are "checking the box" in a responsible manner?
- Can you afford an outage due to the failure of one of these lines?

Given that the average age of our fleet of manufacturing plants has exceeded the original design basis life time; there is a high probability that your buried piping has potentially suffered damage to the pressure boundary either by:

- External degradation due to failure to maintain the cathodic protection system, coatings failure and associated corrosion, environmental cracking, and penetration of the pressure boundary, or

- Internal degradation due to microbial induced corrosion (MIC), process related corrosion/cracking, environmental cracking, etc., and penetration of the pressure boundary

With our alliance partner Lloyds Energy North America's we routinely provide a Risk Based Solution for your above ground piping. Following is our proprietary recipe for your buried piping.

Whether it be process piping or utilities, I hope you are convinced by now that both are equally important to your bottom line. Buried piping must be maintained and inspected in order to meet the local OSHA and EPA requirements. And of course for piping outside the boundary limits don't forget PHMSA and other regulatory agencies, e.g. in Texas -- the Texas Railroad Commission.

> *So let's face it – manufacturing plants are aging and failures appear to be escalating, as evidenced by how busy the Chemical Safety Board has been lately. In some cases, sadly the events are "NEWS WORTHY DISASTERS". We are not saying that buried piping are the root cause of our angst here; but who's to say that at some point they may become your Achilles heel. There is a lot of buried piping.*

TAG has a solution which we are giving you for free. Yes the plan is free, getting it done might cost you something and that is another matter.

Here Is How It Is Done

FIRST YOU WILL NEED to assemble a qualified team to do the work:

- SAFETY, is paramount over all, because you will need to dig some holes inside your plant in key areas chosen by the technical lead. Consequently commitment of a safety professional to oversee the operation is essential to success.
- Ideally the work should be managed by a certified NACE CP/Corrosion Engineer; since, equally important is documenting and guaranteeing the TECHNICAL adequacy of all work.

This Is Not a Termite Inspection, it is Rigorous Technically Challenging Work.

Our Team who does this work have numerous years of experience in the evaluation and management of piping and pipeline integrity issues. The piping we are speaking of here is typically that which cannot be addressed using common internal pigging techniques.

The Dig Team

Your dig team should be assembled and qualified to safely do the work under the watchful (preferably redundant) eyes of the facility management. All to the rigorous safety

requirements of your facility. Safeguards should be put into place to preclude puncturing the pressure boundary when the digs are done.

Written Procedures

All work must be done to meet rigorous documented written procedures exceeding the requirements of OSHA, EPA, PHMSA and/or the local state jurisdictional requirements.

Documentation and Design Basis Review

Ideally work should be proceeded with a documentation review. Send a simple memorandum to all plant personnel and ask that they contribute any knowledge (anecdotal or documented) that they may have on hand. Once assembled, conduct a gap analysis to determine what documentation might be missing. A written procedure should be used to do the gap analysis of existing documentation. What is the code of record for the buried piping within your plant? If none exists establish one and document that this is your minimum acceptable criteria for design of the piping.

Baseline Risk Analysis

After the documentation and design basis review, use the available state of knowledge to develop a risk based inspection benchmark analysis by conducting risk calculations based on your production needs and the requirements of API Recommended Practice (RP) 580 and the based resource document (BRD) 581.

- Development of the baseline risk analysis will assist you with prioritizing and budgeting the physical work.
- In addition, it will ensure you systematically address the appropriate damage mechanisms that to a large degree will be defined by the physical attributes of the installed piping, the soil conditions, and the quality of internal process conditions.

As a part of this process – systematize the piping to similar consequence of failure conditions. As for all work done on your buried piping, even the risk analysis should be done in accordance with recognized and generally accepted written procedures for addressing process and utility piping for facilities.

The RBI analysis of the internal damage mechanisms can be overlaid with a proven common sense approach towards addressing the integrity of the buried piping from external damage mechanisms.

Software and Integrity Assessment

This is complex engineering work, it may not be possible to provide an engineering solution; so one based on risk is recommended. The engineering solution can be obtained using costly probabilistic fitness for service calculations. This may or may not be necessary depending on what is found. Best case dictates an inspection with sufficient documented and defensible coverage that will provide reasonable assurance that the integrity of the coating is sound and that there is no reasonable cause to believe that the pressure boundary integrity might be compromised.

Engineering judgment will rule and dictate whether use of one of the sophisticated Risk Based Inspection Software packages might be useful or not. In the extreme, a full up probabilistic Monte Carlo fracture mechanics analysis might be needed. Let the results of the inspection guide the work, following the risk analysis, to dictate how much rigor might be needed. The Integrity Assessment will most likely include:

> Indirect Survey tools will be used to target potential damaged piping
> Initial Digs should be defined as specified by the CP Engineer and
> Direct Inspections done at the initial dig locations with the results integrated with the indirect inspection techniques.

Inspection Planning

Our overall objective is to document the current condition of the orphaned piping. The general steps outlined above will define the inspections and establish repair and replacement options if needed. Risk analysis following the inspection and any remedial actions will provide the needed documentation and engineering basis for future inspections including timing, scope and acceptance criteria. All can be guided by the risk analysis to a budget deemed acceptable to plant management and owners.

Completion - **So it hasn't been a termite inspection has it?**

Completion should be robust and ensure the work is documented in a completion package, signed off by your management team, suitable for establishment of a file on each process system assembled in accordance with written procedures and work instructions.

Bottom Line - All work should be done in accordance with a recognized and audited quality assurance program and implementing procedures and work instructions.

AND USING THE NOW ROBUST DOCUMENTATION PACKAGE you will have the basis for your risk based inspection program established for the orphaned piping at the plant both inside the boundary limit (ISBL) and outside (OSBL).