

- SECTION EIGHT -

Piping Addendum

Over many years of providing our ultrasonic testing services, CorrView International, LLC has come to recognize and document the fundamental causes of today's most common piping system problems and failures. Unquestionably, the most common form of piping failure exists where threaded Schedule 40 carbon steel has been installed in HVAC open condenser water systems.

This Addendum has been prepared, therefore, in response to that specific condition, and to offer a basic introduction and explanation into other areas of piping design which may negatively affect plant and building operations. Due to our investigation of threaded condenser water pipe as part of this investigation, a review of this section is extremely relevant and will help in the understanding of this report.

In virtually all cases of pipe thread failure, the first noticeable indication of a problem is the appearance of rust or multi-colored brownish/red deposits at the joints of random piping tees, elbows, valves, couplings, etc. Such deposits, while seeming to originate at the exterior surface of the joint, are actually the result of an initial microscopic leakage of water through or around the pipe thread. Dissolved iron and minerals, sub-micron sized particulates, as well as biological material, are all carried through the leak site by the water, where they precipitate out of solution as the water evaporates.

In its initial stage of failure, water leakage is so slight that evaporation alone is capable of dissipating any moisture before accumulating sufficiently to form a water droplet. As the leak progresses, however, water penetration through the leak site exceeds the evaporation rate, and the telltale water stain of contaminants is produced at a ceiling tile or floor location. It is often at this point that a piping problem is first discovered, and corrective action or further investigation considered.

Of primary importance to the understanding this report is our method used in determining the estimated remaining service life of the pipe. Essentially, this determination is based upon three critical values:

- 1) ***The ultrasonically measured wall thickness of a particular section of pipe, which is a function of equipment quality and operator experience, and;***
- 2) ***The calculated minimum allowable wall thickness of that pipe as defined under the existing operating conditions of pipe type, pressure, pipe size, joint type, internal corrosion, and material strength, and;***
- 3) ***The overall time period during which the piping was in service and could experience corrosive deterioration.***

Given the known accuracy of our equipment, the ability to visually verify wall thickness readings as correct at the time of the survey, the high number wall thickness readings upon which we base our reports, and the fact that we do not discount high and low values, we consider identifying existing wall thickness values as the far lesser of both pipe related variables. The installation date, and therefore the actual time in service, is often known.

Identifying the safe minimum permissible wall thickness, however, is not quite as exact. The most frequently used guide to determine the minimum permissible wall thickness limit of a pipe is to compare its existing average wall thickness in relation to 50 percent of its initial specified wall (or some other percentage value).

Therefore, pipe having an existing wall thickness of less than 50% of its original value would be recommended for replacement. In some cases, we have seen replacement recommended after losing as little as 12.5% of the original pipe wall - its actual manufacturing tolerance. Many alternate and arbitrary calculations for minimum acceptable wall thickness have been utilized.

Basing any decision for pipe replacement upon such an arbitrary calculation is dangerous, we feel, since it is directly dependant upon original wall thickness only, and ignores installation and operating conditions such as pressure, pipe material, threading, corrosion rate, etc. While there can be only one true minimum safe operating wall thickness for a given section of piping, two greatly different calculated minimums would be defined depending upon whether Schedule 40 or Schedule 80 pipe was originally installed - the heavier Schedule 80 minimum possibly leading to a premature pipe replacement recommendation, and the lighter Schedule 40 minimum possibly resulting in unanticipated failure.

In defining the minimum safe operating wall thickness values used in our modeling calculations, CorrView International, LLC has returned to the long established piping formula used by mechanical engineers in the basic design of piping systems having known or anticipated operating parameters. This formula is universal in that, given the physical strength and joint efficiency properties of any piping material and grade (steel, copper, plastic, PVC, stainless, etc.), the minimum acceptable wall thickness to provide safe and reliable service may be calculated. Used properly in the design of piping systems for which certain physical aspects will be known (pipe type, size, material, construction, and pressure), and given reasonable estimates of corrosion rate and planned service life, this formula will ensure that the pipe selected and installed will fulfill its intended function.

Since commercially available pipe is produced in specific sizes having relatively fixed physical dimensions, and actual operating conditions will typically produce calculated minimums of intermediate thickness value, pipe of equal or next higher wall thickness than the calculated value should always be selected for installation. Therefore, an application requiring 4 in. welded black pipe, in which the calculated minimum wall thickness is 0.275 in., would dictate the selection of Schedule 80 or Extra Strong pipe at 0.337 in. dimension. Schedule 40 or Standard pipe at 0.227 in. would not fulfill the minimum wall thickness requirement in that case, even though it would offer service use, and would be judged as unacceptable.

The remaining content of Section Eight offers detail of minimum wall thickness calculations, corrosion theory, critical assumptions, piping review, UT theory, wall thickness tables, thread loss tables, and other information and data relevant to the production of this report.