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DRAFT FOR DISCUSSION

February 23, 2018
3420-LTR-01

John D'Angelo
Fuller D'Angelo
45 Knollwood Road
Elmsford, NY 10523

RE: Haldane Central School District Steam System-Pipe Failures

Dear Mr. D'Angelo;

Thank you for meeting me onsite on Tuesday February 6, 2018 to walk the steam system associated with the Haldane Central School District 15 Craigside Drive, Cold Spring NY 10516. The purpose of walk thru was to discover the extent of the previous steam failures and identify appropriate areas for further testing.

Observations- Site Visit

What was observed was the extent of the steam system inclusive of the recently replaced boilers, new interconnect piping, insulated main headers and the existing distribution piping along the service corridors connecting the boiler plant to the two building extensions. Access to the crawlspace piping under the main building was provided but limited to a visual inspection at the start of the crawl space.

The typical class room's steam radiators piping connections and floor penetrations were observed for signs of exterior corrosion. None were observed. Note the bottom of many of the classroom radiators were not visible and may either be present in a false ceiling or wall.

Previous failed pipe sections were provided for off site analysis. Initial review of the piping sections revealed the failures due to a corrosion mechanism in the "Outside-In" direction.

In all approximately 100-150 feet of pipe length were observed for future testing purposes.

Observations - Sample Examination

The two sections of failed pipes provided to us were examined in our lab, where they were provided unique sample identification, photographed, sectioned axially and cleaned. The samples were identified as samples 113950 and 113951.

Our analysis revealed the following for both samples:

1. Severe corrosion damage exhibited on the exterior of the elbow connections
2. Failure (leaks) occurred at the threaded pipe/elbow interface.
3. A hole approx 1/8" diameter was observed approximately 6" from elbow connection.
4. Severe corrosion extends approx. 10" away from the elbow connection
5. Beyond the 10" distance the pipe was observed to be in good condition with only minor surface corrosion present on both the exterior and interior pipe surfaces.
6. Corrosion appears to be limited to the exterior of the pipe.
7. The interior condition was acceptable.

Observations - Previous pipe failures

Table -1 - Pipe Summary Failures- Haldane Schools RAHEPC - 3420 - LTR - 01 dated February 23, 2018			
<u>Haldane Building and Grounds - Piping System Remediation</u>			
<u>Item No.</u>	<u>Approx. Date</u>	<u>Location</u>	<u>Notes</u>
1	2002	MS Science Room	
2	2005-2006	HS Art Room	Access Thru ES Art Room: Condensate Return Pipe
3	2005-2006	Tunnel Entrance	Southern End: steam pipe
4	2005-2006	Crawlspace thru tunnel between two art rooms	Thru ES Library access panel
5	2007	Pipe under present Nurse's office	
6	2010	1 st Floor MS boys room	Steam Pipe

<u>Item No.</u>	<u>Approx. Date</u>	<u>Location</u>	<u>Notes</u>
7	2011-2012	Greenhouse/Room 101	MS Side entrance; steam pipe
8	2014	Under Stage	steam pipe, included abatement
9	2016	Bell Parking Lot entrance	condensate return pipe
10	2016-2017	Room 107	Thru Simon's room ceiling; steam pipe
11	2016-2017	1 st floor ES girls room	Southside leak - Art Room access; steam pipe
12	2016-2017	ES Library	steam pipe

The above list present the log of the previous steam system pipe failures. Not indicated on the table but relayed to us for consideration is the fact these failures exhibited the same characteristics as the samples ,113950 and 113951, which is they all leaked at the threaded elbow connection, exhibited corrosion from the outside which was limited to approximately 10" from the leak at the elbow.

Conclusions/Next Steps

The cause of the observed failures as represented by samples 113950 and 113951 is outside in corrosion. This occurs when the exterior of the pipe becomes wet and is allowed to remain wet as is the case under insulation. Failures occurred at the elbows as these typically present breaks or ends of insulation that allow water/moisture to enter the pipe surfaces. This process can be cyclical and can take years to failure.

The source of the wetness responsible for the corrosion for the samples presented for examination was not identified. It is interesting to note there was a section of steam pipe distribution that was understood to be original and exhibits exterior corrosion similar to the samples provided. Please see Figure 2A and 2B.

Table 1 lists the other failures observed over the past 16 years. If the mechanism of failure was similar to our tested samples the source of the wetness was not immediately evident in those areas. The pipes observed in our walk thru did not reveal a degraded corrosion condition that would lead to failure as reported or observed in our samples.

It would be our recommendation to conduct a greater survey of the steam system. As an example trace out piping within the crawlspace. Expose piping concealed by either wall or ceiling for a visual inspection. Additionally, the sources of wetness responsible for the corrosion should be determined and used a predictor for the rest of the original piping

portions of the system.

If there are any questions regarding these results please do not hesitate to call.

Very truly yours,

R A HOFFMANN ENGINEERING, PC

A handwritten signature in black ink, appearing to read "Robert Hoffmann", written in a cursive style.

Robert Hoffmann
Mechanical Engineer

REH/:tep
cc: RA.Hoffmann

DRAFT FOR DISCUSSION

FIGURES

1A



1C



1B



Figures 1. **Boiler Room**: Figures 1A and 1B show the recent boilers. Figure 1C shows the insulated steam pipe headers and main distribution piping.

2A



2B

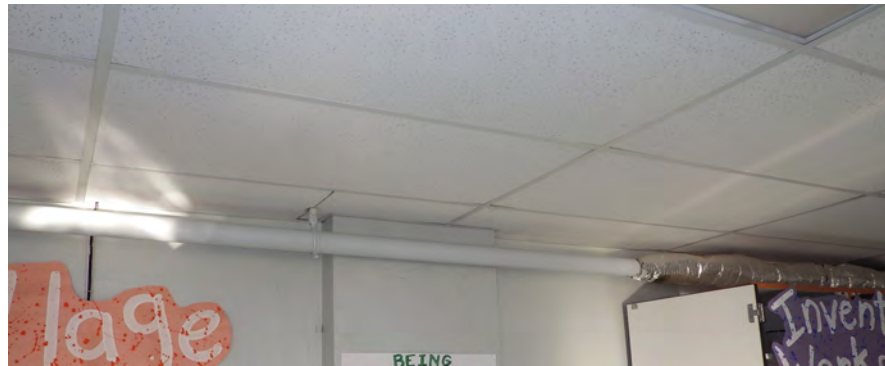


Figures 2A & 2B. **Boiler Room - Corrosion on exposed piping.** Figure 2A highlights a small section of steel piping associated with the Condensate Treatment Feed system an unavoidable hot and aggressive environment. Figure 2 B represents a section of steam distribution piping that is believed to be original. Note the exterior corrosion present.

3A



3B



3C



Figures 3A,3B and 3C. **Service Corridor/Art Room B5** Figures 3A notes thje service corridor and the well insulated lines Figures 3B and 3C reveal the condition of the partially exposed steam line within the art toom. Figure 3C is of the elbow. Not corrosion was noted.

4A



4B



Figures 4A and 4B. **Exposed Steam piping - Steam/HW Room** Figures 4 reveals the exposed condition of a portion of uninsulated piping within the Steam/HW HX room that provides HW heating to the 1960's era expansion space. Extensive corrosion is not present.

5A



5B



5C



5D



5E



Figures 5. **Typical Radiator Pipe Penetrations:** Figures 5A thru, 5E reveal the typical floor pipe penetrations. No visible pass thru visible to the lower floors. Figure 5E is of the 1st Floor ES Girls Room. (Item # 11 on the ITable1) A sleeve was provided to protect the pipe.

6A



6B



6C



6D



6E



Figures 6. **Sample 113950 and 113951** Figures 5A, documents the samples as recieved. Figures 6B,C,D, and E reveal the exterior and interior of the sample 113951 after sectioning as well as before and after media blast cleaning.

7A



7B



Figures 76. **Sample 113951** Composite images 7A, 7B reveal the interior of the failed pipe sample after being sectioned and. One half was cleaned. The variation in pipe wall thickness from thin (failed) to normal the further away from the elbow (figure 7B arrows). Note the perforation in 7A.