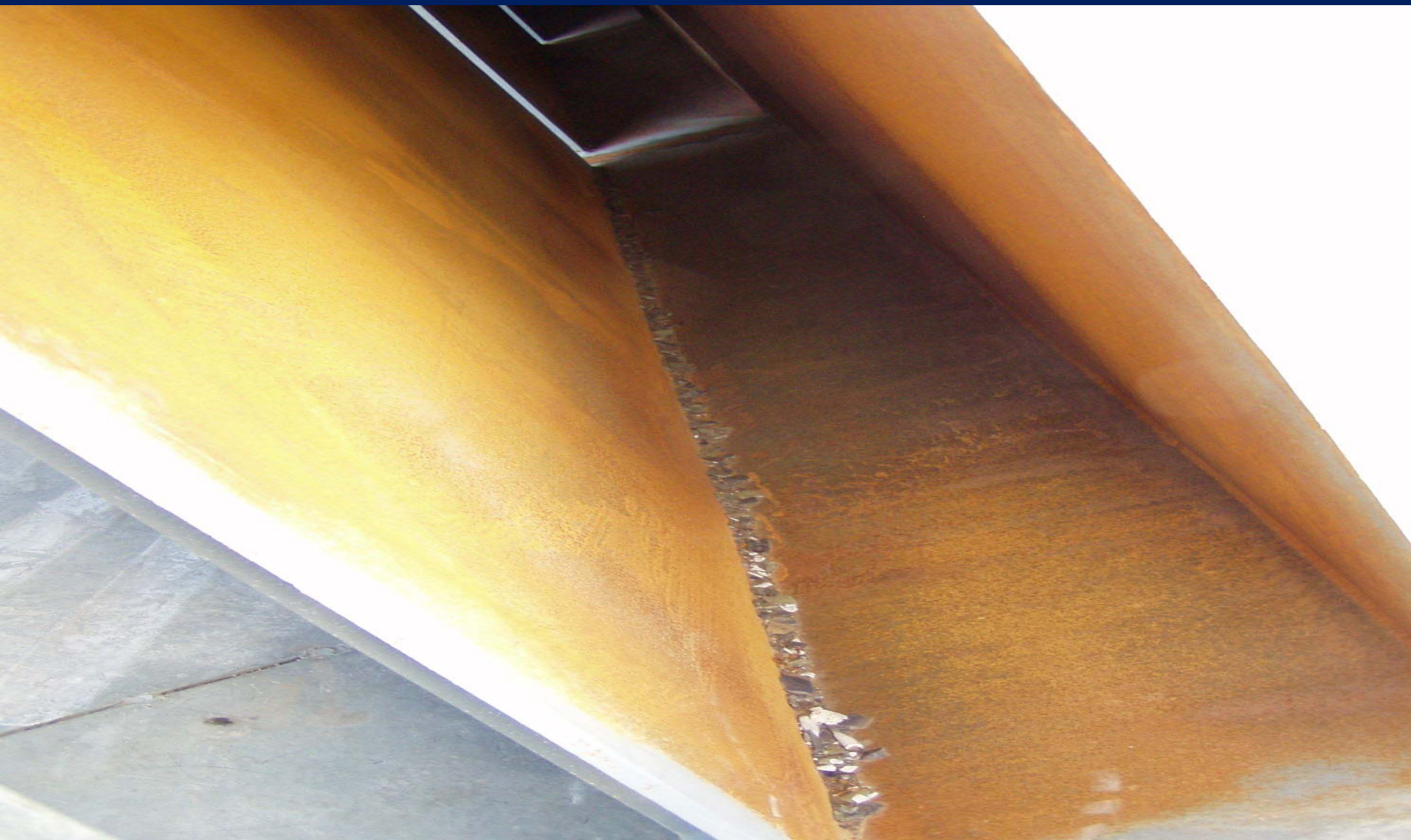
Experience with Particulate Filtration on Startup at Comanche Unit 3

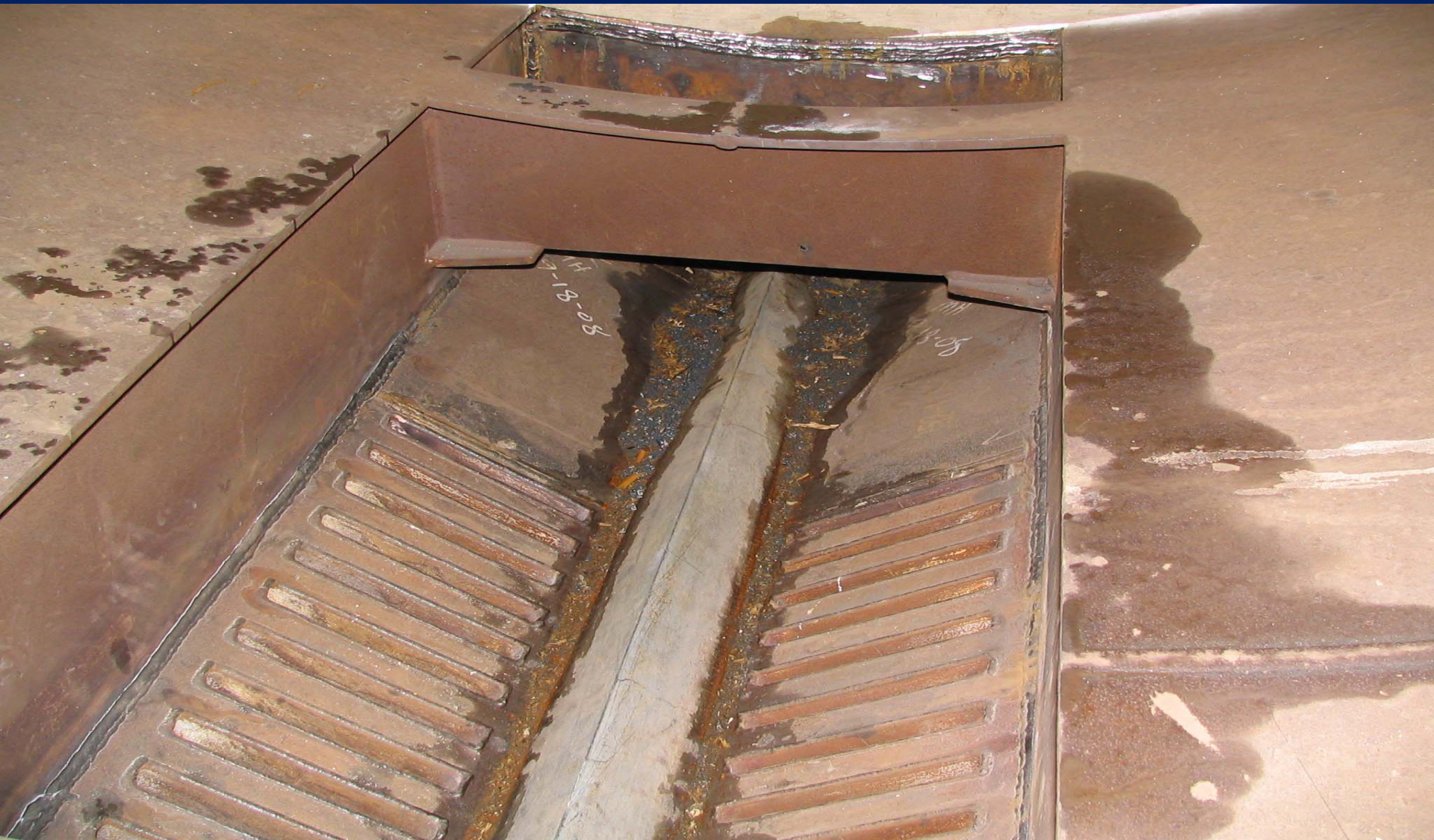
Initial ACC Cleanup

- There were challenges with the initial cleanup of the ACC
- Performed an initial flush of the system just to get the normal manufacturing debris out
- There was also construction debris that needed flushed out
- The water was run through the polishers during this process and the first batch of resin that was exhausted was due to iron fouling and nothing else

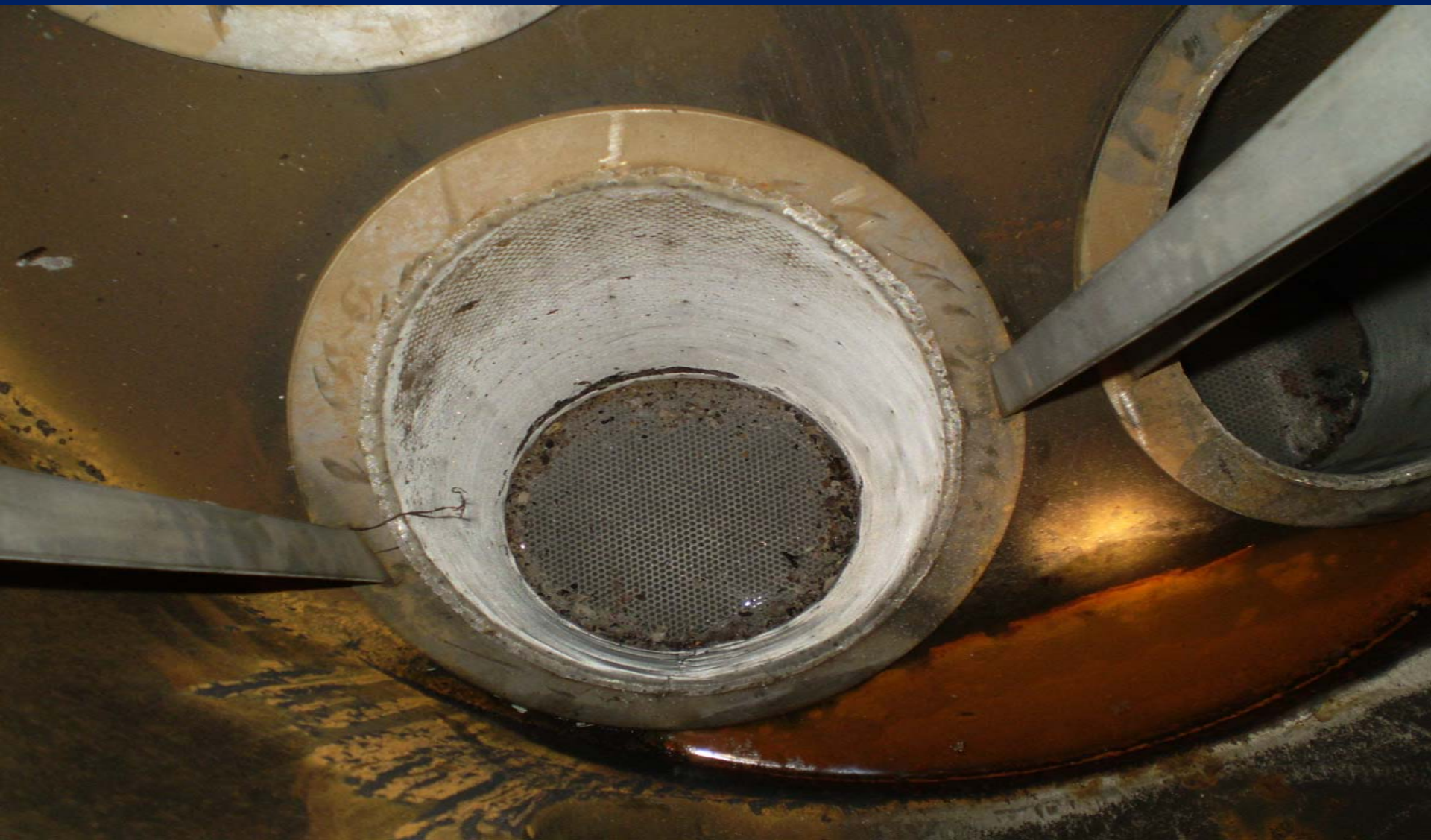
Debris in Condensate Collection Header



Debris in Upper Duct

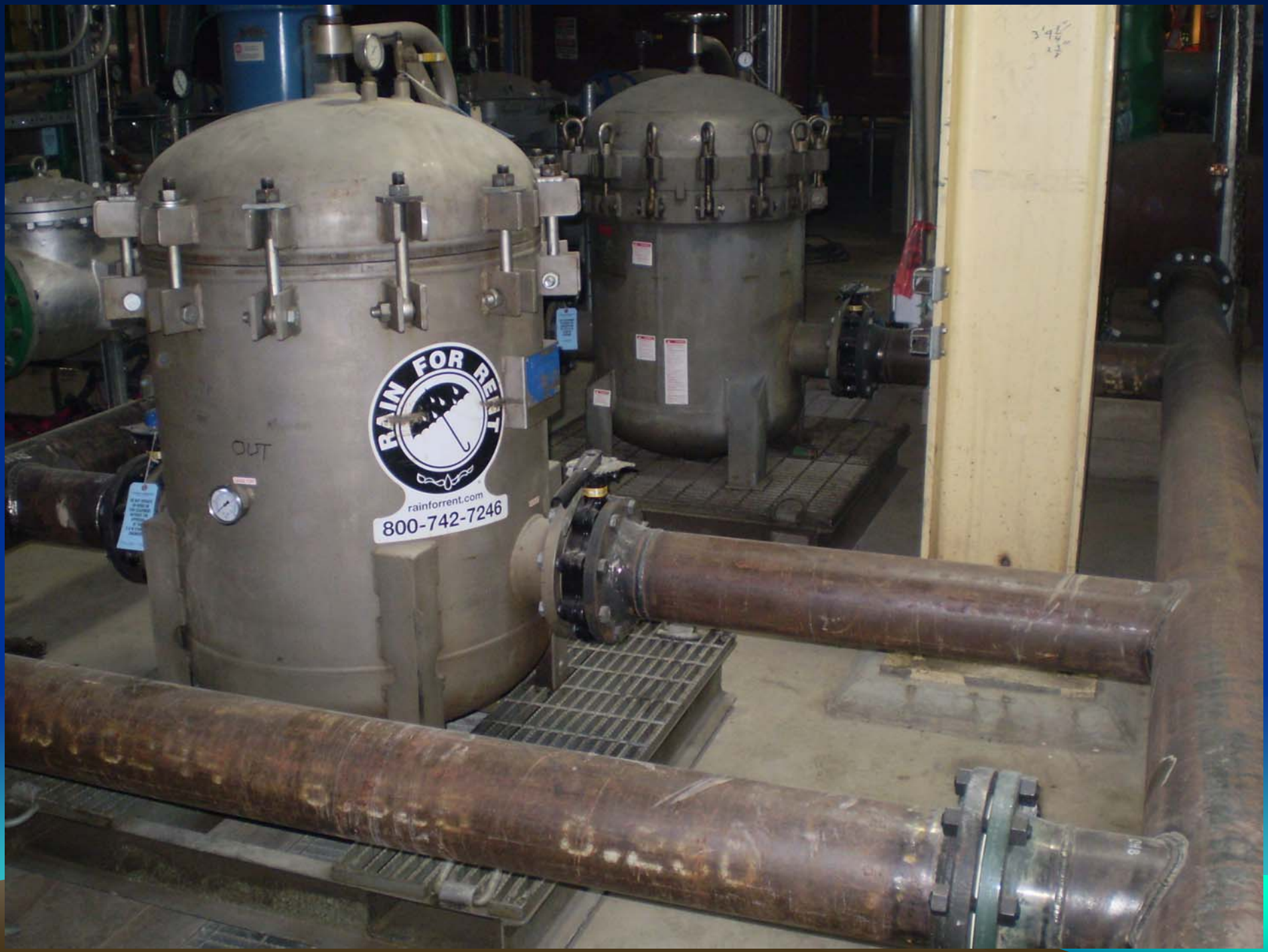


Debris in Strainers prior to Condensate pumps



Initial ACC Cleanup cont.

- Goal was to clean up one street at a time until water quality was acceptable and then move to next street.
- Started with Streets 1-4, which are always in service, then added additional streets as things cleaned up
- Sidestream filtration with 10 um filters
- 500 gpm coming off Condensate Pump Discharge, through filters, and looped back to the Hotwell.


RAIN FOR RENT
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800-742-7246
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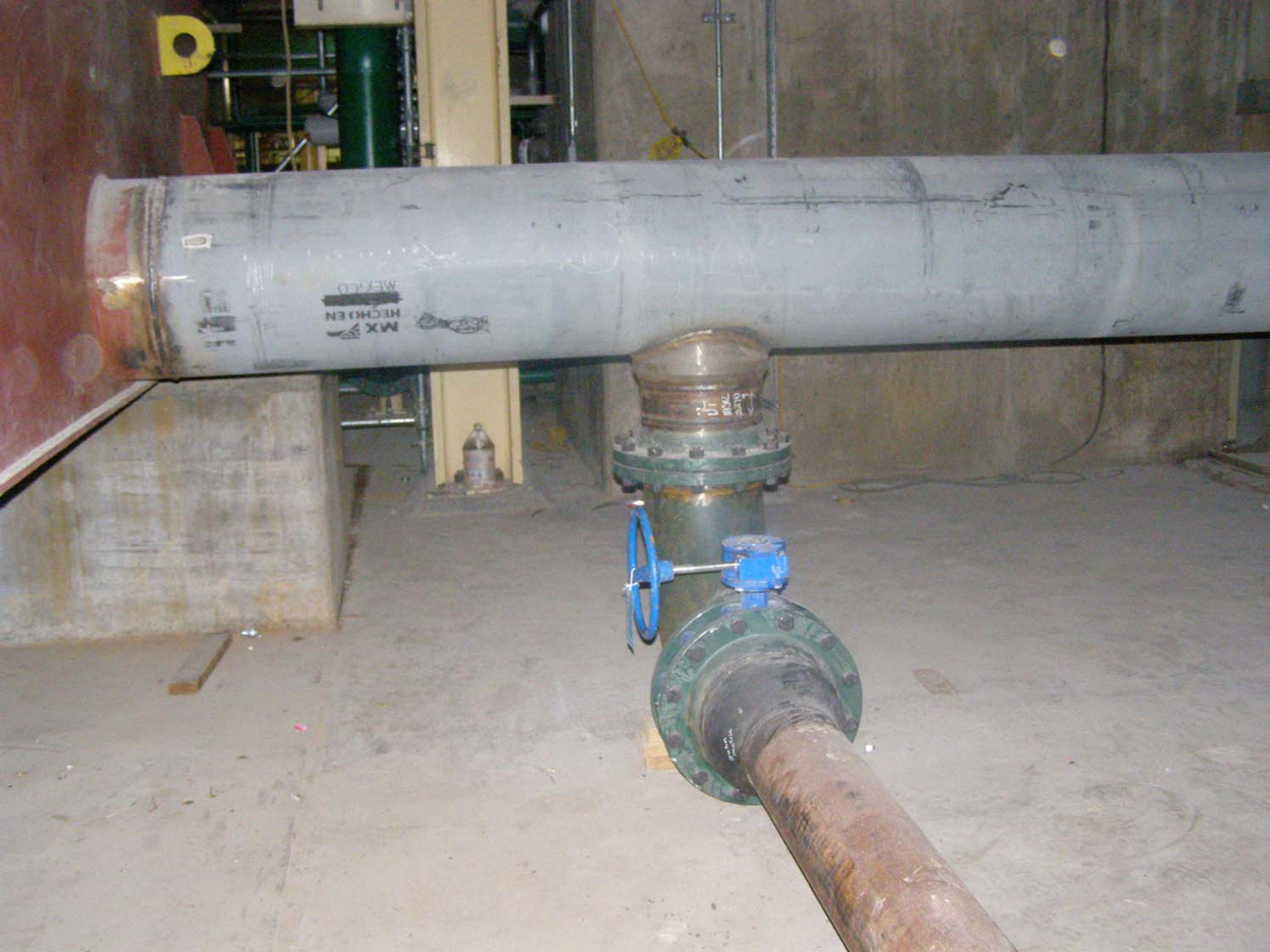
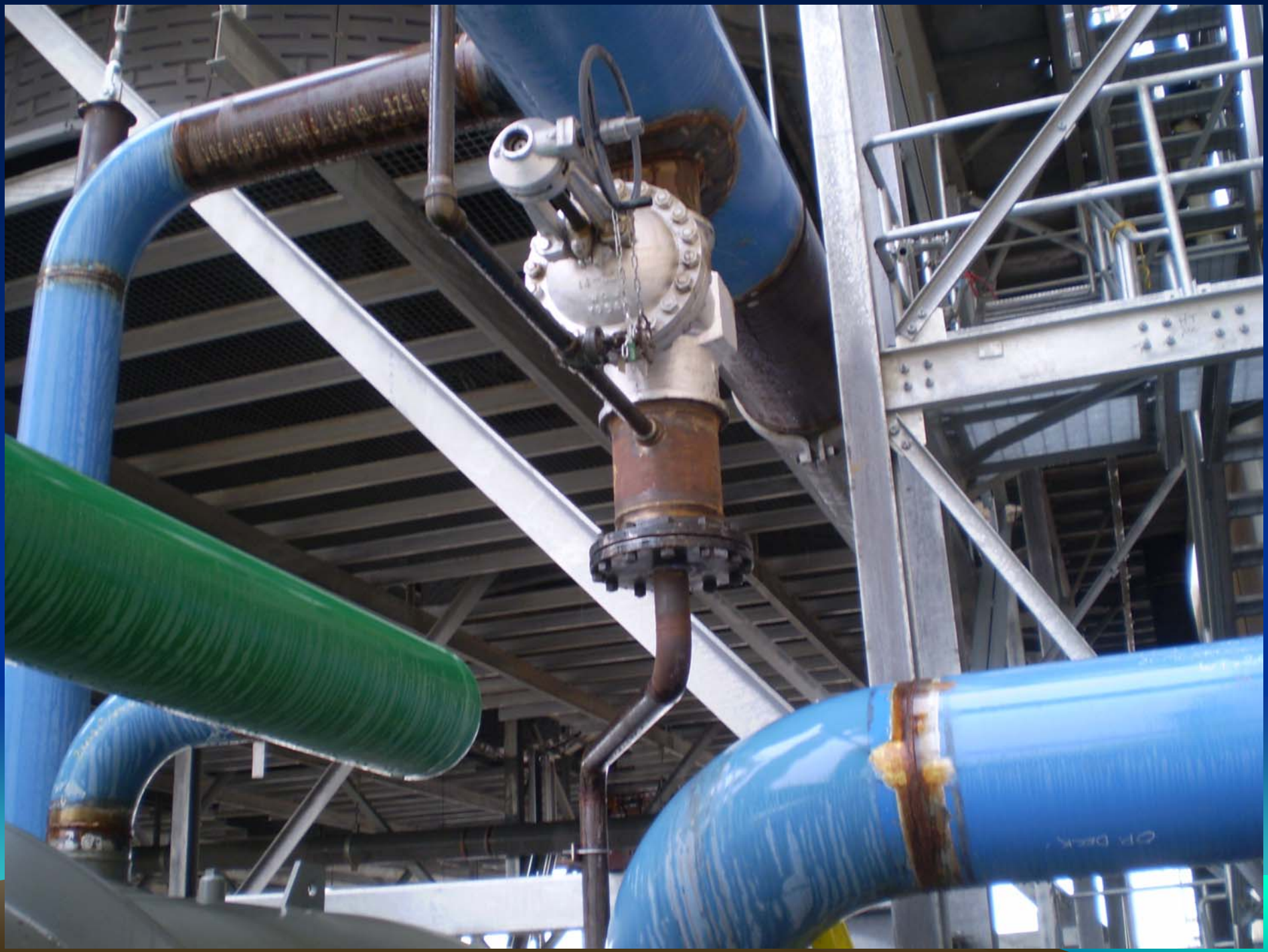
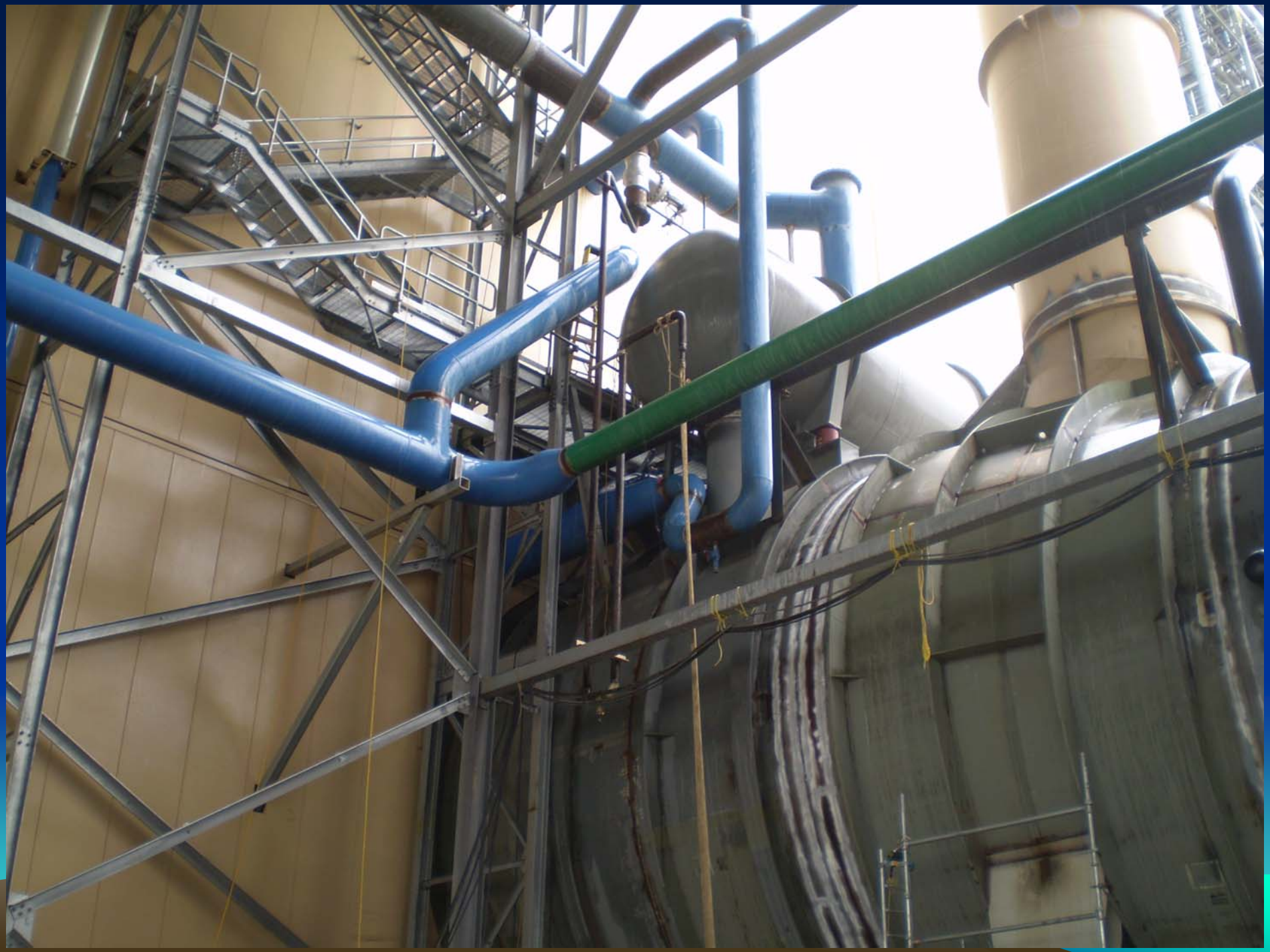
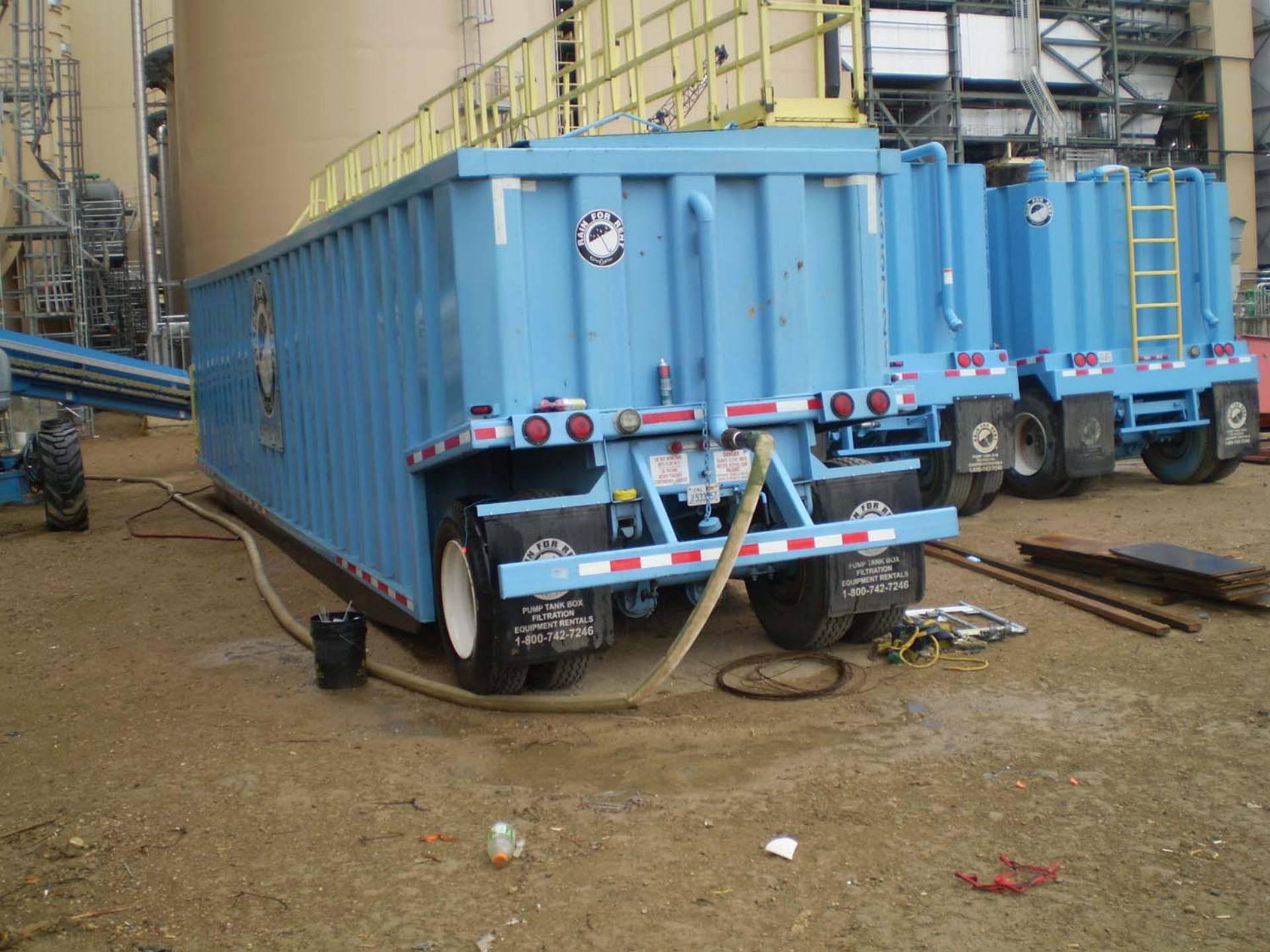


Initial ACC Cleanup, cont.

- 200 GPM coming off prior to ACC DA through temporary piping and fire hose
- Water ran through a series of Frac tanks
- First tank to slow water flow and dropped out larger particles
- Second tank had baffles to assist in dropping out smaller particles
- Third tank was a holding tank to cool water before it went to the drain



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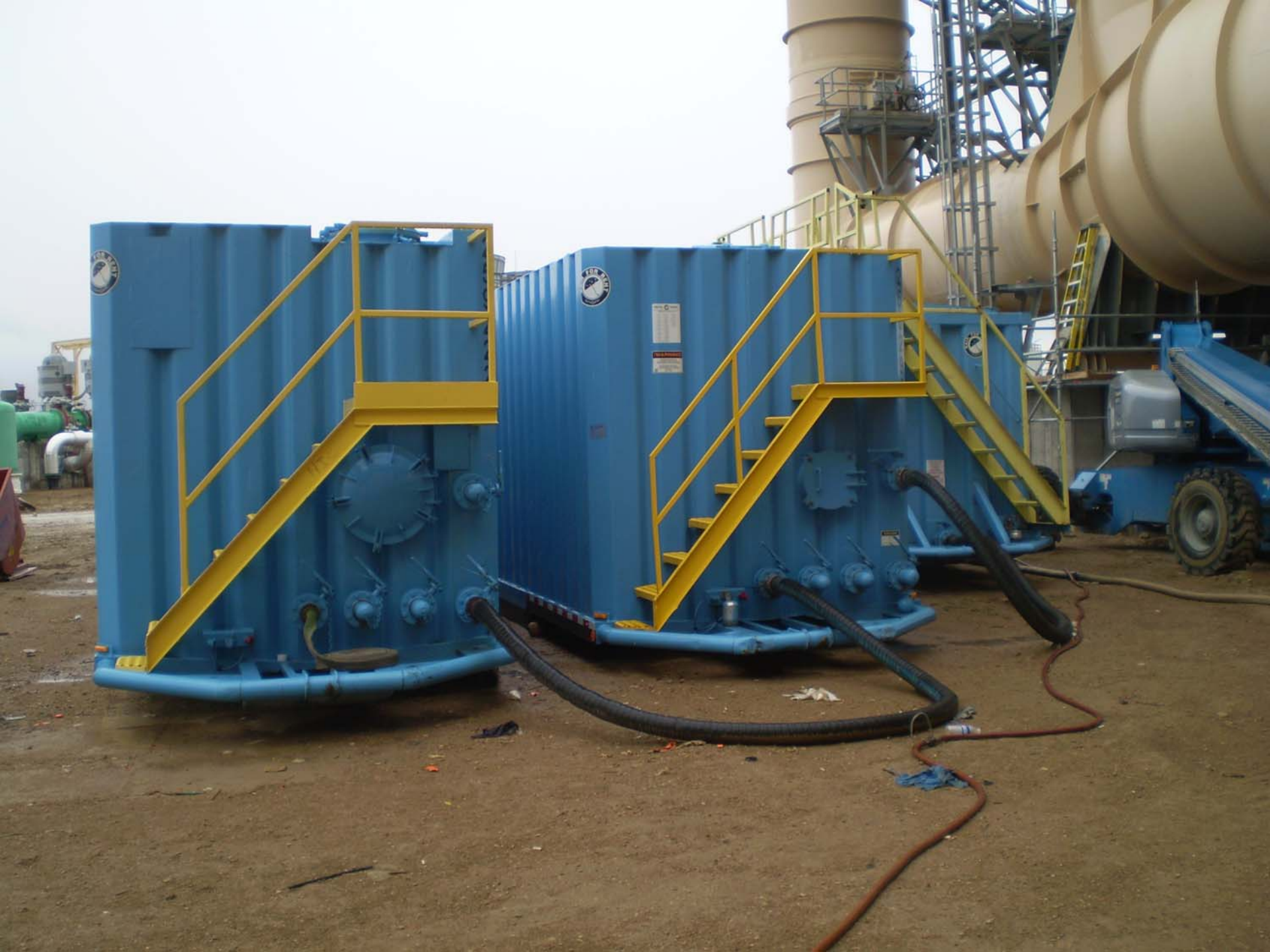
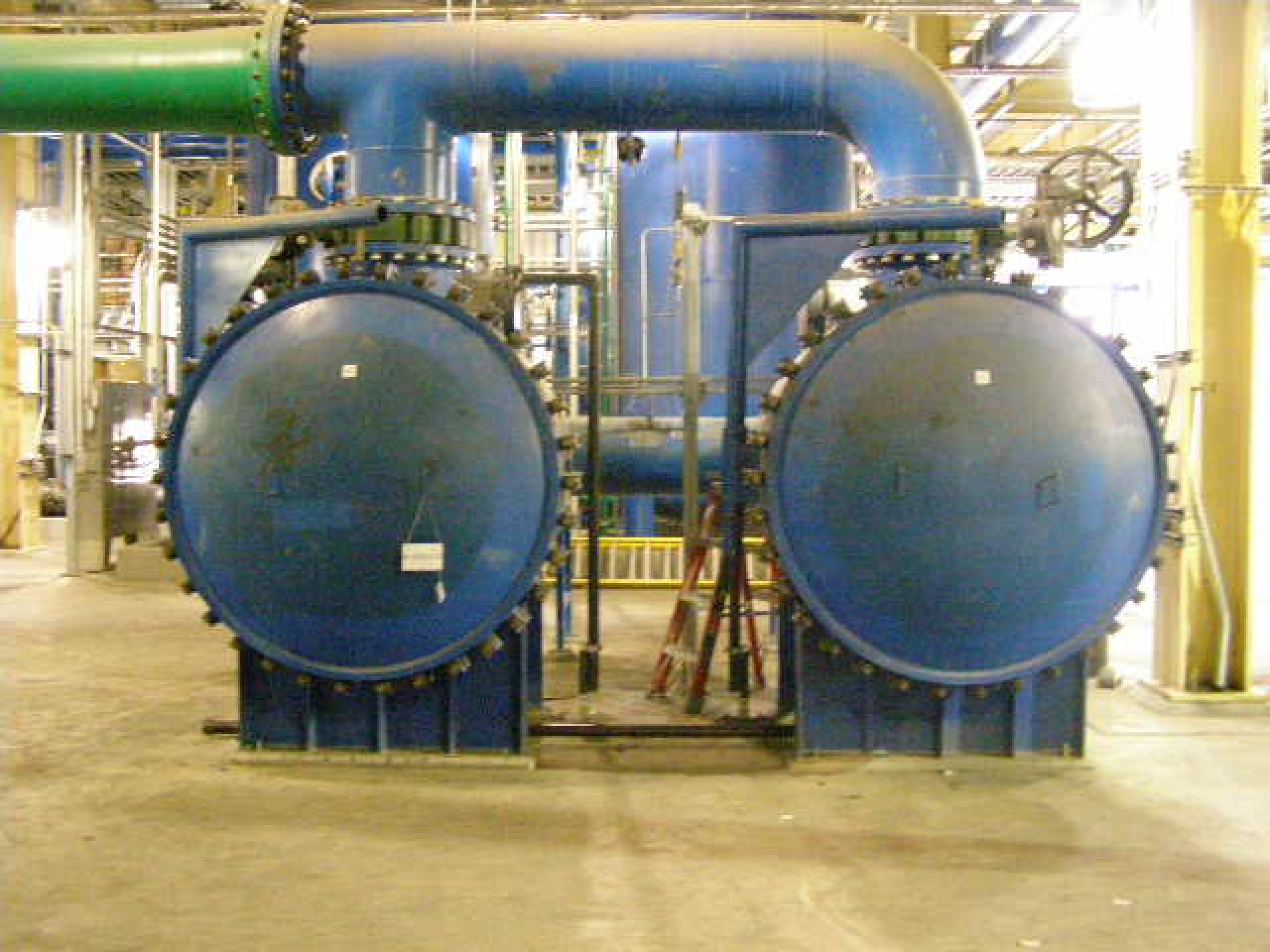


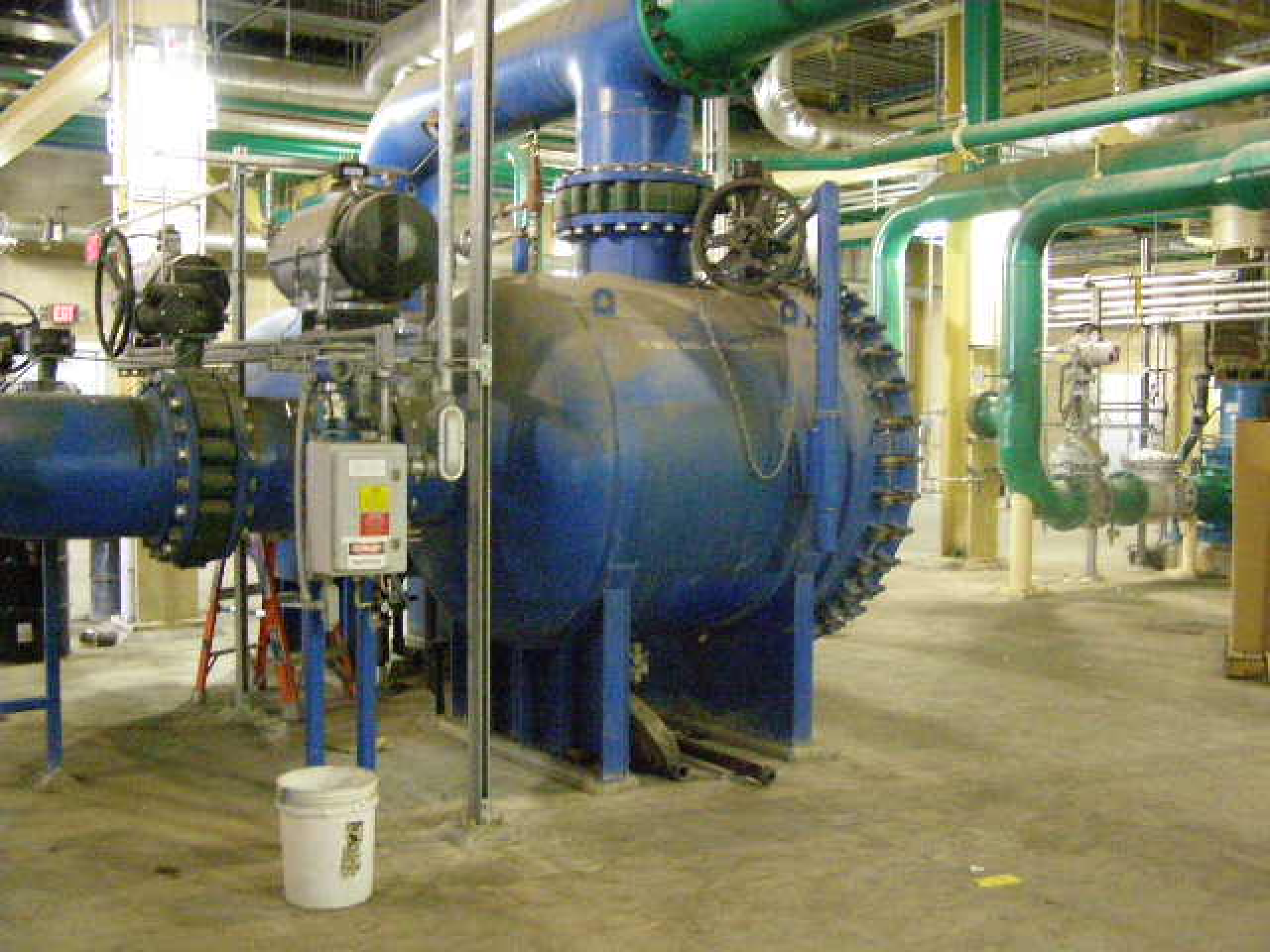
Comanche 3 Condensate Filtration

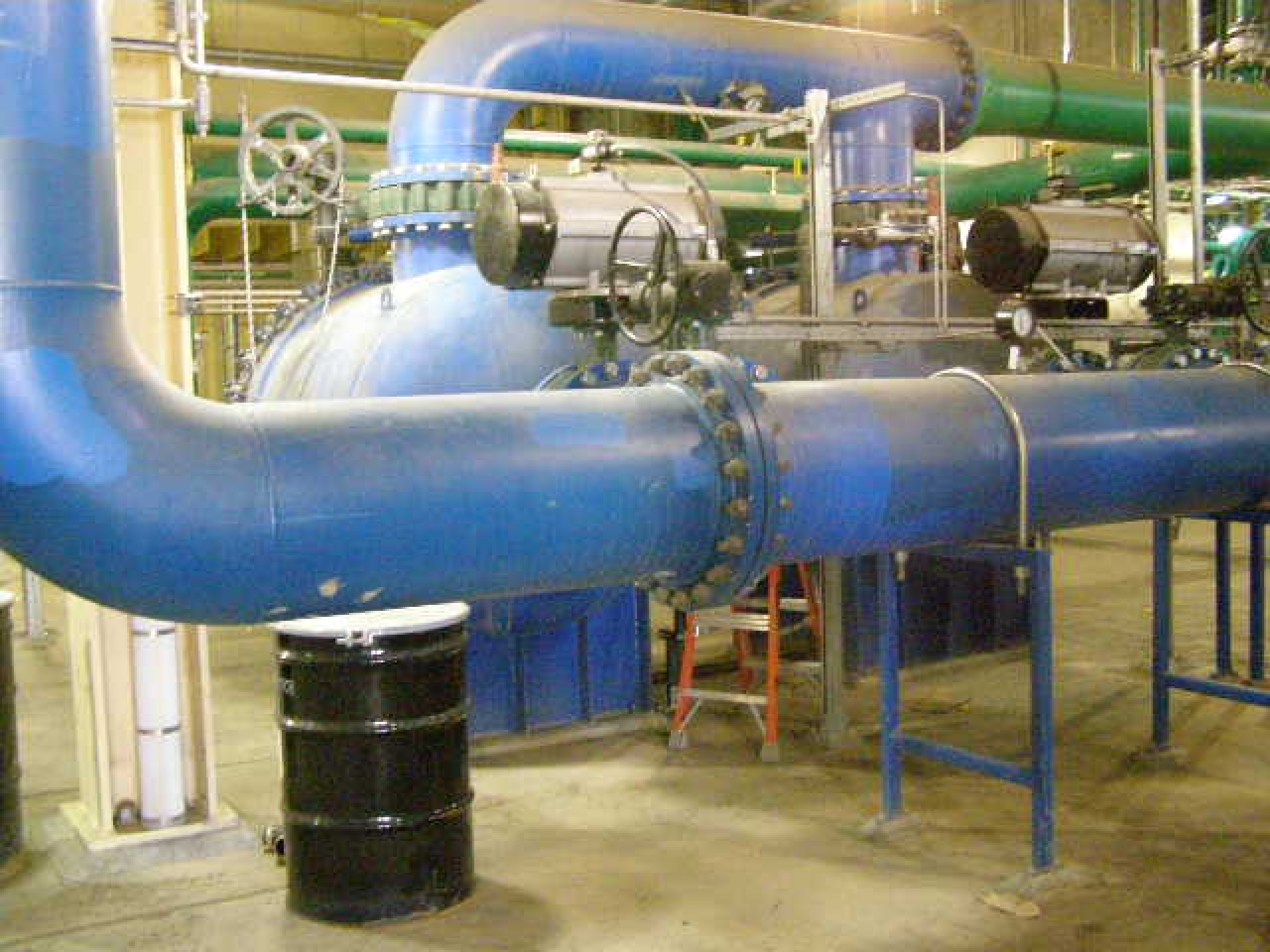
- Why use particulate filtration? Large carbon steel surface area in ACC, particulate iron oxide release
- Deep-bed condensate polishers not suitable for filtration and lose capacity with iron fouling
  - contamination into supercritical boiler
  - expense for off-site resin regeneration



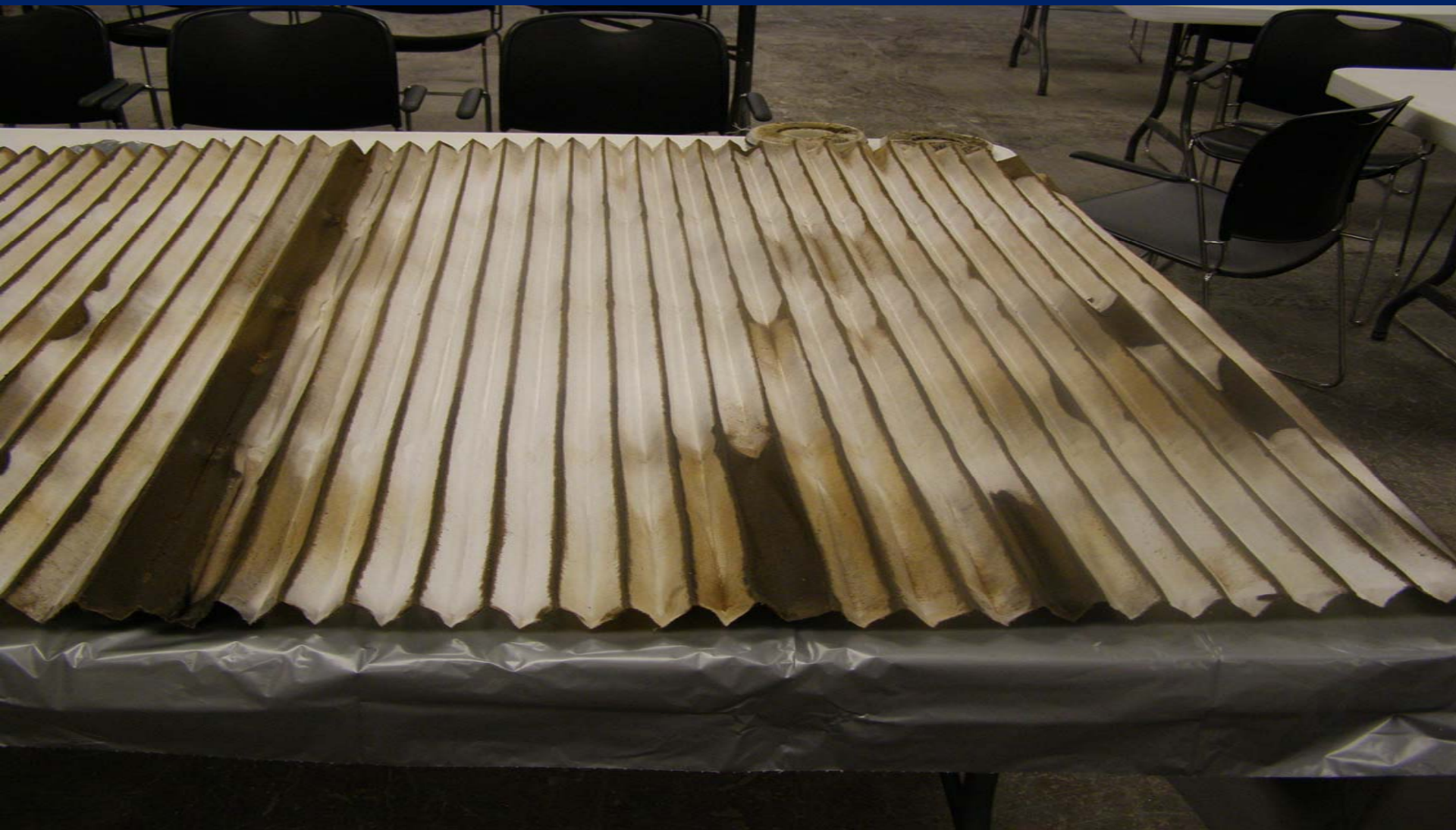
Permanent Iron Filtration

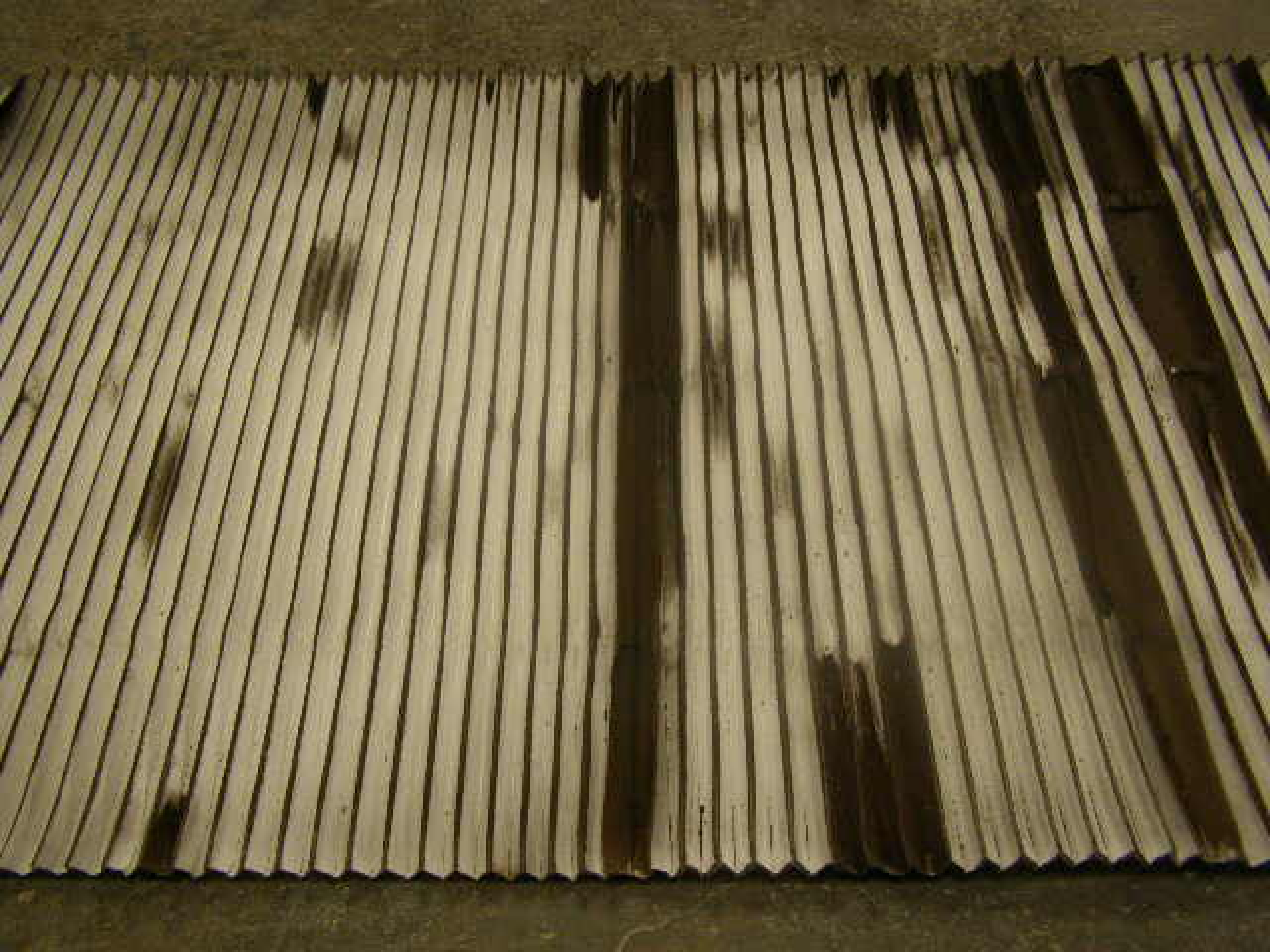
- 2 Fil-trek vessels (9000 gpm condensate flow) One in service at all times, one in stand-by
- Each vessel holds 47 filter elements.
- Started out initial cleanup with 40 um filter elements
- Used approximately 14 sets of 40 um filters





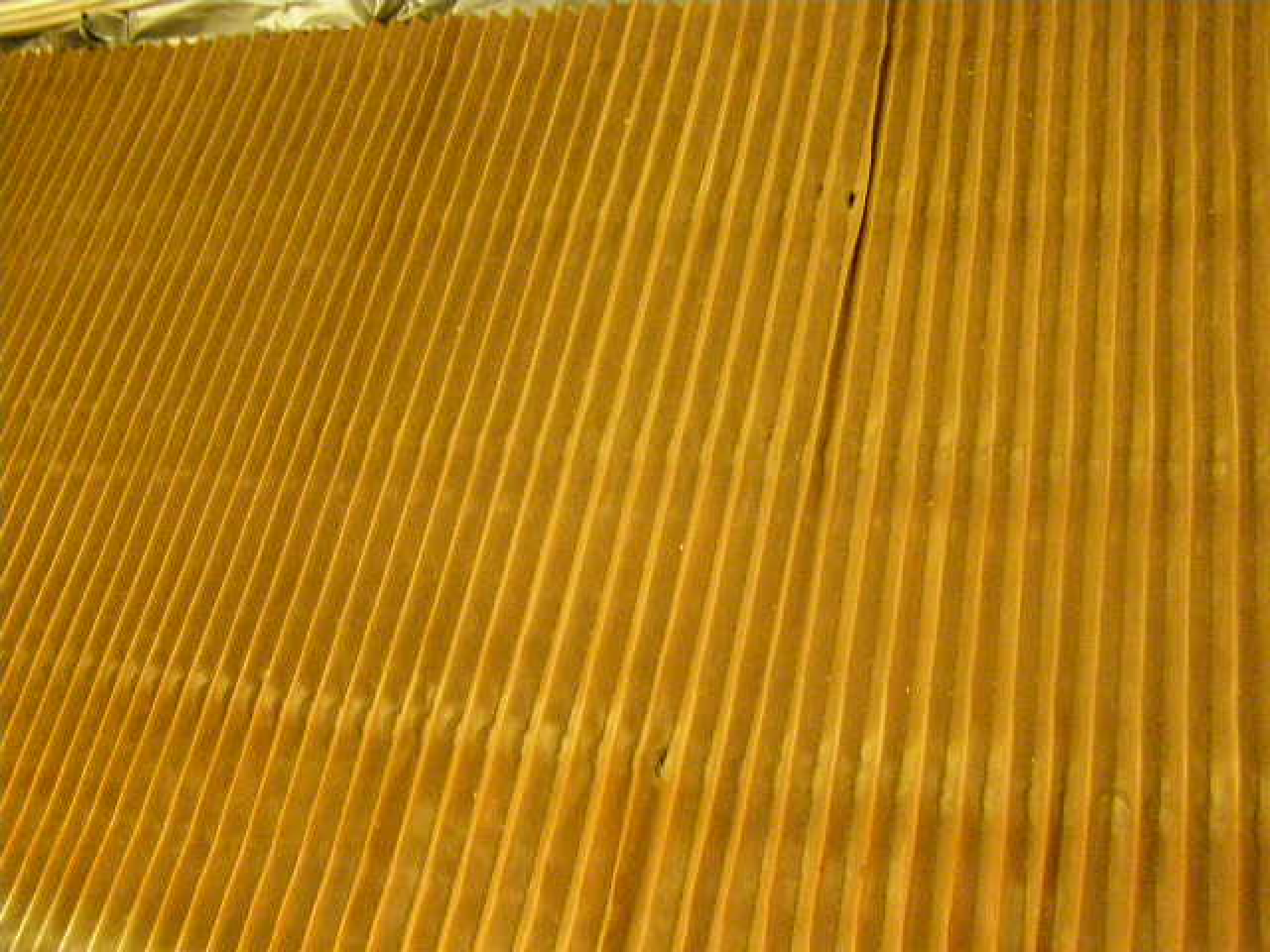
40 um filters cut open and exhibited poor distribution





- Contacted supplier and asked for a design change
- After 40 um’s used, went to 10 um filter elements with the eventual goal of 3 um to be in service all the time
- 10 um’s continued to exhibit poor pickup of particulate. Differential pressure of 15 was being reached before filters were full

- Pre-weighed filters to determine pounds of iron collected
- Iron pickup ranged from 1 pound per filter element to 5 pounds with latest design per filter
- Design change and also longer runs yielded filters being completely coated when taken out of service



- Started putting 3 micron filters in service for startup
- Even distribution and pick up of iron in system
- Filters lasted 14 days before exhausting

- 10 um filters registered differential pressure of 8 when first put in service
- Also saw fluctuations in differential pressure, depending on load
- Unsure if we could ever use 3 um’s, except on startup
- Proper installation of filters is imperative
- Noticed a huge difference in effectiveness when Xcel Maintenance took over installation

- We have been able to use 3 micron filters at full load
- Continuing to see longer runs. Hopefully, that trend will continue
- Shortest time in service since we came to steady state operation is 8 days, most recent filters have been in 30+ days

Questions?