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WELLESLEY MIDDLE SCHOOL
HEATING DISTRIBUTION PIPING & SYSTEM UPGRADES STUDY

Submitted to: **Mr. Joseph F. McDonough, P.E., Town of Wellesley**

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Submitted by: RDK ENGINEERS

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SECTION 1

INTRODUCTION AND CONCEPTUAL DESIGN SUBMITTAL CHECKLIST

SECTION 1.0 – Introduction and Conceptual Design Submittal Checklist

RDK has been contracted by the Town of Wellesley Facilities Management Department (FMD) to complete a comprehensive study of the steam heating condensate piping distribution systems and potentially to provide new hot water boilers to replace the steam to hot water heat exchangers at the Middle School in Wellesley, Massachusetts. The scope of work includes site surveys, review of existing building documentation, analysis of existing conditions and recommendations for improvements. The intent of this report is to provide Wellesley FMD with viable renovation options that provide a basis for decisions with regard to capital expenditures. The recommendations herein address the following:

- Provide new piping installed such that there is minimum impact to operation of the existing heating systems.
- Provide a construction scenario whereby the building can be quickly and efficiently fit out with new piping for a long term fix to address the imposing piping failures.
- Provide new hot water boilers to replace the obsolete steam to hot water heat exchangers.
- Identify interim measures that can be taken to limit impact of system failures that may occur prior to implementation of a permanent solution.

Deliverables:

☒	Project Narrative: - Existing conditions analysis - Explanation of proposed solution
☒	Conceptual Design Drawings
☒	Code Analysis
☒	Budgetary Cost Estimate
☒	Photographs
☒	Ultrasonic Testing
☒	Destructive (Pipe Removal Testing)

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SECTION 2

PROJECT NARRATIVE

2.1a INTRODUCTION

2.1b EXECUTIVE SUMMARY

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2.2b ULTRASONIC TESTING REVIEW

2.2c SERVICE LIFE

2.2d FIELD SAMPLING OF CONDENSATE PIPING

2.3a PROPOSED DESIGN (Explanation of Proposed Solution)

2.3b LCAA SUMMARY

2.4 INTERIM MEASURES (Explanation of proposed immediate actions to reduce risk of school shutdown)

RDK ENGINEERS
200 Brickstone Square | Andover, MA 01810-1488
P: 978-296-6200 | F: 978-296-6201

SECTION 2 - PROJECT NARRATIVE

SECTION 2.1a - Introduction

RDK Engineers has been contracted by the Town of Wellesley Facilities Management Department (FMD) to complete a comprehensive study of the steam heating condensate distribution piping systems and potentially to provide new hot water boilers to replace the steam to hot water heat exchangers at the 228,000 square foot Wellesley Middle School built in 1952 with additions in 1958 and 1966 and renovations in 2006-2008 and 2011, located at 40 Kingsbury Street, Wellesley, Mass.

RDK Engineers surveyed the building, discussed the current operation with maintenance and operational personnel, and reviewed available building drawings. The purpose of this report is two-fold:

1. to evaluate/confirm the existing conditions of the steam heating condensate distribution piping systems
2. to evaluate replacing the steam to hot water heat exchangers with high efficiency hot water boilers.

Additionally this report will analyze the existing conditions and provide options to implement specific recommendations of corrective actions to the Town of Wellesley. This report includes Project Schedule Information and Estimated Project Costs which can be used for budgetary purposes.

SECTION 2.1b - EXECUTIVE SUMMARY

Overall, RDK has recommended that the existing steam heating condensate distribution piping be replaced and has recommended high efficiency hot water boilers replace the steam to hot water heat exchangers. These recommendations, if implemented, will align the entire steam/condensate heating system for another 25-30 years of useful life expectancy.

TOWN MUST PLAN FOR IMMINENT FAILURE

The condensate system at the WMS has reached a critical condition in our opinion, it is not a matter of if the system will fail, but rather how often and how severe the failures will be.

1. Numerous recent pipe failures have already occurred, deterioration is accelerating (near catastrophic failures in April 2015 and December 2016).
2. Ultrasonic pipe testing has confirmed that the majority of condensate piping has completely deteriorated – are not correct or required thickness, and shows signs of "deep pitting".
3. Physical pipe removal for inspection has confirmed that piping is no longer viable.
4. Visual inspections by our engineers noted very aged piping (67 years) well beyond expected life expectancy of 50 years.
    - We noted poorly supported piping and failing hangers
    - Piping sagging in several locations
    - Insulation wet and damaged, causing exterior corrosion in addition to the noted interior corrosion
    - Fittings showing signs of leaks and drips
5. Shell and Tube Heat Exchangers that serve large classroom wings are at risk of failure based on age, the condition of the piping and considering the fact that these have narrow tube bundles and are likely more susceptible to thinning pipe thicknesses.

Replacement of the piping system at WMS was originally included in the 2006-2008 renovation scope of work, but was deferred for budget reasons. A previous study by SMMA (2014) also recognized the need for replacement.

ACTIONS REQUIRED – SHORT TERM

Recognizing the overall time needed to implement a permanent solution (design, bidding, Town approval, contracting and construction), two interim measures can be taken to help prepare and mitigate the expected continued failures:

1. Replace obsolete isolation valves to limit extent of shutdowns in areas of the building that will have failures (already completed by FMD Maintenance staff).

2. Develop plans to repair existing steam heat exchangers (HEX) in the event of failure of one to allow one HEX to continue functioning.
    a. These are critical to school, and are 60 years old.
    b. Contract with repair vendor in case of failure for 24-48 hour repair.

ACTIONS REQUIRED – LONG TERM

The obvious and only solution in our opinion is to replace the existing steam condensate piping to the greatest extent possible. We also strongly recommend replacement of the steam-to-hot water heat exchangers (HEXs) with hi-efficient hot water boilers. These systems are beyond service life and exhibiting signs of failure.

1. Completely replace all horizontal steam condensate piping in the building (crawl spaces & tunnel):
    - Most work is below the occupied levels in confined space areas.
    - Upgrade crawl spaces and tunnels with improved access for maintenance.
    - Upgrade crawl spaces and tunnels with ventilation for humidity control.
    - Upgrade crawl spaces to include minimum lighting and power.
    - Note, small run-outs to Unit ventilators will remain in place to avoid work in the classrooms but will be equipped with new shut off valves in the crawls spaces.
2. The above mentioned pipe work cannot be done over one or two summers only, and will likely require work during the school year which could be done on 2nd shift.
3. Removal and replacement of the HEXs will yield significant operating savings with the addition of hot water boilers.
    - The HEXs are a relic of past technologies and should not be part of a 30 year plan
    - Installing the boilers remotely in the classroom wings will also eliminate dependency on lengthy runs of existing hot water piping in the crawl spaces. Although the hot water piping has not experienced failures it's reasonable to expect that it will be replaced in the near future do its age and environment.
    - The new boilers will yield an 18%-20% efficiency gain in the areas served (two 1966 wings and the 1957 south wing). A LCCA indicates an 8 year payback.
    - Gas company incentives should be available for this project.
4. Tremendous overall increase in efficiency (Note: Wellesley Middle School uses twice as much natural gas as the high school on a square foot basis).

ITEMS NOT INCLUDED IN THIS PROJECT SCOPE

1. The replacement of all steam unit ventilators, heaters, baseboard, etc. (equipment and devices largely replaced in 2006-2008 renovation).
2. Auditorium, Gym A&B and Kitchen H&V Units (deleted from 2006-2008 renovation due to budget and pending as future town Capital projects FY 21).
3. Steam Supply Piping (deemed to have adequate remaining service life).
4. Steam Boilers (installed in 2006-2008).

5. Steam, condensate and hot water piping above the basement crawl space/tunnel level.
6. Vertical condensate piping (testing yielded positive life expectancy).

BUDGETARY COST ESTIMATE

The anticipated conceptual level project costs include estimated hard construction costs, as well as soft costs for designer services and Owner's Project Manager (OPM) services. Escalation factors to reflect anticipated bidding dates and contingencies to reflect the nature of renovation work in a school building are included. Contingencies must address constraints such as working second shift and summers to minimize construction impacts to the learning environment.

The cost estimates will be refined as the project progresses through define phases and ultimately through receipt of competitive bids. The current estimated total project cost to replace the steam heating condensate distribution piping and the two heat exchangers with new condensing boilers is approximately $4,340,000.

PROJECT SCHEDULE

The current project schedule assumes that design funds will be requested at the 2018 Annual Town Meeting (ATM) and construction funds will be requested one year later at the 2019 ATM. This "two step" process of requesting design funds first and then requesting construction funds with "bids-in-hand" is the preferred approach by the Town's Permanent Building Committee (PBC). It is particularly appropriate for "non-routine" projects (school construction limitations, confined space issues, etc.) such as this; which are often difficult to estimate.

The construction would ideally start immediately after the 2019 ATM, which would require that the funds be made available as part of the FY19 budget. The early start would allow for material ordering and ensure that on-site work could begin upon summer recess. Work would continue into the fall, but would then be performed on "second shift" to minimize impact to school functions. If necessary, construction will be completed in the next summer (2020).

SECTION 2.2a - EXISTING CONDITIONS

STEAM HEATING PLANT

The Middle School is currently being provided heat from three (3) cast iron sectional boilers. Each boiler has a maximum output of 4,240,000 MBH and each have been sized for approximately 67% of the building total heating load. The boilers each have a Power Flame burner which was a dual fuel burner (#2 fuel oil and gas); however, these have been modified to fire natural gas only now. A buried oil storage tank was removed by the Town in 2016. Steam is distributed throughout the school via supply piping and returned using both gravity and pumped condensate systems to a boiler feed unit. The 1966 additions and 1957 South addition are heated by hot water generated by two steam to hot water heat exchangers. The hot water is distributed throughout the building by primary hot water pumps at the heat exchangers and secondary hot water pumps located in the crawlspace and old generator room. The heat exchangers and pumps appear original to the time of construction. Water treatment equipment exists within the boiler room and records of treatment appear well defined. In addition, other repair such as condensate pump/transfer units, have been replaced by FMD. Key aspects of the existing steam heating plant are shown in the plan following.

PLAN – EXISTING CONDITIONS

Combustion air is introduced into the boiler room mechanically by a dedicated steam heated ventilation unit and appears in compliance with mechanical codes. All the boilers have breeching that leads into a masonry chimney that goes up through the roof. The HVAC equipment is controlled and monitored by existing digital and electric-mechanical controls (Metasys).

Based on reviews of previous reports all asbestos containing materials (ACM) within the boiler room and the distribution piping and equipment beyond has been removed.

MECHANICAL DISTRIBUTION SYSTEMS

The Wellesley Middle School is equipped with a combination heating system consisting of both steam and hot water distribution system comprised mostly of steel piping feeding fin tube radiation, cabinet unit heaters, unit heaters, air handling units, and unit ventilators. The steam heating system consists of two pipes. Steam (supply) conveys a gas (i.e. steam) and the return is a liquid (condensate). By nature, each has a significant difference in life expectancy of the piping material. The heating steam and hot water supply and return mains are fed throughout the school mostly via accessible crawlspaces and tunnels (confined space situations) beneath the ground floor or exposed within ground floor ceilings. The piping located within these areas is typically wrapped with fiberglass insulation. The insulation of the piping within the trench is in poor condition with its vapor barrier breeched, insulation degraded due to moisture from previous leaks, high humidity, and sections missing in multiple locations. The steam supply and hot water supply and return piping located within the crawlspaces and ground floors, as well as the runouts to the terminal units, are original to the years of construction and are in fair condition based upon the age and its' physical condition as evidenced by the photographs shown in the appendix (Section 6.4). The steam condensate piping located within the crawlspaces and ground floors, however, appears to be in poor to failed conditions based on upon the age, observed repairs, destructive and non-destructive testing results, and its physical condition. FMD maintenance data (Section 6.5 of appendices) also support these observations. Test reports note that in select locations up to 90% of the original piping wall thickness has deteriorated/corroded away making the piping susceptible to imminent failure. This is particularly evident at the threaded pipe joint locations, as well as long sections of un-sloped piping, allowing collection of standing water for long periods of time during the heating off-season.

Potential Issues

There are several issues of concern with the current conditions. First is the age of piping, with a majority of the system approaching 70 years. This is well beyond the life expectancy for steel piping, especially for condensate systems carrying a mixture of water and air that contributes to oxidation and degradation of the piping wall thicknesses. Refer to the Service Life Table in Section 2.2c, Table 2.2.c.1, for more information. This leads to eventual failure, particularly at threaded piping joints where the wall thickness is already compromised. These failures (leaks) can be large enough to force a heating system shutdown to accommodate an immediate repair causing the temporary loss

of use of the facility or parts thereof. FMD reported two such occurrences in April 2015 and December 2016. The rates of failure generally tend to increase with each year of use beyond an expected life of 50 years.

The second issue is the cost associated with increased maintenance consisting of piping repairs and/or replacements with higher labor costs during emergency repairs occurring off-hours, chemical treatment to address the higher conductivity (solids) levels in the piping from corrosion, insulation repair and/or replacement at areas of piping repair/replacement, and increased steam trap maintenance/failures due the contaminants in the heating media from corrosion among them. The most significant cost is that related to potential shut-down of school for an extended period and cost impacts to WPS and parents. The exact dollar value would be difficult to quantify, but it would be significant.

A third issue is the decrease in efficiency of the steam to hot water heat exchangers due to contaminants within the heating media increasing the fouling factors for each exchanger. This reduces the amount of surface area available for heat transfer thus requiring higher steam inputs to maintain constant hot water temperature outputs requiring more work and energy (fuel) of the existing boilers. This increase increases fuel cost and also translates into additional maintenance and/or repairs for all the sub-systems serving the boiler systems.

In addition, the HEXs are over 50 years old with a typical life expectancy of 25 years. Past failures have occurred with these HEXs. Since these are critical to the school's heating system, they require replacement.

SECTION 2.2b. ULTRASONIC TESTING REVIEW

RDK engaged CorrView International, LLC to perform ultrasonic inspections of the steam and condensate piping at several locations. Ultrasonic testing (UST) uses high frequency transmitting gear to perform non-destructive examinations of piping.

This ultrasonic testing and analysis report should be viewed as a first step in determining the general condition of the steam and steam condensate piping systems at the Wellesley Middle School. Although it is based upon accepted engineering calculations, ASTM pipe specifications, and the latest ultrasonic technology, it is not, in every case, intended to serve as an absolute and conclusive determination of pipe condition. The complete report is included in 6.2 of the Appendices.

Conclusions and Recommendations

The purpose of this summary section is to give a thorough and complete knowledge of the condition of the piping addressed in our field investigation. This report contains a large volume of new and often interrelated findings and/or relationships requiring a narrative explanation. Reviewing the specific test locations referenced throughout this narrative will likely assist in understanding its content.

This investigation was prompted due to various failures at primarily the steam condensate piping, but also at one example of steam supply pipe. Given the age of the school, interest was raised to define the condition of both piping systems in order to assist future planning decisions.

The results, which were accumulated over two days of field investigation by two ultrasonic technicians, are separated based upon piping system and are sorted based upon pipe size.

Steam Supply - Locations 1 through 36

UST identified generally excellent results for the steam supply system. Testing showed standard or schedule 40 pipe installed and a combination of carbon steel and wrought iron pipe. Wrought iron pipe was commonly used for steam and steam condensate systems prior to 1970 due to its high natural corrosion resistance and durability. It was removed from production in 1965 and is no longer available. Its presence at the Wellesley Middle School is a tremendous benefit as our results now document.

In terms of corrosion rate alone, UST identified low corrosion activity well below what would be considered normal for steam service. Average corrosion rates were typically at 0.2 mils per year (MPY) or slightly above, in comparison to the 0.5 (MPY) standard which is considered acceptable.

Best results were identified at any vertical or well inclined sections of pipe where testing measured almost negligible wall loss.

At locations No. 2 and 3, testing identified noticeably higher corrosion and pitting activity well beyond other pipe sections. A closer look at this expansion loop pipe section found it at a low point of the system and on a negative incline with a likely non-functioning steam trap. Testing the larger diameter mains elsewhere throughout the steam system produced excellent results showing generally very high and uniform average wall thickness approaching new pipe specifications.

For a school property of this size, the large number of large diameter steam supply mains raises the potential for higher steam condensate production. This places an added demand on steam traps both in their correct placement at low points of the system and to their proper functioning. Our understanding from speaking with others involved in this investigation from the school is that some steam traps were replaced a few years ago, but that not all steam traps have been replaced. It would be a very reasonable assumption that any older steam trap in service for more than 10 years is now non-functioning, and is either not removing steam condensate from the steam piping, or allowing steam to blow through into the condensate lines.

One failure brought to our attention at the steam condensate pipe where steam was released into the crawlspace, filling the entire crawlspace of the school. This could have only occurred due to steam trap failure pressurizing the failed condensate piping with live steam.

Shown at left and at location No. 50, rust evidence propelled upward against the wall and other piping from a steam condensate pipe failure could have only occurred if it was driven by pressure originating from the steam side. Otherwise, the water and rust contained within the condensate pipe would have simply leaked onto the ground.

To the question to define the condition of the steam system, our results are excellent and show virtually unlimited service life throughout the majority of steam pipe examples tested.

Results were even outstanding at small diameter examples of steam supply pipe where two additional factors of inherently lower wall thickness and an outside thread cut become relevant.

Toward the very end of the North crawlspace steam line at location No. 29 we again identified higher corrosion and pitting activity and can attribute that condition to a collection of condensate in the lines. Adjacent to this test location, a failure at the steam side had occurred. We believe this is a localized event due to steam condensing and remaining at the very end of the supply line and furthermost from the boilers. The steam pipe within this area of failure was of small 1-1/2 diameter and threaded, which also added further weakness.

Although the general condition of the steam piping is excellent, it must be recognized that our field investigation was limited by physical access and also by what could be completed during a scheduled two-day field investigation. Therefore, we suspect that additional examples of higher deterioration along the bottom of some steam pipe similar to locations No. 2 and 3 likely exist.

> **We would therefore recommend a more thorough physical walk through inspection of the steam pipe for additional examples where a negative pitch exists and where its installation favors the collection of condensate. The installation of new steam traps for those that have not been recently replaced is also strongly recommended due to the strong possibility they are not functioning and causing damage to both the steam and steam condensate systems. This inspection should take place during the design phase of the project.**

Inadequate or negative pitch is always a greater concern in low pressure and therefore lower temperature steam systems having a higher tendency to collect condensate, as well as the large number of main steam lines which may not all be active at once. We can reasonably suspect that additional steam traps are required, as well as the potential need for piping layout modifications to avoid negative pitch in certain areas.

<u>Steam Condensate</u> - Locations 37 through 91

Having quickly identified far less corrosion concerns for the steam supply piping system, a greater focus was made toward assessing the steam condensate pipe.

One immediate finding from our investigation was to the lack of any higher wall thickness measurements in the range of extra heavy or schedule 80 specifications. The standard design specification for such low pressure steam systems is to install standard or schedule 40 pipe for the steam piping and then extra heavy or schedule 80 pipe on the condensate return side. This is due to the well recognized and documented much higher corrosion and pitting activity common for steam condensate service. Deep pitting at the water line and below is common to steam condensate piping.

In this investigation we found no evidence that heavier schedule 80 pipe was installed. At examples such as location No. 77 where piping incline was obviously very high, testing identified extremely uniform wall thickness still at new schedule 40 specifications. Location No. 80 provides another example. Such strong uniformity would contradict any possibility that those pipe examples could have corroded from substantially higher schedule 80 wall thickness specifications. Such results, which were identified from various areas of the steam condensate system, clearly show that only standard pipe was installed. The outstanding condition of some steam condensate pipe also demonstrates the benefit of adequate grade or incline.

Although the steam boilers themselves are chemically treated to reduce corrosion activity at their tubes, the chemical treatment typically remains within the boilers and is not carried through with the steam system. Steam, when it condenses into condensate, becomes slightly acidic due to the production of weak carbonic acid, and can reduce the pH of the steam condensate to 6.5 or less. This in turn more aggressively attacks the carbon steel steam condensate pipe compared to the steam side, and is the reason for commonly installing heavier schedule 80 pipe.

Our findings for the steam condensate piping shows dramatically different results - typical for such systems. In some locations we have documented severe deterioration and low wall thickness well below minimum standards, yet other examples our testing has identified the pipe in near new condition. The common denominator becomes obvious based upon the presence or absence of any pitch to the pipe. For examples of vertical pipe such as locations No. 80, 82, and 91, testing identified outstanding results showing high and uniform wall thickness still near new standard for schedule 40 specifications. Where the pipe was inclined, results were also very favorable in every example.

> **In contrast, we identified the most deteriorating conditions where horizontal pipe orientation was level, and therefore favored the collection of steam condensate.**

From our understanding as related by FMD personnel, there have been two steam condensate failures previously. Locations No. 50 and 55 in the North wing crawlspace near column XJ represents one failed area relating to a 2 in. main return line, and was caused by inadequate pitch. At this time, we are therefore recommending the need to replace this pipe from the end of the run at the South wall of the north wing at location No. 68 until reaching pipe of 2-1/2 in. and greater, which is near location No. 48 and column X0. This is a length of approximately 75 to 100 ft.

The second steam condensate failure occurred on the opposite side of the same crawlspace at the North wall near column XJ, and was at a 1-1/2 in. pipe section. This area is shown by locations No. 60 through 64. Our testing identified pipe sections before and after the replaced area severely deteriorated and in need of replacement.

During the removal of insulation at test site No. 61 we had noticed the insulation itself was waterlogged and minor outer corrosion activity was present. During our removal of the outer surface rust for ultrasonic testing a small pinhole leak was discovered. Upon its discovery, FMD maintenance personnel were notified of its condition and advised the need for its repair prior to the steam system operation.

> **Based upon our testing in the areas addressed, we are recommending the replacement of any steam condensate line in this area of 2 in. diameter and less. We were not able to physically access this line beyond the area shown at location No. 57 along the North wall, which was identified in failing condition.**

Testing identified another area of weakness at a large 3 in. main return line to the condensate tank within the boiler room itself. This deterioration is likely attributed to inadequate pitch as well and should also be replaced at this time.

Overall, this investigation provides far more favorable results than likely expected. This is especially true due to our finding that only standard or schedule 40 pipe was installed for the more corrosion susceptible steam condensate system. Given its age, and especially the fact that much thinner pipe was installed than steam condensate design specifications typically call for, most results are still generally very favorable.

We recommend a careful engineering review during design phase of the layout of both the steam and steam condensate systems with a focus on locating areas of either improper or an adequate

pitch. This is far more important for the steam supply side pipe due to its larger diameter, greater difficulty and costs to repair or replace, and consequences should it fail. The identification of any improperly graded steam line should be addressed by either a modification to its physical installation, or through the installation of additional steam traps.

Highest deterioration for the steam condensate piping is clearly shown in the North connector crawlspace due to inadequate grade. Considering that corrosion rates of near 2 MPY is not uncommon for steam condensate systems, test results showing much lower corrosion activity as well as thinner schedule 40 pipe still presents a very favorable piping assessment. For many of the problem areas identified in this report, the much older age of this piping must be considered, as well as the natural service life limitations of any small diameter threaded schedule 40 pipe installed into such higher corrosion conditions.

Results for the steam condensate side show higher wall loss globally, with deep pitting activity shown throughout. Deep pitting activity at the small diameter threaded horizontal mains is shown to have reached the depth of the thread cut at many locations.

Higher corrosion activity is shown at the horizontal steam condensate mains. Graph #4 shows generally very high and uniform remaining service life throughout the steam piping system. We show a wide range of remaining service life at the steam condensate side which is due to specific conditions which exist at each location.

At very least, the UST report shows the need for the widespread and immediate replacement of the horizontal steam condensate mains of 2 in. and greater within the North connector crawlspace; without which, short term future failures of the piping system are guaranteed.

It is also very obvious that any older steam traps must be replaced, and that newer steam traps should be inspected for proper operation.

Random weakness still remains throughout many areas of the steam condensate system. We can therefore predict additional failures to occur although at a far less frequency than expected at the more deteriorated North crawlspace. Since the wide variation in steam condensate pipe condition produces examples of deeper pitting and low service life in some random areas, a second recommendation would be to plan for the replacement of any 2 in. or greater diameter horizontal main steam condensate piping anywhere throughout the Wellesley Middle School.

Ultimately, the only certain means to avoid any future failure of the steam and steam condensate piping would be to replace both systems in their entirety. We consider this entirely unnecessary, especially for the steam supply side, but can suggest that the more steam condensate pipe replaced in areas showing higher deterioration, the greater the future reliability of the heating system.

SECTION 2.2c. SERVICE LIFE

The steam heating plant and mechanical distribution systems have key elements, which each have an estimated service life during which they are expected to need little to no maintenance. The exact number of years vary somewhat based on the referenced standard used. The equipment values shown below were taken from ASHRAE and represent *median* service life values, which we feel are a reasonable representation of what can be expected. The ultrasonic testing program results for piping (Appendices) has more specific information on piping service life.

Middle School Equipment and Piping Service Life (Years)				
Component	**Expected Service Life**	**Age as of 2017**	**Remaining Service Life**	**Comment**
Steam Piping	90	65	25-50	UST, Field Inspection
Condensate Return Piping	50	65	**0**	**Past service life - UST, Samples**
Hot Water Piping	90	51	40	
Dist. Pumps	20	51	**0**	**Past service life**
Heat Exchangers	24	51	**0**	**Past service life**
Large Isolation Valves (Boiler Rm)	30	65	**0**	12 replaced in 2017
Dist. Equip (AHUs, Univents, fan coils, etc.)	20 to 25	11	9 to 14	2006-2008 Reno - Excluding gyms, auditorium and kitchen
CI Sectional Boilers	35	11	24	Currently experiencing leaks
Gym, Cafe and AHUs	24-30	50	0	Future project to replace

TABLE 2.2.c.1

It can be seen from the above table that any new piping should have a service life at least equal to the remaining life of the steam piping, cost iron boilers and distribution equipment – say 25 years.

SECTION 2.2d. FIELD SAMPLING OF CONDENSATE PIPING

RDK evaluated approximately 12 locations of piping that were physically removed from the steam condensate piping within the crawl spaces by FMD. Samples were taken and inspected for corrosion, pitting and wall thickness.

In all cases our inspection revealed findings that were consistent with the ultrasonic testing report. Photographs of piping below show extensive corrosion, major pitting, and decreased wall thickness.

All of these items, are typical and expected for piping of this age. These defects can cause system failure within the piping itself or through clogged valves and steam traps.

Pipe wall thickness reduction due to corrosion

Corrosion evident along the piping welding of ERW piping

Scale build up and pipe wall thickness reduction

Heavy oxidation and pitting evident in seamless piping

SECTION 2.3a - PROPOSED DESIGN (Explanation of Proposed Solution)

MECHANICAL

Replacement of crawlspace steam condensate piping with new and replacement of steam to hot water converters with high efficiency gas-fired hydronic boilers with variable speed pumping.

All the steam heating condensate piping located within the crawlspaces and tunnel, and exposed on ground level floors outside of the boiler room should be replaced with new schedule 80 piping and fittings with appropriate slopes for proper drainage. This replacement would include all steam riser and end of main drip traps including the nipples from the supply piping, isolation valves, strainers, unions, bypasses, and connections to the new condensate piping. This piping would be insulated with pre-formed fiberglass sections with all joints taped or sealed to maintain the insulations vapor barrier.

The two (2) heat exchanger sets and their associated primary pumps, air separation and expansion systems, controls, and make-up water systems located in the boiler room, as well as the secondary pump sets located outside of the boiler room proper and all interconnecting hot water piping, would be demolished. This would include the steam and condensate piping to/from the heat exchangers and their connections to the steam and condensate systems serving the boilers. These would be replaced by high efficiency, gas-fired hot water boilers, air separation and expansion systems, variable speed primary pumps, exhaust and sealed combustion air flues/ducts and controls along with connecting hot water supply and return piping to the existing distribution piping. Each boiler would have a 25 to 1 turndown which will allow the burners to more accurately match the heating load and reduce natural gas usage and operating costs. One of these systems would be located within the utility room on the ground floor of the North 1966 wing and the other within the old generator room on the ground floor of the South 1966 wing. New gas piping would extend from the existing boiler room to each location via the crawlspace for the North wing and exposed in the ceiling space of the South wing. The new boilers will be specified to have self-contained controls to operate the boilers most efficiently, as high as 95% thermal efficiency during the shoulder months, and a communication connection to the existing BMS through BacNet for scheduling, outside temperature inputs, etc. The boilers direct exhaust and combustion air intakes would exit the building near the boiler location through new areaways (if required) and then extend up the building and termination 3’-0” above the roof.

With the heating load of the heat exchangers removed from the school’s heating system, one of the three existing steam boilers could possibly be taken offline and prepared for long term storage for additional energy and maintenance savings, or the operating sequence could be modified to reduce run time on all three boilers. In addition, the combustion air unit serving the boiler room would be rebalanced to the lower boiler input.

The new high efficiency boilers and variable speed frequency drives for the pumps would be eligible for incentive, prescriptive rebates from National Grid for improved energy savings.

The implementation of the recommendations above will need to take into consideration the use of the facility as a school and its occupants, as well as mandated heating system operational dates (Oct. 15th to May 15th). Impacts from construction such as having outside work forces on site, security, noise and odors originating from construction activities, utility/service interruptions, material/equipment deliveries and storage, and hauling of construction debris would have to be considered and procedures established to minimize each to be incorporated into the requirements for execution of the work. A majority of these concerns would be best addressed by the scheduling of the work during school closures such as the summer periods. Any remaining work that extends into the school season would likely have to either occur off-hours (evening/overnight) shifts. Other construction requirements could include dedicated ventilation at work areas with external monitoring, established security procedures (i.e. badges, worker back-ground checks, etc.), limited on-site storage, and off-hour deliveries and utility interruptions. The proposed work is summarized into two tasks:

TASK 1: REPLACE THE STEAM HEATING CONDENSATE PIPING SYSTEMS
Within a phased approach, perform all demolition and replacement of condensate piping including testing and insulation on the ground floor exposed areas during extended periods of school recess (i.e. summer break) as this is the most disruptive work. Demolition and replacement of the steam heating condensate piping systems within the crawlspaces including testing and insulation will continue into the school year (second shift) allowing the additional time if necessary to accomplish prior to the October heating season. If necessary, the second summer recess could be used to complete the project. Flushing and cleaning of new piping would be required prior to energizing the heating system.

TASK 2: INSTALL HIGH EFFICIENCY GAS HOT WATER BOILERS
Within a phased approach, install the new boilers in the locations noted including the piping specialties, flues, gas piping, electrical, controls, pumps, and connecting piping to the existing distribution system. Pipe testing, flushing, and soft start-up to follow the during a scheduled off-hours period perform the tie-in to the existing distribution system. The demolition of the existing heat exchangers, pumps, and connecting piping should occur after the new boilers have been made operational, and connections have been installed to ensure maintaining heating capability at all times.

Key aspects of the proposed design are shown in the plan following.

PLAN – PROPOSED DESIGN

SECTION 2.3b - LIFE CYCLE COST ANALYSIS

A life cycle cost analysis is used to perform an in depth economical analysis to compare two or more possible design solutions.

Typically systems are compared to a baseline system, usually expected to be the lowest initial capital cost.

In our case, baseline is defined as keeping the steam HEXs in place but replacing them with new HEXs, cost of $200,000 initially. Our option to be considered is to replace the HEXs with hi-efficiency condensing boilers at a cost of $500,000. Given that the new boilers will have greater efficiency, the expected fuel costs will decrease for the school.

We have also included increased life expectancy on the existing steam boilers due to fewer hours of operation.

Factors that are used to evaluate the life cycle cost are:

- Net present value (to be thought of as that amount of money you would need today to build, operate and maintain the system for the next 30 years in our case.
- Interest rate, cost to borrow money
- Operational cost, cost of fuel typically with a given escalation rate
- Initial capital cost, cost to build each option today
- Maintenance cost, annual expected maintenance cost, with expected escalation.

Using these factors, a payback can be derived and noted to occur during the 30 year analysis period. At this time, we predict an 8-9 year payback, with an even quicker payback if utility incentives are granted.

SECTION 2.4 - INTERIM MEASURES (Explanation of proposed immediate actions to reduce risk of school shutdown)

As mentioned previously, the total project completion may take three (3) years from the date of this report to be fully implemented. The overall goal of these recommendations is to bring the entire school's heating system in line with a 25 year life expectancy.

In the meantime, interim measures to reduce the risk of heating system failure that may affect school shutdowns can be implemented.

1. Install steam isolation valves: This work was completed during the summer of 2017 as a result of the study team's evaluation. The Facilities Department has installed eleven (11) isolation valves that can be closed in the event of a major steam leak. Previously there was no way to isolate sections of the building and the entire school would have to be shutdown to make repairs. With these new valves, the areas for shutdown will be much smaller and it is expected that the remaining areas could remain open.

2. Heat Exchangers: The primary heating components that serve the North and South classroom and Superintendent's wings are 50 years old steam to hot water heat exchangers located in the main mechanical room. There is no way to visually inspect or test these units, but there have been localized failures in the past. These units are duplex type in nature and with that have some redundancy but it is not 100%. These units need to stay operable for two more heating seasons. Any failure, will greatly affect the operation of the heating system in these areas.

   Recent upgrades, such as window replacement, has decreased the load on these HEXs, but the risk still exists if a failure were to occur on "design days" below 25°F.

   It is recommended that the town undertake a contract with a repair facility that can perform 24 to 48 hour repairs in the event a tube leak were to occur with one of the HEXs. The town can also mitigate down time by eliminating night set back and morning warm-up until the repaired HEX is placed back in service.

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SECTION 3

CODE ANALYSIS

3.1 INTRODUCTION

3.2 APPLICABLE CODES & STANDARDS

3.3 BUILDING DESCRIPTION & SCOPE OF WORK

3.4 EVALUATION OF CODE REQUIREMENTS

SECTION 3.1 – INTRODUCTION

The intent of this report is to summarize the 780 CMR Chapter 34 requirements applicable to the proposed renovations at the Middle School in Wellesley, Massachusetts.

The evaluation is organized such that each Chapter 34 code section is identified and evaluated, in the order that they appear in the Code, for application to the existing building and proposed scope of work.

►*Conclusions and recommendations for each section are italicized and preceded by a bullet-symbol.*

Summary of Recommendations

Based on the scope of work proposed, the following additional improvements are necessary for 780 CMR Chapter 34 compliance; or are otherwise recommended as additional prudent fire / life safety measures:

1. No additional improvements have been identified for 780 CMR Chapter 34 Compliance.

SECTION 3.2 – APPLICABLE CODES & STANDARDS

The codes and standards applicable to the alteration under consideration are as follows:

- Building: 780 CMR, Massachusetts State Building Code 8th Edition (Amended 2009 International Building Code (IBC))
- Existing Building: 780 CMR Chapter 34 (Amended 2009 International Existing Building Code (IEBC))
- Fire Prevention: 527 CMR, Massachusetts State Fire Prevention Regulations
- Accessibility: 521 CMR, Massachusetts Architectural Access Board Regulations

  28 CFR, Part 36, Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities
- Mechanical: 780 CMR §28, (Amended 2012 International Mechanical Code)
- Electrical: 527 CMR §12, Massachusetts Electrical Code (Amended 2011 National Electric Code)
- Plumbing: 248 CMR, Massachusetts State Fuel Gas & Plumbing Code (Includes Amended 2002 ANSI Z223.1-NFPA 54)
- Energy: 780 CMR §13, (Amended 2012 International Energy Conservation Code)
- Sustainability: MSBA Accelerated Repair Sustainability Requirements

SECTION 3.3 – BUILDING DESCRIPTION & SCOPE OF WORK

Building Description

The Middle School in Wellesley, Massachusetts is one and two stories high with a full basement level in some wings. Total building area is 228,000 SF.

Scope of Work

The proposed scope of work involves the replacement of failed heating piping located outside the mechanical room. The rooms will remain unaltered to the extent that the existing structure will remain the same.

New boiler rooms that will be constructed are solely related to the repair/replacement of the heating system. Boiler rooms will be provided with appropriate egress, access and ratings.

SECTION 3.4 – EVALUATION OF CODE REQUIREMENTS

§3401.1: Scope

In addition to mandating minimum levels of fire and life safety for existing buildings, 780 CMR Chapter 34 sets forth a framework that describes to what extent "new construction" or "current code" requirements must be applied to existing buildings undergoing repair, alteration or addition.

By reference, Chapter 34 requires compliance with the 2009 International Existing Building Code (IEBC) as amended by 780 CMR Chapter 34. References to IEBC sections in this report are inclusive of the applicable Massachusetts amendments.

§100: Scope and Application

The amended IEBC administrative chapter contains general scoping and administrative requirements and also carries over several legacy Massachusetts "Chapter 34" requirements from previous editions of the Code.

§102.2.2 "Existing Hazardous Conditions": Minimum requirements for existing means of egress, ventilation and lighting are mandated by IEBC §102.2.2. These provisions are intended to identify and correct deficiencies that pose an immediate threat to fire and life safety. The requirements of §102.2.2 are applied globally to the entire building in its unaltered state without respect to the scope of work contemplated.

§102.2.2.1 "Existing Non Conforming Means of Egress":

1. The minimum number of exits required by 780 CMR Chapter 10 must be provided for every space and / or story of the building.

► *The existing means of egress systems serving the building include exits of sufficient capacity.*

However, the crawl space, while not considered an occupied space, would be considered a "confined space". RDK recommends that new improved access doors be added for better/safer access and that an S.O.P. be developed for employees entering the area including appropriate signage and training.

§102.2.2.5 "Unsafe Lighting and / or Ventilation": Where existing lighting levels and / or ventilation in any portion of an existing building do not meet the minimum criteria of 780 CMR Chapter 12 and in the opinion of the local building official the condition is "dangerous, or hazardous, to the health and safety of the occupants" the building official shall order the abatement of such condition.

► *The existing lighting levels and ventilation rates meet the minimum criteria of 780 CMR chapter 12 for the building.*

In regards to the crawl space; the lighting and ventilation is not adequate and should be modified to provide minimum code levels. In addition, the installation of fire alarm devices should also be added for anyone that may be working in the area. We also recommend power receptacles be added for maintenance/tools.

§400: Classification of Work

When utilizing the "Work Area Compliance Method", Chapter 4 is used to classify work into specific scoping categories:

- Repairs: Restoration or replacement of damaged materials, elements, equipment, or fixtures for the purposes of maintaining such components in sound condition with respect to existing loads or performance requirements. Work must comply with IEBC Chapter 5.
- Level 1 Alteration: Removal, replacement or covering of existing materials, elements or equipment using new materials, elements or equipment that serves the same purpose. Work must comply with IEBC Chapter 6.
- Level 2 Alteration: Reconfiguration of a space, addition or elimination of a door or window, reconfiguration or extension of a system, or installation of new equipment. Work must comply with IEBC Chapters 6 and 7.
- Level 3 Alteration: Work area exceeds 50% of the aggregate building area. Work must comply with IEBC Chapters 6, 7 and 8.
- Change of Occupancy: Change in purpose or level of activity that involves a change in the application of the IEBC. Work must comply with IEBC Chapter 9.
- Additions: Increase in the building area or height. Work must comply with IEBC Chapter 10.
- Historic Buildings: Alterations to a Historic Building as defined by the IEBC. Work must comply with IEBC Chapter 11.
- Relocated Buildings: Relocated or moved buildings. Work must comply with IEBC Chapter 12.

►*The proposed alteration represents a "Level 1 Alteration".*

§701: Level 1 Alteration - General

Level 1 alteration work must comply with Chapter 6 for Level 1 work, which generally mandates that the existing level of performance of the building features and systems not be diminished by the alteration work.

►*The proposed alteration work complies with Chapter 6 for Level 1 alterations in that the performance of the building is not lessened by the proposed work.*

§711: Level 1 Alteration – Energy Conservation

Energy conservation for existing buildings must comply with §711, which in turn requires compliance with the International Energy Conservation Code (IECC).

► *The new mechanical systems to be installed as a part of this alteration comply with the 2012 International Energy Conservation Code* **.**

The Town of Wellesley – Stretch Energy Code

► *Wellesley has adopted the Stretch Energy Code. All new materials, insulation and equipment shall and will comply with that standard.*

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SECTION 4

BUDGETARY COST ESTIMATE

SECTION 4 – BUDGETARY COST ESTIMATE

Conceptual level project costs have been prepared for budgetary planning purposes. Total project costs include hard construction costs, and "soft costs" for designer services, Owner's Project Manager (OPM) services and miscellaneous expenses.

Construction costs are impacted by many factors including the unique challenges/difficulty of the project (i.e. renovation versus new) as well as the competitiveness of the "market" at the time of the bid. Inflation/escalation modifiers are included to reflect the expected bid date. Contingencies are included to reflect the various unknowns and the relatively early phase of this project (feasibility study). Premium labor time, expected to be required (second shift) due to constraints of working in an active school environment, are also reflected in the estimates.

Soft costs include the engineer's costs to design and bid the project, as well as construction administration services. Because the construction cost will exceed $1,500,000, MGL Chapter 149, §44 requires that the Town engage the services of an Owner's Project Manager (OPM) to act as the Town's agent and consultant throughout the design and construction process. Costs for OPM services have been assumed as 5% of the construction cost.

The total estimated project cost for the work identified in this report is $4,340,121. This is the amount that the Town should carry at this point for planning and future appropriation requests. The piping related work represents approximately 70% of the total project cost, with the heat exchanger/boiler work comprising the remainder of the cost. This estimate assumes the work will be bid and executed in accordance with the project schedule. Changes to the bid date, scope of work and the bidding market can impact actual costs. As the project advances to schematic design, design development and ultimately to construction documents phase, the level of confidence in the cost estimate will be greatly increased; however, the actual bids received will represent the actual cost of the work. The budgetary cost estimate is shown in summary below. Detailed "backup" cost estimating sheets are included in Appendices.

TOTAL PROJECT COST

Construction ("Hard Costs")

• General Requirements	$ 569,310	
• Concrete	$ 124,104	
• Boiler Room Construction	$ 42,713	
• Plumbing	$ 119,554	
• HVAC/Mechanical Piping	$1,170,321	
• HVAC/Boilers	$ 502,419	
• Electrical	$ 111,604	
Subtotal =	$2,640,025	
• G.C., OH, Bond, Profit (15%)	$ 396,004	
• Escalation to 2019 (1.5 years @4% = 6%)	$ 182,162	
Total Construction Cost =		**$3,218,191**

"Soft Costs"

• Engineering Services		
o Design & Bidding Assistance	$235,082	
o Construction Administration	$133,291	
o Reimbursable expenses	$ 20,000	
Subtotal =	$388,373	
• Other Professional Services		
o Owner's Project Manager (5% construction)	$158,680	
o OPM Design Services	$ 50,000	
o Clerk of the Works (1/2 time)	$ 60,000	
o Professional Cost Estimator	$ 30,000	
Subtotal =	$298,680	
Total "Soft" Costs =		**$687,053**

Owner's Contingencies

• FMD custodial/maint. costs (including second shift)	$ 10,000	
• Construction Contingency (10%)	$321,819	
• Soft Cost Contingency (15%)	$103,058	
Total Owner's Contingency Costs =		**$434,877**
TOTAL APPROPRIATION REQUEST =		***$4,340,121***

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SECTION 5

PROJECT SCHEDULE

SECTION 5 – PROJECT SCHEDULE

The current project schedule assumes that design, bidding assistance and some Owner's Project Manager (OPM) funds will be requested at the Town's 2018 Annual Town Meeting (ATM). It further assumes that construction funds and funds for remaining designer and OPM services will be requested one year later at the 2019 ATM. This "two step" process of requesting design funds first and then requesting construction funds with "bids-in-hand" is the preferred approach by the Town's Permanent Building Committee (PBC), as it has been used successfully on many other projects. It is particularly appropriate for "non-routine" projects (school construction limitations, confined space issues, etc.) such as this; which are often difficult to estimate.

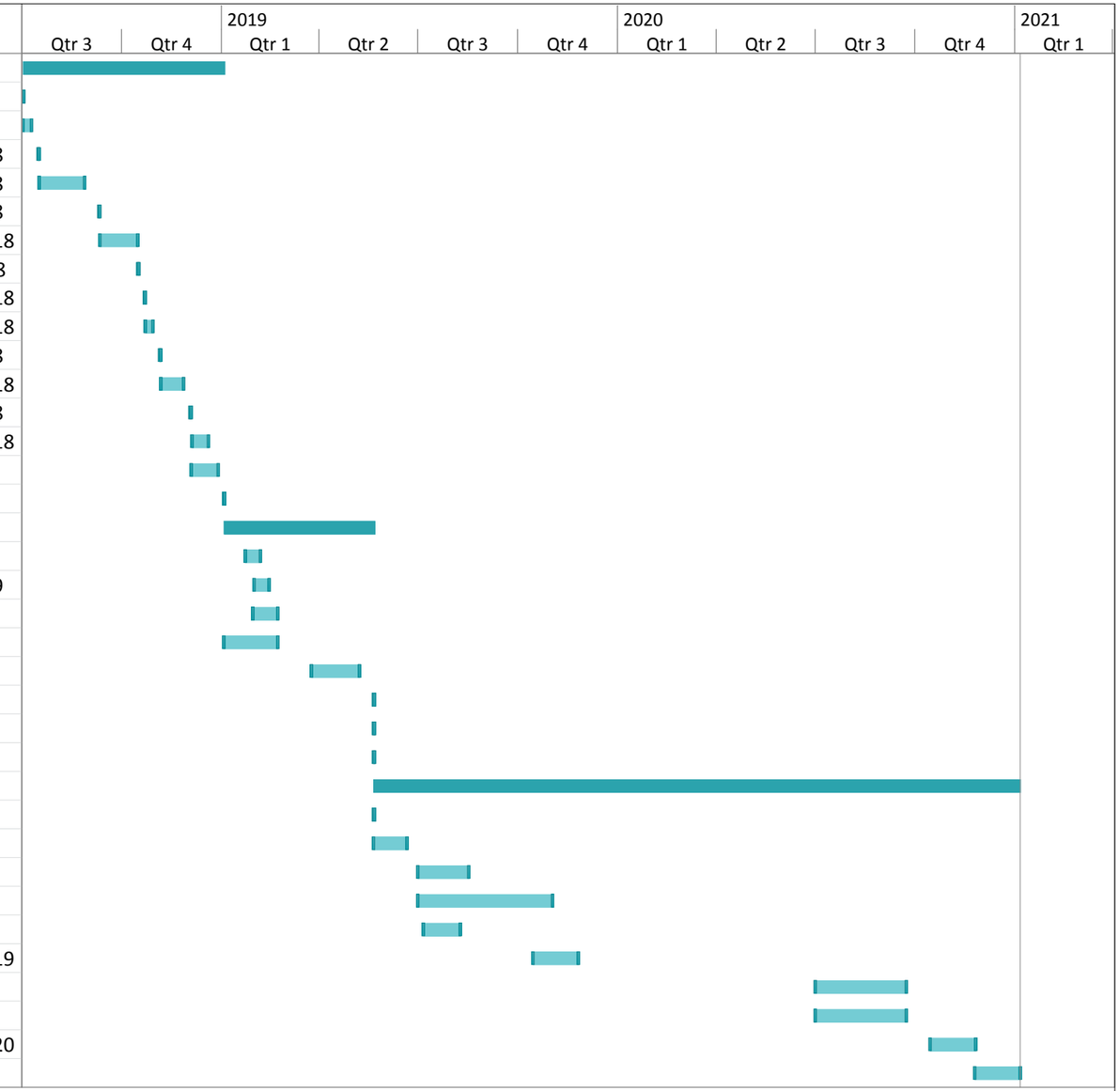
The construction would ideally start immediately after the 2019 ATM, in May 2019. This will require that the funds be made available as part of the FY19 budget. Typically, the 2019 ATM would be appropriating *FY20* funds for capital projects; however, this would not make them available until July 1, 2019. Requesting an FY19 construction appropriation will allow an early start of the project (processing submittals, ordering materials, mobilization), so that meaningful and disruptive work could take place over the summer 2019 while students and staff are out of the building.

The current schedule assumes that work would continue into the school year, but that it would be performed on "second shift" (3:30 p.m. to midnight) to minimize impact to school functions. We understand that this approach is currently being successfully used by the Town for another school project (School Security). It's possible that the project could be completed within one year; however, due to the many unknowns at this point, we are assuming that the second summer (2020) will be needed to complete the project.

The project schedule is summarized below and also shown in detail by task on the bar chart schedule that follows:

- Fall/Winter 2017 — RDK Study Results reviewed & discussed with Town boards
- Spring 2018 ATM — Design & Bidding Funds approved
- Spring 2019 ATM — Construction Funds approved
- May 2019 — Construction Notice to Proceed
- June-August 2019 — On-Site Construction (summer)
- Sept 2019 to June 2020 — On-Site Construction (second shift)
- June-August 2020 — On-Site Construction (summer – if needed)
- Sept 2020 to Aug 2021 — One-Year Warranty Period

ID		Task Mod	Task Name	Duration	Start	Finish
1			**DESIGN**	**134 days**	**Mon 7/2/18**	**Thu 1/3/19**
2			Kick off meeting	1 day	Mon 7/2/18	Mon 7/2/18
3			Site Evaluation	6 days	Mon 7/2/18	Mon 7/9/18
4			Meeting #2	1 day	Mon 7/16/18	Mon 7/16/18
5			Select Equipment	30 days	Tue 7/17/18	Mon 8/27/18
6			Meeting #3 to review equipment selection	1 day	Mon 9/10/18	Mon 9/10/18
7			RDK starts work on 90% Design Documents	25 days	Tue 9/11/18	Mon 10/15/18
8			RDK Submits Draft 90% Design Docments	1 day	Tue 10/16/18	Tue 10/16/18
9			Meeting #4 with Wellesley Middle School to review 90% draft docum	1 day	Mon 10/22/18	Mon 10/22/18
10			RDk submits final 90% Design Documents	5 days	Tue 10/23/18	Mon 10/29/18
11			Meeting #5 to review 90% final Design Documents	1 day	Mon 11/5/18	Mon 11/5/18
12			RDK submits Draft 100% Design Documents for review	15 days	Tue 11/6/18	Mon 11/26/18
13			Meeting #5 to review 100% Design Documents	1 day	Mon 12/3/18	Mon 12/3/18
14			RDK places ad in Central Register	11 days	Wed 12/5/18	Wed 12/19/18
15			RDK submits 100% Design Documents for Bidding	19 days	Tue 12/4/18	Fri 12/28/18
16			Documents available to contractors	1 day	Thu 1/3/19	Thu 1/3/19
17			**Bidding**	**99 days**	**Thu 1/3/19**	**Tue 5/21/19**
18			Prebid Walkthrough	10 days	Wed 1/23/19	Tue 2/5/19
19			Filed Sub-Bids	10 days	Thu 1/31/19	Wed 2/13/19
20			General Bids	17 days	Wed 1/30/19	Thu 2/21/19
21			Contract Prep	36 days	Thu 1/3/19	Thu 2/21/19
22			Town Meeting	32 days	Mon 3/25/19	Tue 5/7/19
23			Contract Review & Award	1 day	Tue 5/21/19	Tue 5/21/19
24			Notice to Proceed	1 day	Tue 5/21/19	Tue 5/21/19
25			Funds available	1 day	Tue 5/21/19	Tue 5/21/19
26			**Construction**	**426 days**	**Tue 5/21/19**	**Tue 1/5/21**
27			Preconstruction Meeting	1 day	Tue 5/21/19	Tue 5/21/19
28			Shop Drawing Review	23 days	Tue 5/21/19	Thu 6/20/19
29			Demolition & installation of existing condensate system Phase I	35 days	Mon 7/1/19	Fri 8/16/19
30			Installation of new condensing boilers	90 days	Mon 7/1/19	Fri 11/1/19
31			Demolition & installation of existing condensate system Phase 2	25 days	Sat 7/6/19	Thu 8/8/19
32			Start-up of new condensing boilers	30 days	Tue 10/15/19	Mon 11/25/19
33			Demolition & Installation of existing condensate system Phase 3	60 days	Wed 7/1/20	Tue 9/22/20
34			Tunnel & crawl space work	60 days	Wed 7/1/20	Tue 9/22/20
35			Substantial completion	30 days	Thu 10/15/20	Wed 11/25/20
36			Final Completion	30 days	Wed 11/25/20	Tue 1/5/21



Project: Wellesley Middle School Heating Distribution Study
October 16, 2017 - Rev #6

Task	Project Summary	Inactive Milestone	Manual Summary Rollup
Split	External Tasks	Inactive Summary	Deadline
Milestone	External Milestone	Manual Task	Progress
Summary	Inactive Task	Duration-only	Manual Progress

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SECTION 6

APPENDICES

6.1 LCCA CALCULATIONS

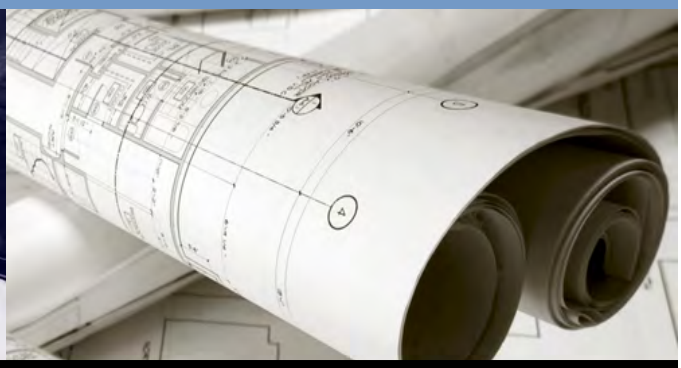
6.2 ULTRASONIC TESTING & ANALYSIS REPORT

6.3 CONSTRUCTION COST EST.

6.4 PHOTOGRAPHS

6.5 MAINTENANCE DIRECT WORK ORDER SYSTEM

6.6 CONCEPTUAL DESIGN DRAWINGS



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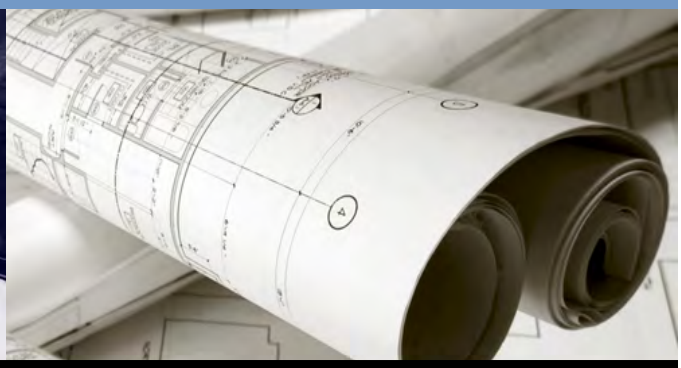
APPENDIX

6.1 LCCA CALCULATIONS



RDK Engineers — **LIFE CYCLE COST ANALYSIS**

200 Brickstone Square
Andover, MA 01801-1488
(978) 296-6218 telephone
(978) 296-6201 facsimile
e-mail: DWALL@RDKengineers.com

Project: **Wellesley Middle School**
Subject: **baseline: steam HEXs (replaced)**
Acct.: 20170393
Calc'd by: DJW
Date: October 16, 2017 Rev. #6

Description: Steam Heating Distribution Piping Systems
Discount rate: 3.00%
Years of study: 30
Initial cost: $0

NPV= Investment Required $5,450,000

year	expenses	net cash flow	present worth of cash flow	accumulated present worth
0		$0	$0	
1	$370,800	($370,800)	($360,000)	($360,000)
2	$169,744	($169,744)	($160,000)	($520,000)
3	$174,836	($174,836)	($160,000)	($680,000)
4	$180,081	($180,081)	($160,000)	($840,000)
5	$185,484	($185,484)	($160,000)	($1,000,000)
6	$191,048	($191,048)	($160,000)	($1,160,000)
7	$196,780	($196,780)	($160,000)	($1,320,000)
8	$202,683	($202,683)	($160,000)	($1,480,000)
9	$208,764	($208,764)	($160,000)	($1,640,000)
10	$416,614	($416,614)	($310,000)	($1,950,000)
11	$221,477	($221,477)	($160,000)	($2,110,000)
12	$228,122	($228,122)	($160,000)	($2,270,000)
13	$234,965	($234,965)	($160,000)	($2,430,000)
14	$242,014	($242,014)	($160,000)	($2,590,000)
15	$716,665	($716,665)	($460,000)	($3,050,000)
16	$256,753	($256,753)	($160,000)	($3,210,000)
17	$264,456	($264,456)	($160,000)	($3,370,000)
18	$272,389	($272,389)	($160,000)	($3,530,000)
19	$280,561	($280,561)	($160,000)	($3,690,000)
20	$288,978	($288,978)	($160,000)	($3,850,000)
21	$297,647	($297,647)	($160,000)	($4,010,000)
22	$306,577	($306,577)	($160,000)	($4,170,000)
23	$315,774	($315,774)	($160,000)	($4,330,000)
24	$325,247	($325,247)	($160,000)	($4,490,000)
25	$335,004	($335,004)	($160,000)	($4,650,000)
26	$345,055	($345,055)	($160,000)	($4,810,000)
27	$355,406	($355,406)	($160,000)	($4,970,000)
28	$366,068	($366,068)	($160,000)	($5,130,000)
29	$377,050	($377,050)	($160,000)	($5,290,000)
30	$388,362	($388,362)	($160,000)	($5,450,000)
	$8,715,406	**($8,715,406)**	**($5,450,000)**	

EXPENSES:

quantity	× amount	= total	1st year incurred	last year incurred	escalation rate	description
1	$145,000	$145,000	1	30	3.0%	Fuel costs
3	$5,000	$15,000	1	30	3.0%	Maintenance
1	$200,000	$200,000	1	1	3.0%	cost of new HEXs and pun
1	$150,000	$150,000	10	10	3.0%	replace steam B1
1	$150,000	$150,000	15	15	3.0%	repalce steam B2
1	$150,000	$150,000	15	15	3.0%	repalce steam B3
1		$0	1	1	3.0%	rebate/incentive
1	$0	$0	5	5	3.0%	reserved
1	$0	$0	8	8	3.0%	reserved
1	$0	$0	10	10	3.0%	reserved
1	$0	$0	25	25	3.0%	reserved
total expenses =		**$810,000**				

RDK Engineers — **LIFE CYCLE COST ANALYSIS**

200 Brickstone Square
Andover, MA 01801-1488
(978) 296-6218 telephone
(978) 296-6201 facsimile
e-mail: DWALL@RDKengineers.com

Project: **Wellesley Middle School**
Subject: **condensing boiler payback**
Acct.: 20170393
Calc'd by: DJW
Date: October 16, 2017 Rev. #6

Description: Steam Heating Distribution Piping Systems
Discount rate: 3.00%
Years of study: 30
Initial cost: $0

NPV= Investment Required $4,670,000

year	expenses	net cash flow	present worth of cash flow	accumulated present worth
0		$0	$0	
1	$647,870	($647,870)	($629,000)	($629,000)
2	$136,856	($136,856)	($129,000)	($758,000)
3	$140,962	($140,962)	($129,000)	($887,000)
4	$145,191	($145,191)	($129,000)	($1,016,000)
5	$149,546	($149,546)	($129,000)	($1,145,000)
6	$154,033	($154,033)	($129,000)	($1,274,000)
7	$158,654	($158,654)	($129,000)	($1,403,000)
8	$163,413	($163,413)	($129,000)	($1,532,000)
9	$168,316	($168,316)	($129,000)	($1,661,000)
10	$173,365	($173,365)	($129,000)	($1,790,000)
11	$178,566	($178,566)	($129,000)	($1,919,000)
12	$183,923	($183,923)	($129,000)	($2,048,000)
13	$189,441	($189,441)	($129,000)	($2,177,000)
14	$195,124	($195,124)	($129,000)	($2,306,000)
15	$434,673	($434,673)	($279,000)	($2,585,000)
16	$207,007	($207,007)	($129,000)	($2,714,000)
17	$213,217	($213,217)	($129,000)	($2,843,000)
18	$219,614	($219,614)	($129,000)	($2,972,000)
19	$226,202	($226,202)	($129,000)	($3,101,000)
20	$503,905	($503,905)	($279,000)	($3,380,000)
21	$239,978	($239,978)	($129,000)	($3,509,000)
22	$247,177	($247,177)	($129,000)	($3,638,000)
23	$254,593	($254,593)	($129,000)	($3,767,000)
24	$262,230	($262,230)	($129,000)	($3,896,000)
25	$270,097	($270,097)	($129,000)	($4,025,000)
26	$278,200	($278,200)	($129,000)	($4,154,000)
27	$286,546	($286,546)	($129,000)	($4,283,000)
28	$295,143	($295,143)	($129,000)	($4,412,000)
29	$303,997	($303,997)	($129,000)	($4,541,000)
30	$313,117	($313,117)	($129,000)	($4,670,000)
	$7,340,957	**($7,340,957)**	**($4,670,000)**	

EXPENSES:

quantity	× amount	= total	1st year incurred	last year incurred	escalation rate	description
1	$125,000	$125,000	1	30	3.0%	Fuel costs
4	$1,000	$4,000	1	30	3.0%	Maintenance
1	$500,000	$500,000	1	1	3.0%	cost of condensing boilers
1	$150,000	$150,000	15	15	3.0%	replace steam B1
1	$150,000	$150,000	20	20	3.0%	replace steam B1
1	$0	$0	1	1	3.0%	Rebate/Incentive
1	$0	$0	4	4	3.0%	reserved
1	$0	$0	5	5	3.0%	reserved
1	$0	$0	8	8	3.0%	reserved
1	$0	$0	10	10	3.0%	reserved
1	$0	$0	25	25	3.0%	reserved
total expenses =		**$929,000**				

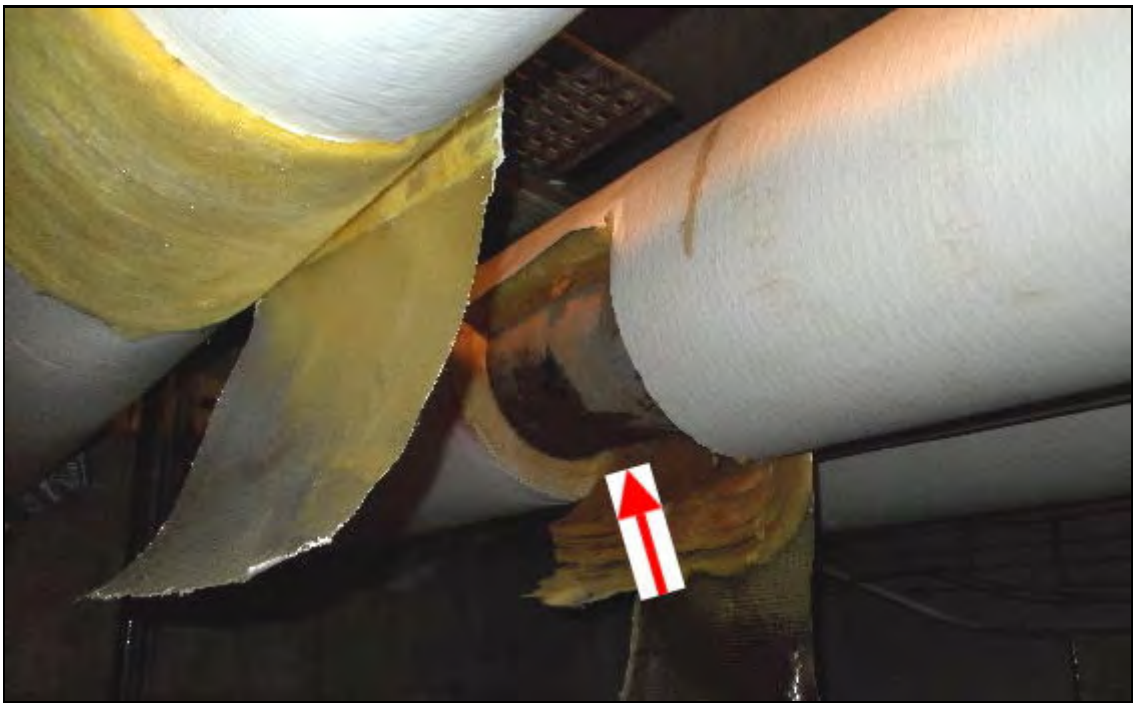
RDK ENGINEERS

APPENDIX

6.2 ULTRASONIC TESTING & ANALYSIS REPORT

Location No: 1

Photo File #: wes-1-08.jpg
Detail: Pipe Location
Orientation: Below Side View



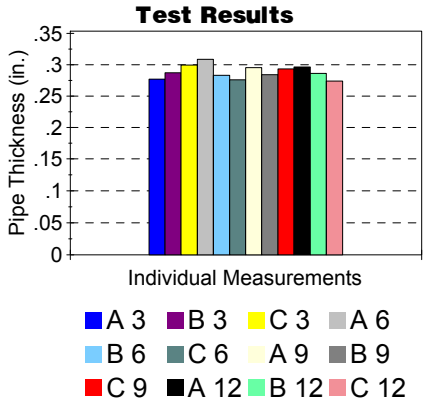
Pipe Identification and Operating Conditions

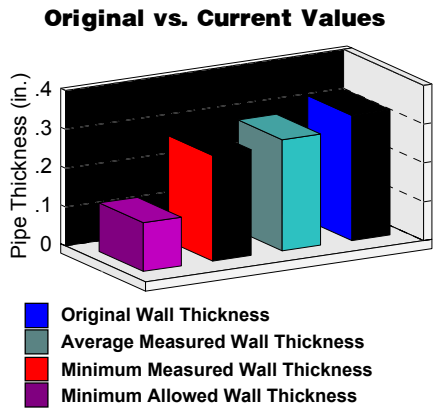
Service: Steam
Nominal Pipe Size: 8 in.
Actual Pipe Size: 8.63 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-8-04
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Main low pressure steam supply line, near door to MER, 3rd line. Test points located 4 ft. from MER wall.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.322 in.
Minimum Allowable Thickness: 0.125 in. (0.003)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.010 in. / **High to Low Range:** 0.034 in.
Minimum Theoretical Wall Thickness: 0.255 in.
Pitting Index: 5.0 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.286 in.
Average Pipe Loss: 0.036 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 18.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

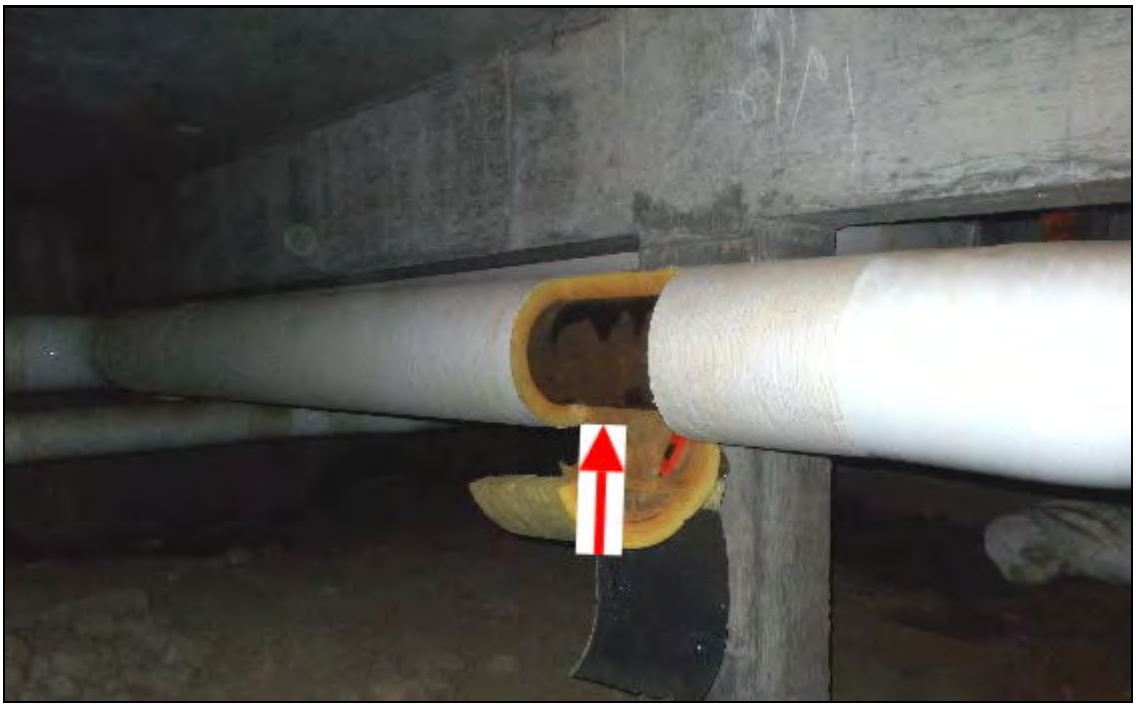
Minimum Thickness: 0.272 in.
Maximum Pipe Loss: 0.050 in.
Corrosion Rate: 0.8 Mils Per Year
Percent of Allowable Pipe Loss: 25.4 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Ultrasonic testing at this steam supply line produces excellent results. Wall thickness is high and not far below new pipe specifications after 65 years of service. Virtually unlimited service life remains.

Location No: 2

Photo File #: wes-2-28.jpg
Detail: Pipe Location
Orientation: Side View



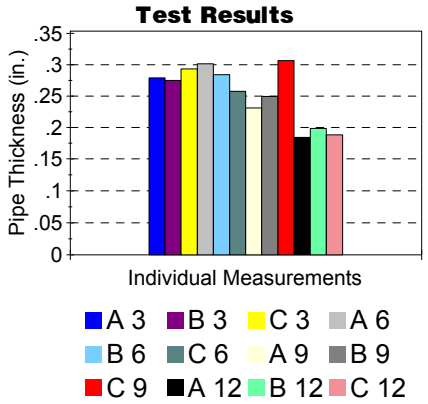
Pipe Identification and Operating Conditions

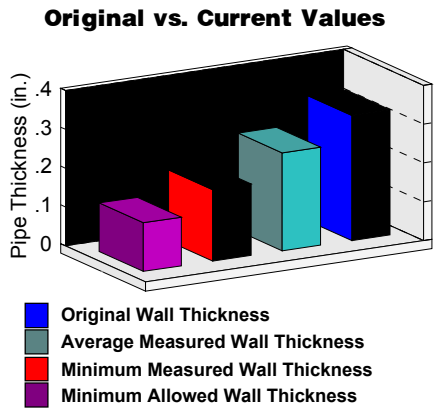
Service: Steam
Nominal Pipe Size: 8 in.
Actual Pipe Size: 8.63 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-8-109
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line, inside gated area outside MER, near column XBQ-X41. Test points located 3-4 ft. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.322 in.
Minimum Allowable Thickness: 0.125 in. (0.003)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.043 in. / **High to Low Range:** 0.120 in.
Minimum Theoretical Wall Thickness: 0.123 in.
Pitting Index: 27.1% - High Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.253 in.
Average Pipe Loss: 0.070 in.
Corrosion Rate: 1.1 Mils Per Year
Percent of Allowable Pipe Loss: 35.3 %
Remaining Pipe Life: 119.5 Years
Estimated Retirement **January 2137**

Worst Case Scenario

Minimum Thickness: 0.184 in.
Maximum Pipe Loss: 0.138 in.
Corrosion Rate: 2.1 Mils Per Year
Percent of Allowable Pipe Loss: 70.1 %
Remaining Pipe Life: 27.8 Years
Estimated Retirement **June 2045**

Testing Indicates: Pipe Condition Good

Comments: Testing at this section of pipe shows far less favorable results. Corrosion and pitting activity are high, a condition likely due to the collection of condensation at this low point. Long service life remains.

Location No: 3

Photo File #: wes-2-31.jpg
Detail: Pipe Location
Orientation: Side View

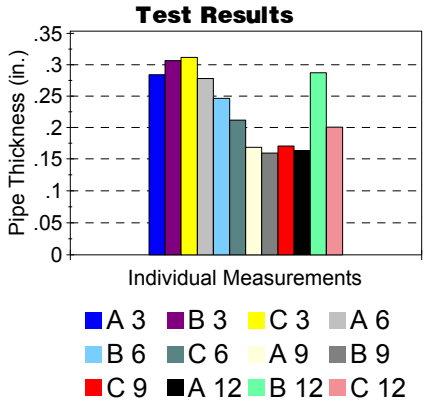
Pipe Identification and Operating Conditions

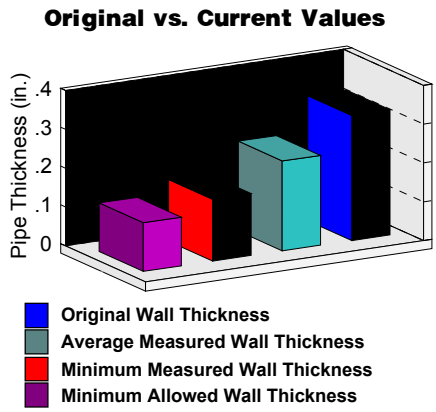
Service: Steam
Nominal Pipe Size: 8 in.
Actual Pipe Size: 8.63 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-8-110
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line, inside gated area outside MER, near column XBQ-X41. Test points located between elbows.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.322 in.
Minimum Allowable Thickness: 0.125 in. (0.003)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.059 in. / **High to Low Range:** 0.150 in.
Minimum Theoretical Wall Thickness: 0.055 in.
Pitting Index: 31.2% - Heavy Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.231 in.
Average Pipe Loss: 0.091 in.
Corrosion Rate: 1.4 Mils Per Year
Percent of Allowable Pipe Loss: 46.2 %
Remaining Pipe Life: 75.9 Years
Estimated Retirement **June 2093**

Worst Case Scenario

Minimum Thickness: 0.159 in.
Maximum Pipe Loss: 0.163 in.
Corrosion Rate: 2.5 Mils Per Year
Percent of Allowable Pipe Loss: 82.7 %
Remaining Pipe Life: 13.6 Years
Estimated Retirement **March 2031**

Testing Indicates: Pipe Condition Satisfactory

Comments: We produce similar results for this nearby section of pipe. Corrosion and pitting activity are heavy, and is likely due to condensate collection. Acceptable service life remains.

Location No: 4

Photo File #: wes-1-02.jpg
Detail: Pipe Location
Orientation: Below Side View

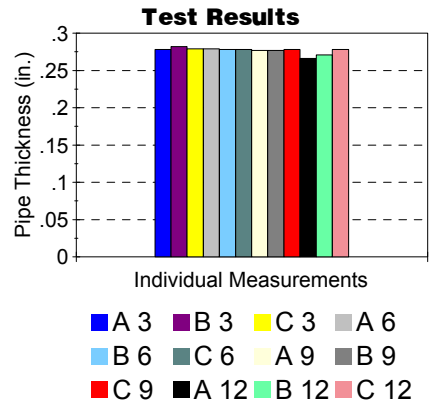
Pipe Identification and Operating Conditions

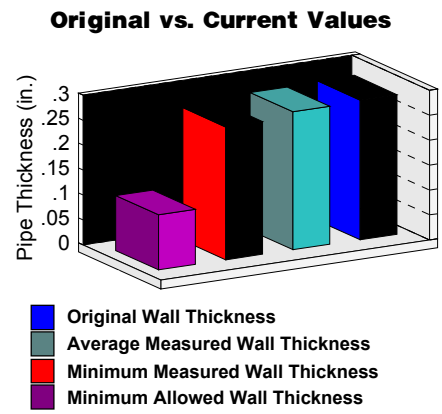
Service: Steam
Nominal Pipe Size: 6 in.
Actual Pipe Size: 6.63 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-6-02
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line, near door to MER. Test points located 4-5 ft. before 45° elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.280 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.004 in. / **High to Low Range:** 0.016 in.
Minimum Theoretical Wall Thickness: 0.264 in.
Pitting Index: 3.9 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.277 in.
Average Pipe Loss: 0.003 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 1.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.266 in.
Maximum Pipe Loss: 0.014 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 8.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing at this example shows high and uniform wall thickness approaching new pipe specifications. Strong uniformity can be viewed in the top right bargraph. Virtually unlimited service life remains.

Location No: 5

Photo File #: wes-2-30.jpg
Detail: Pipe Location
Orientation: Side View

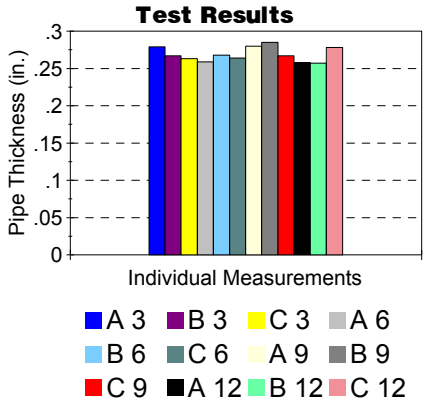
Pipe Identification and Operating Conditions

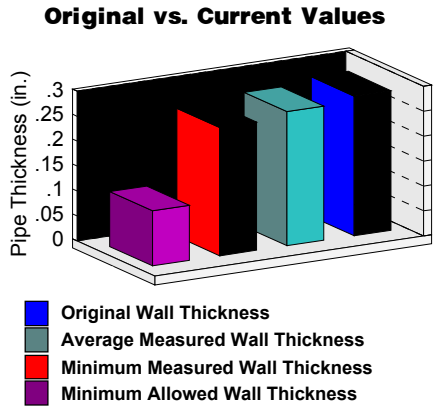
Service: Steam
Nominal Pipe Size: 6 in.
Actual Pipe Size: 6.63 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-6-34
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply line, in NE corner, near column XAN, in front of stone wall offset. Test points located 3-4 ft. after elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.280 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.009 in. / **High to Low Range:** 0.028 in.
Minimum Theoretical Wall Thickness: 0.240 in.
Pitting Index: 4.4 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.269 in.
Average Pipe Loss: 0.011 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 6.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

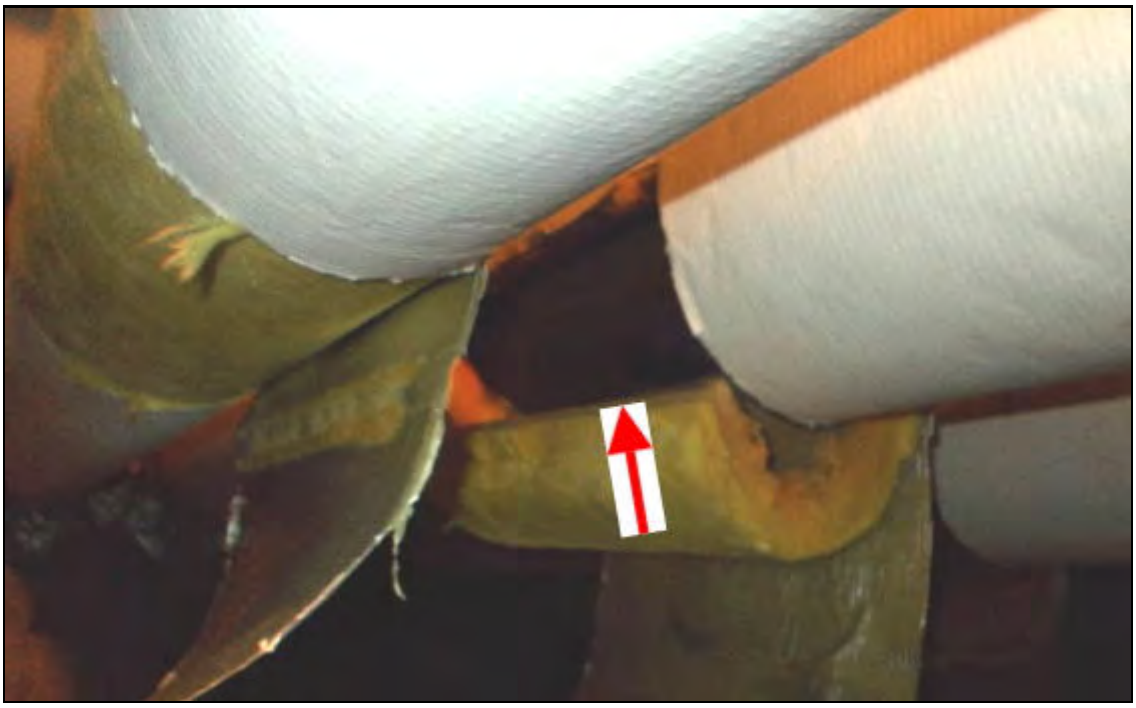
Minimum Thickness: 0.257 in.
Maximum Pipe Loss: 0.023 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 13.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Measurements show similar results compared to the previous location. Corrosion activity is low, with mild pitting. Wall thickness is not far below new pipe specifications. Virtually unlimited service life remains.

Location No: 6

Photo File #: wes-1-09.jpg
Detail: Pipe Location
Orientation: Below Side View



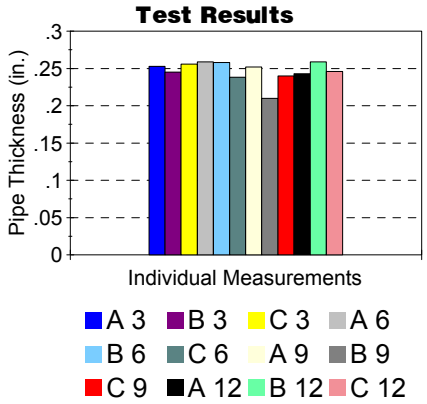
Pipe Identification and Operating Conditions

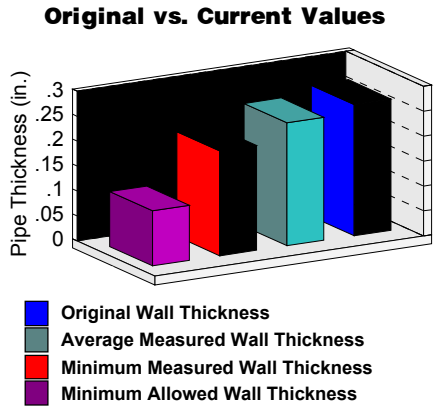
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-03
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line, near door to MER, 2nd line. Test points located 4 ft. from MER wall.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.014 in. / **High to Low Range:** 0.049 in.
Minimum Theoretical Wall Thickness: 0.205 in.
Pitting Index: 14.8% - Significant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.247 in.
Average Pipe Loss: 0.016 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 10.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

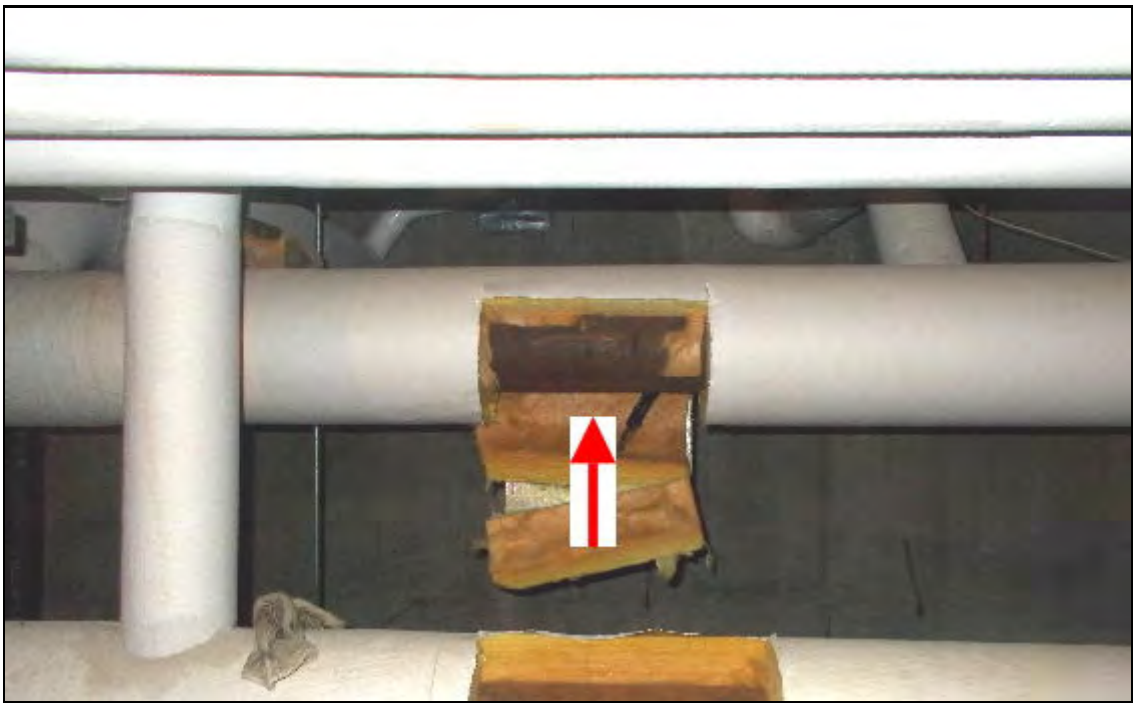
Minimum Thickness: 0.210 in.
Maximum Pipe Loss: 0.053 in.
Corrosion Rate: 0.8 Mils Per Year
Percent of Allowable Pipe Loss: 34.6 %
Remaining Pipe Life: 122.9 Years
Estimated Retirement **June 2140**

Testing Indicates: Pipe Condition Excellent

Comments: Testing at this wrought iron section of pipe produces excellent results. Average wall thickness is not far below new pipe specifications due to low and normal corrosion activity. Extremely long service life remains.

Location No: 7

Photo File #: wes-1-39.jpg
Detail: Pipe Location
Orientation: Side View



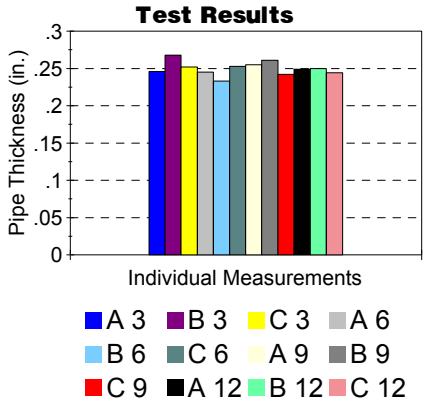
Pipe Identification and Operating Conditions

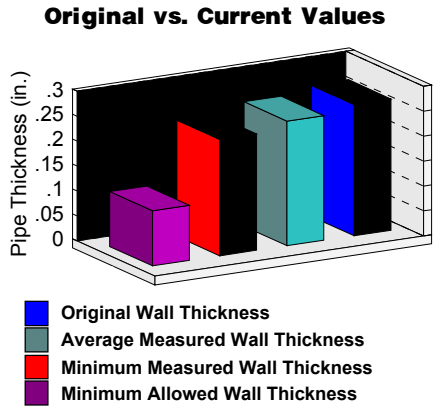
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-14
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply line, at corner, near column XX at South wall. Test points located 20 ft. after elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.009 in. / **High to Low Range:** 0.035 in.
Minimum Theoretical Wall Thickness: 0.222 in.
Pitting Index: 6.7 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.250 in.
Average Pipe Loss: 0.013 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 8.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

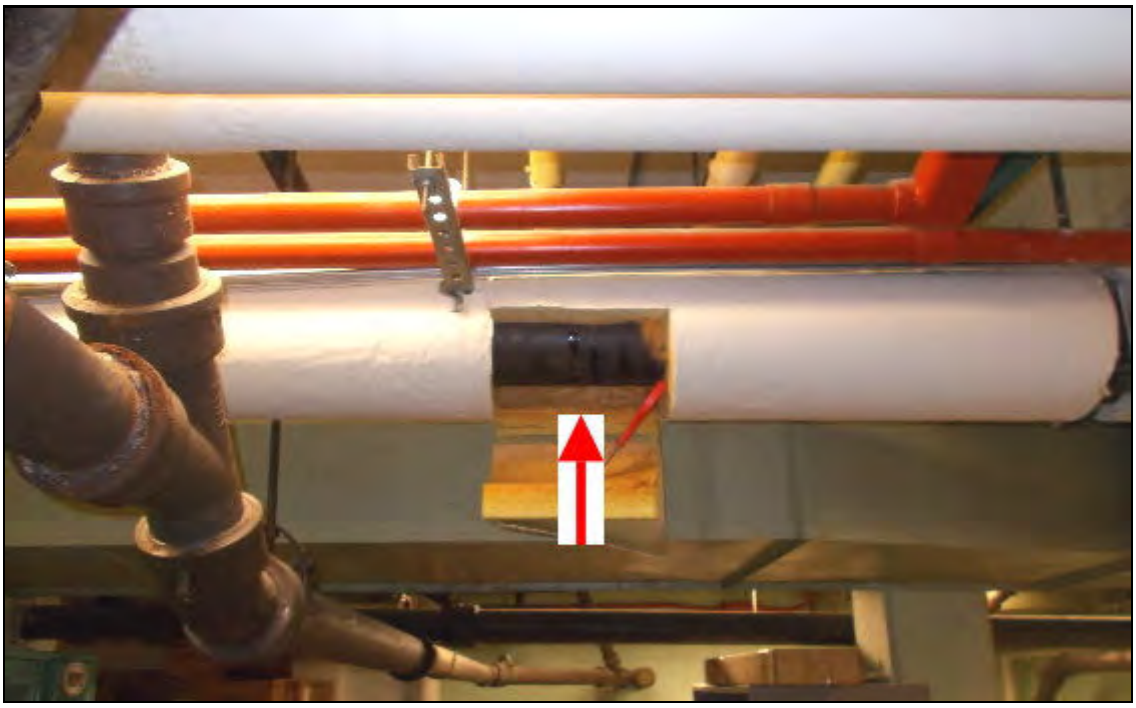
Minimum Thickness: 0.233 in.
Maximum Pipe Loss: 0.030 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 19.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Once again, we produce very favorable results for this steam system in most areas. Pitting activity is moderate, with high average wall thickness not far below new pipe specifications. Virtually unlimited service life remains.

Location No: 8

Photo File #: wes-2-42.jpg
Detail: Pipe Location
Orientation: Below Side View



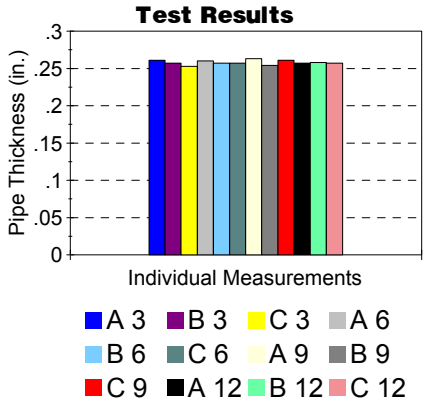
Pipe Identification and Operating Conditions

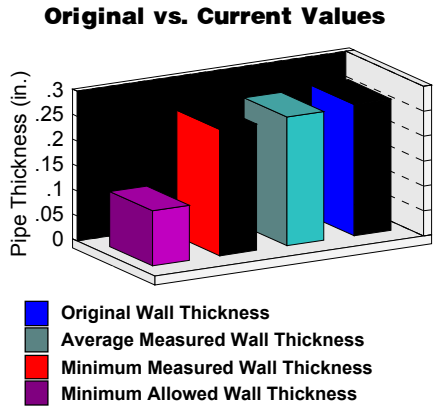
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-35
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - South Wing Basement Storage Room: Low pressure steam supply line, in front of lockers. Test points located 6 ft. from wall.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.003 in. / **High to Low Range:** 0.010 in.
Minimum Theoretical Wall Thickness: 0.249 in.
Pitting Index: 1.9 % - Insignificant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.258 in.
Average Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 3.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

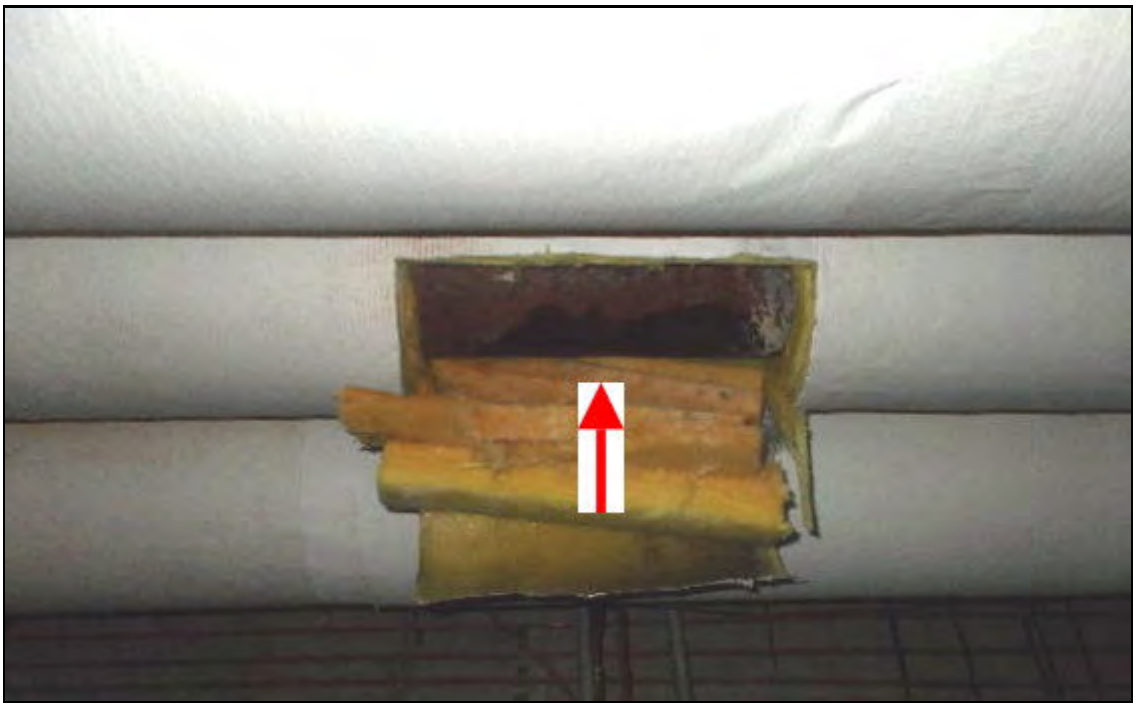
Minimum Thickness: 0.253 in.
Maximum Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 6.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows high wall thickness approaching new pipe specifications. Wall thickness is extremely uniform, as depicted in the top right bargraph. Virtually unlimited service life remains.

Location No: 9

Photo File #: wes-1-07.jpg
Detail: Pipe Location
Orientation: Below Side View



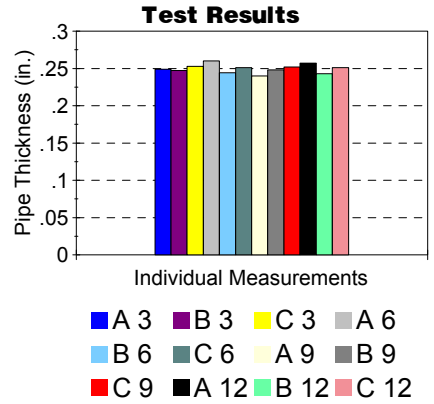
Pipe Identification and Operating Conditions

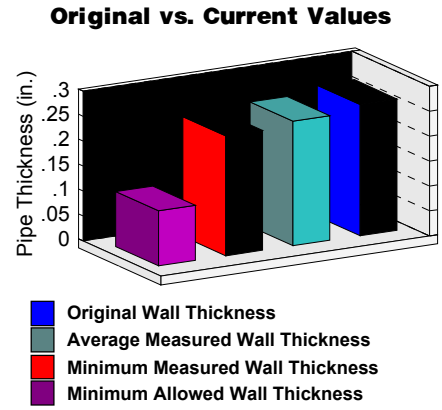
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-77
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line, near door to MER, 4th line. Test points located 8 ft. from wall to MER.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.006 in. / **High to Low Range:** 0.020 in.
Minimum Theoretical Wall Thickness: 0.232 in.
Pitting Index: 3.8 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.250 in.
Average Pipe Loss: 0.013 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 8.8 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

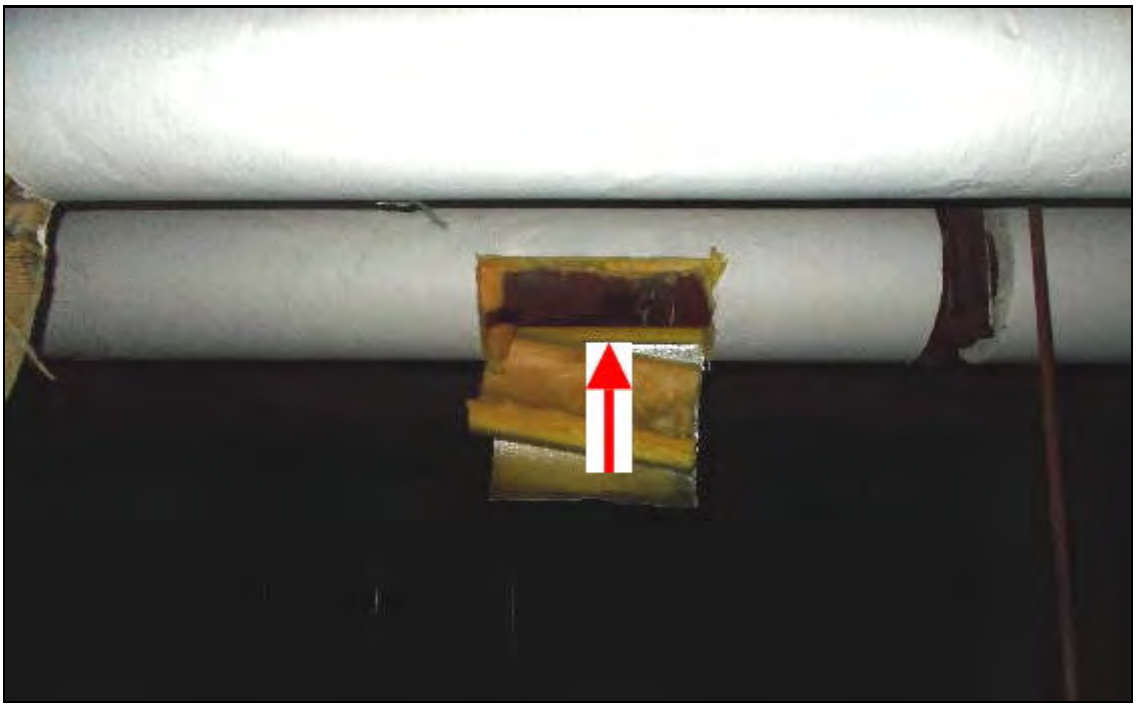
Minimum Thickness: 0.240 in.
Maximum Pipe Loss: 0.023 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 15.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We show another example of extremely durable wrought iron pipe having high and uniform wall thickness near new pipe specifications. Virtually unlimited service life remains.

Location No: 10

Photo File #: wes-1-11.jpg
Detail: Pipe Location
Orientation: Below Side View



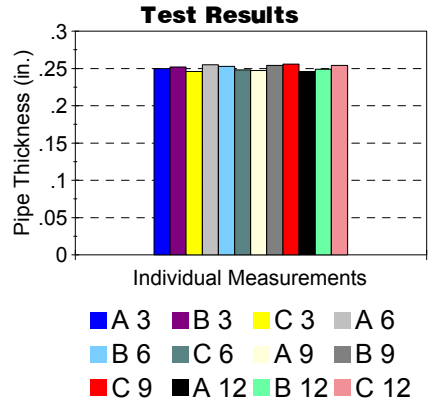
Pipe Identification and Operating Conditions

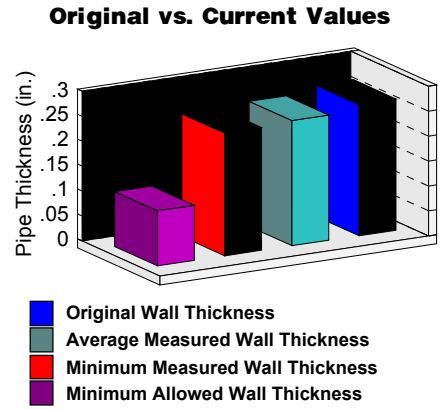
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-79
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line. Test points located midpoint between 1st elbow and wall.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.004 in. / **High to Low Range:** 0.010 in.
Minimum Theoretical Wall Thickness: 0.240 in.
Pitting Index: 1.9 % - Insignificant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.251 in.
Average Pipe Loss: 0.012 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 8.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

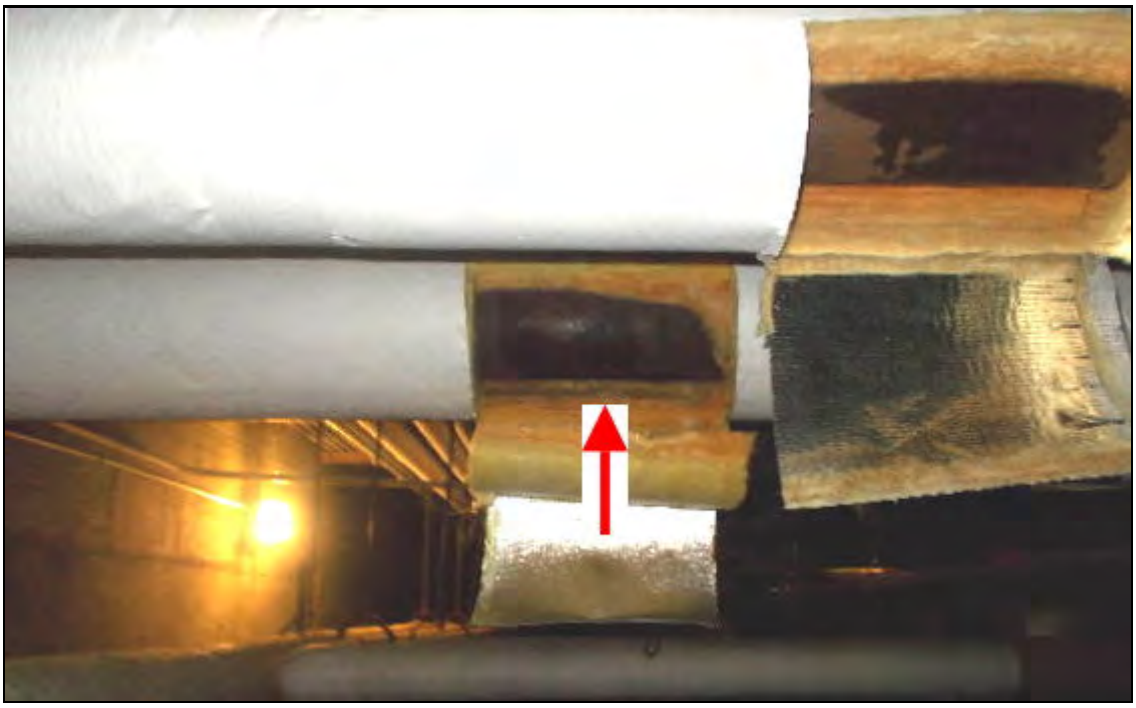
Minimum Thickness: 0.246 in.
Maximum Pipe Loss: 0.017 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 11.1 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We produce excellent results at this example of pipe. Corrosion is very low and uniform. Virtually unlimited service life remains.

Location No: 11

Photo File #: wes-1-15.jpg
Detail: Pipe Location
Orientation: Below Side View



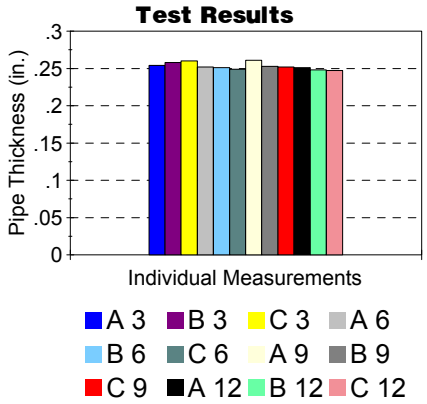
Pipe Identification and Operating Conditions

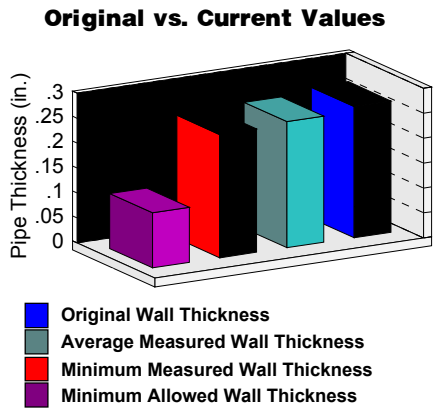
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-82
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line, near column X53-XAF. Test points located 8 ft. after wall.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.005 in. / **High to Low Range:** 0.014 in.
Minimum Theoretical Wall Thickness: 0.239 in.
Pitting Index: 2.4 % - Low Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.253 in.
Average Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 6.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

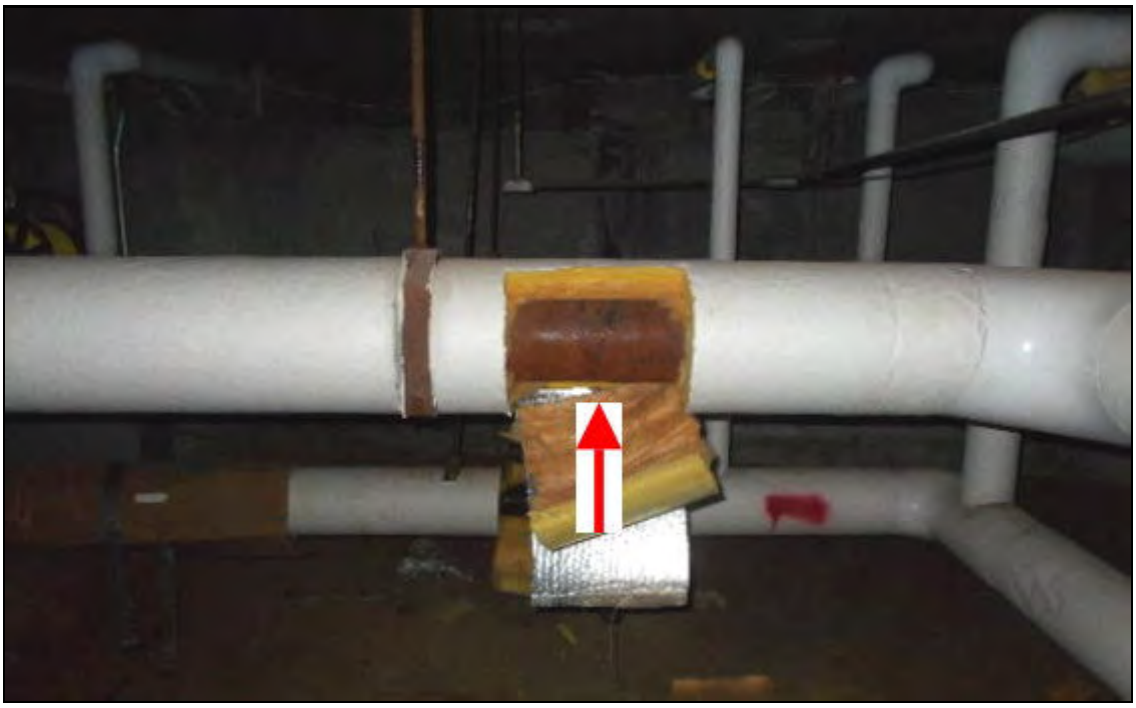
Minimum Thickness: 0.247 in.
Maximum Pipe Loss: 0.016 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 10.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We produce excellent results at this example of pipe. Wall thickness is near that of new schedule 40 carbon steel pipe. Virtually unlimited service life remains.

Location No: 12

Photo File #: wes-1-19.jpg
Detail: Pipe Location
Orientation: Side View



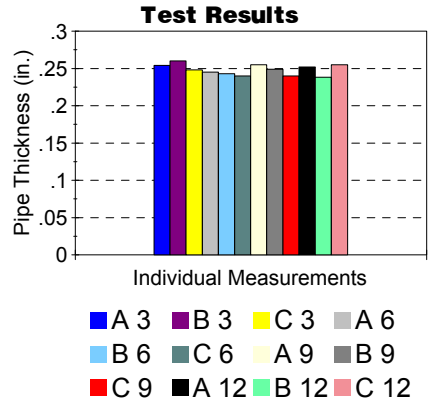
Pipe Identification and Operating Conditions

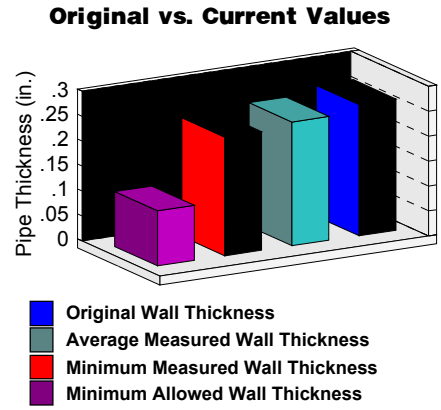
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-84
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - South Wing Crawlspace: Low pressure steam supply line, at corner of room, near column X49-XZ. Test points located 3 ft. after elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.007 in. / **High to Low Range:** 0.022 in.
Minimum Theoretical Wall Thickness: 0.227 in.
Pitting Index: 4.1 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.248 in.
Average Pipe Loss: 0.015 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 9.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

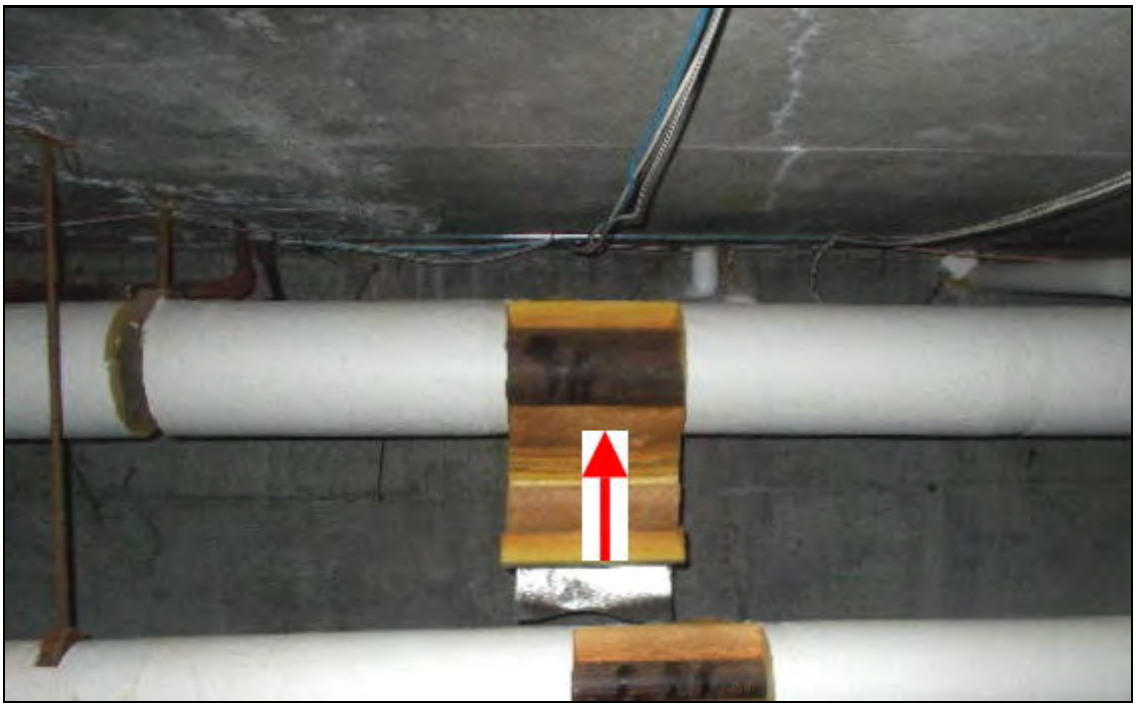
Minimum Thickness: 0.238 in.
Maximum Pipe Loss: 0.025 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 16.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows another example of excellent results. We measure high and uniform wall thickness due to low corrosion activity. Virtually unlimited service life remains.

Location No: 13

Photo File #: wes-2-13.jpg
Detail: Pipe Location
Orientation: Side View



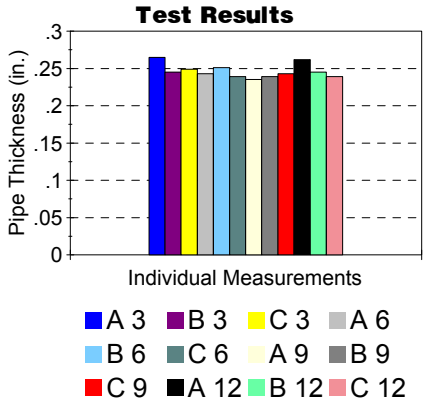
Pipe Identification and Operating Conditions

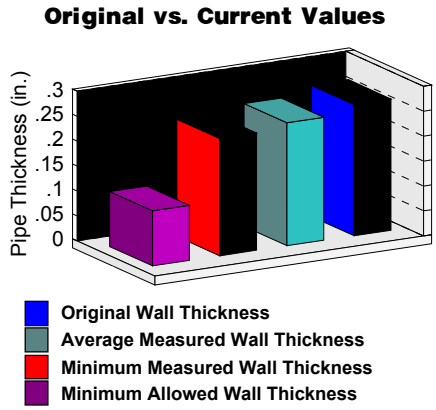
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-104
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply line, near column XS, at North wall. Test points located 25 ft. before chainlink fence, behind stonewall offset.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.009 in. / **High to Low Range:** 0.030 in.
Minimum Theoretical Wall Thickness: 0.219 in.
Pitting Index: 4.6 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.246 in.
Average Pipe Loss: 0.017 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 10.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

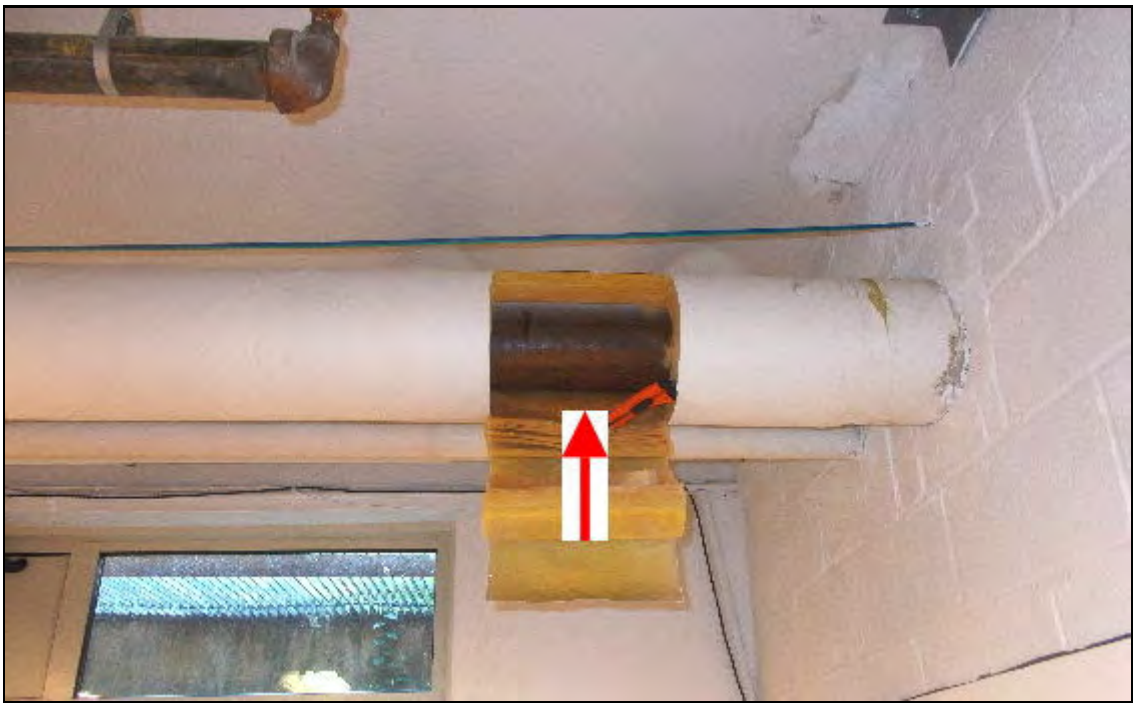
Minimum Thickness: 0.235 in.
Maximum Pipe Loss: 0.028 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 18.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We show another example of larger main steam pipe with the same results. Virtually unlimited service life remains.

Location No: 14

Photo File #: wes-2-46.jpg
Detail: Pipe Location
Orientation: Below Side View



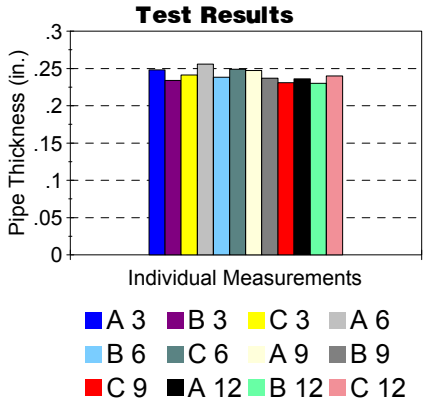
Pipe Identification and Operating Conditions

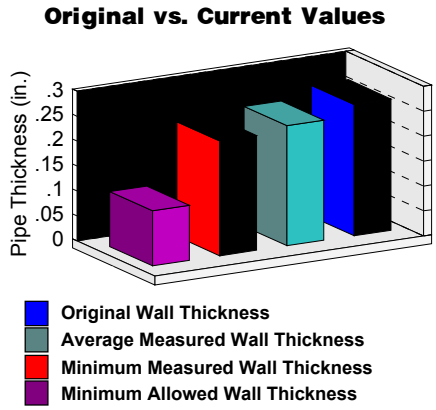
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-117
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Conference Room 3: Low pressure steam supply line. Test points located between take-offs.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.008 in. / **High to Low Range:** 0.026 in.
Minimum Theoretical Wall Thickness: 0.217 in.
Pitting Index: 4.4 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.241 in.
Average Pipe Loss: 0.022 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 14.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.230 in.
Maximum Pipe Loss: 0.033 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 21.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We show another example of larger main steam pipe with the same results. Virtually unlimited service life remains.

Location No: 15

Photo File #: wes-2-50.jpg
Detail: Pipe Location
Orientation: Below Side View

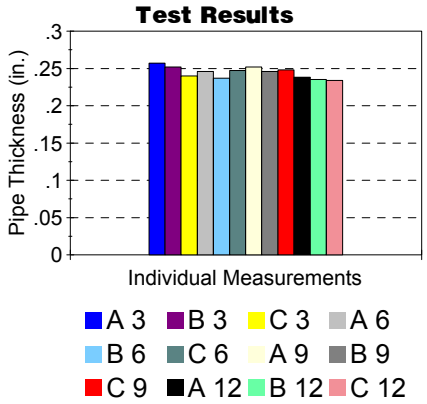
Pipe Identification and Operating Conditions

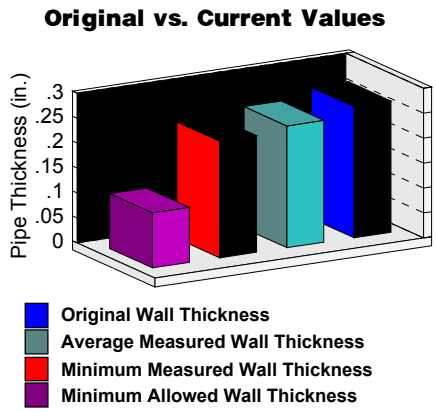
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-118
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Corridor: Low pressure steam supply line, in front of exterior door B8. Test points located 1 ft. before wall.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.007 in. / **High to Low Range:** 0.023 in.
Minimum Theoretical Wall Thickness: 0.222 in.
Pitting Index: 4.2 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.244 in.
Average Pipe Loss: 0.019 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 12.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

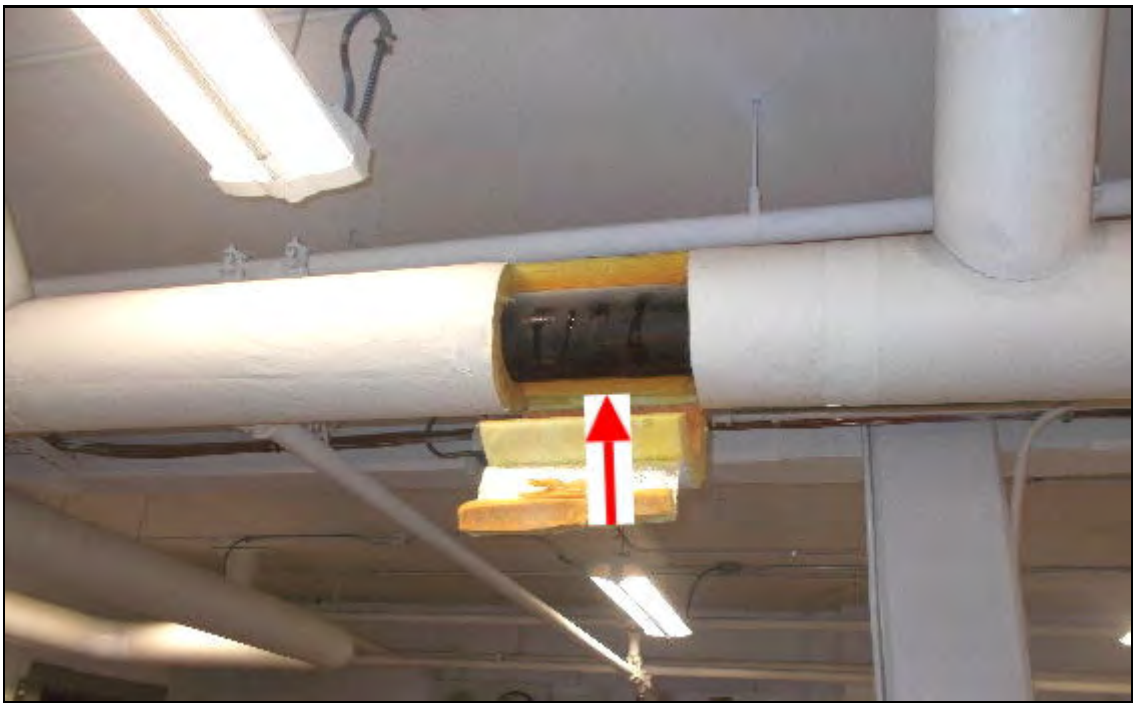
Minimum Thickness: 0.234 in.
Maximum Pipe Loss: 0.029 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 19.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing produces another example showing excellent results. We measure high and uniform wall thickness due to low corrosion activity. Virtually unlimited service life remains.

Location No: 16

Photo File #: wes-2-53.jpg
Detail: Pipe Location
Orientation: Below Side View



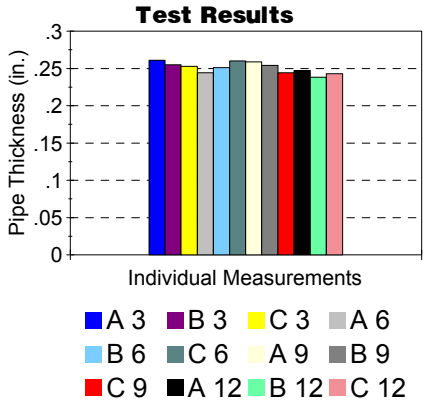
Pipe Identification and Operating Conditions

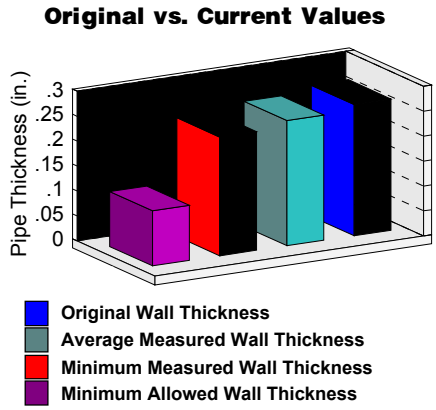
Service: Steam
Nominal Pipe Size: 5 in.
Actual Pipe Size: 5.56 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-5-120
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Production Center: Low pressure steam supply line. Test points located 2 ft. before 2nd take-off from expansion loop.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.263 in.
Minimum Allowable Thickness: 0.110 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.008 in. / **High to Low Range:** 0.023 in.
Minimum Theoretical Wall Thickness: 0.228 in.
Pitting Index: 5.1 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.251 in.
Average Pipe Loss: 0.012 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 8.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

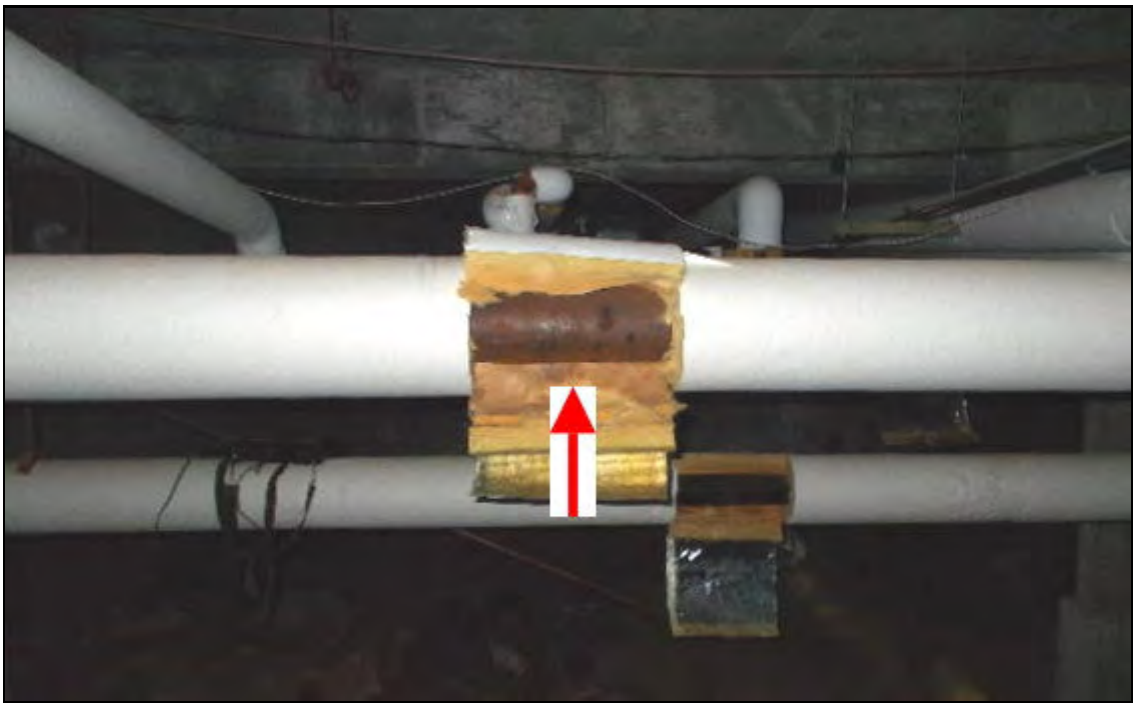
Minimum Thickness: 0.238 in.
Maximum Pipe Loss: 0.025 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 16.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows high wall thickness approaching new pipe specifications. Wall thickness is extremely uniform, as depicted in the top right bargraph. Virtually unlimited service life remains.

Location No: 17

Photo File #: wes-1-29.jpg
Detail: Pipe Location
Orientation: Side View



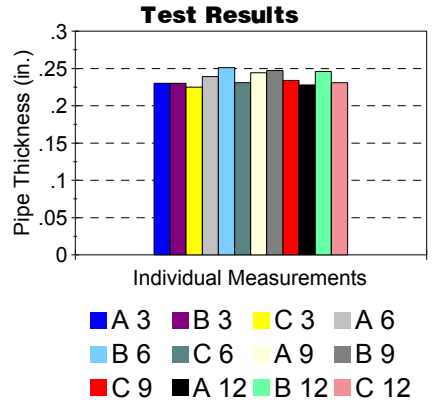
Pipe Identification and Operating Conditions

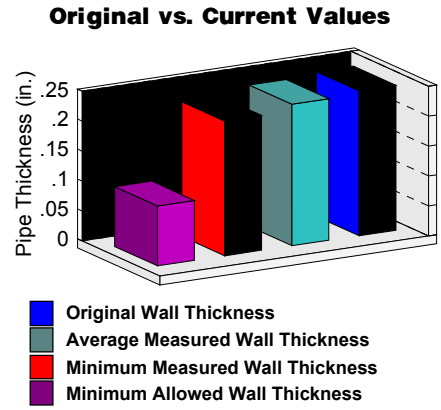
Service: Steam
Nominal Pipe Size: 4 in.
Actual Pipe Size: 4.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-4-09
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply line, after expansion loop, near column X36-XV. Test points located 8 ft. after expansion loop elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.242 in.
Minimum Allowable Thickness: 0.100 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.009 in. / **High to Low Range:** 0.026 in.
Minimum Theoretical Wall Thickness: 0.210 in.
Pitting Index: 4.8 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.236 in.
Average Pipe Loss: 0.006 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 4.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

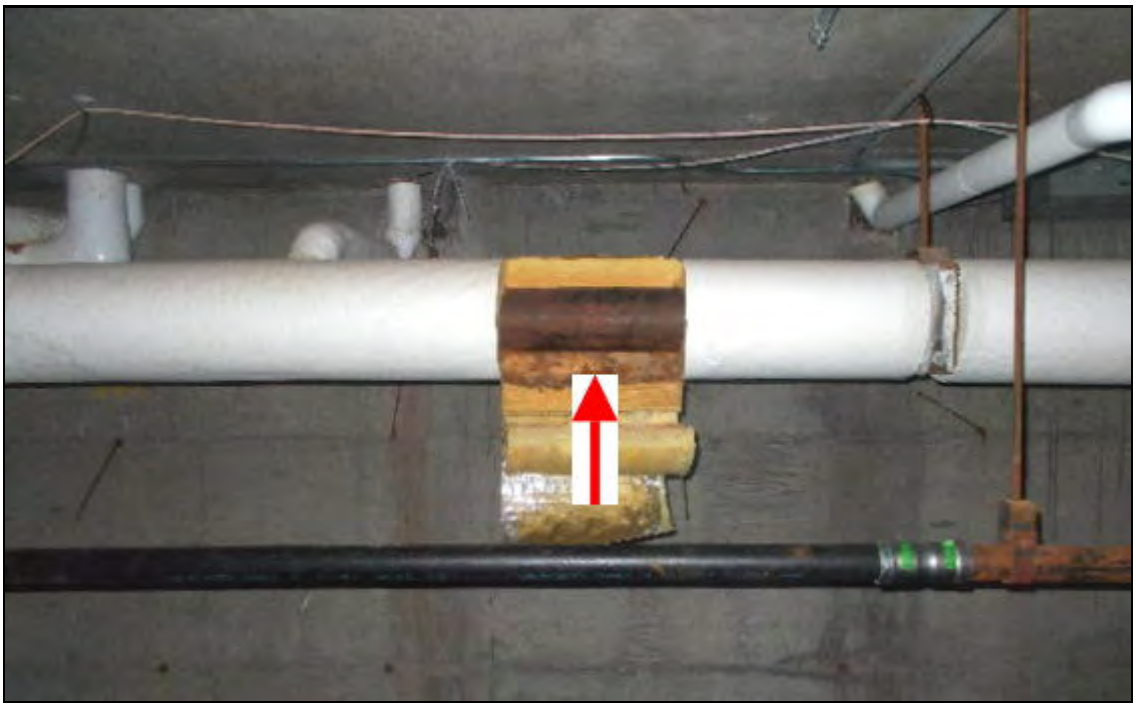
Minimum Thickness: 0.225 in.
Maximum Pipe Loss: 0.017 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 12.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We produce the same results for this small diameter 4 in. steam pipe. Corrosion activity is uniform and very low. Virtually unlimited service life remains.

Location No: 18

Photo File #: wes-2-01.jpg
Detail: Pipe Location
Orientation: Side View



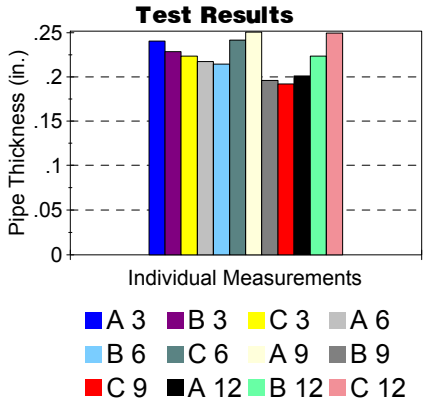
Pipe Identification and Operating Conditions

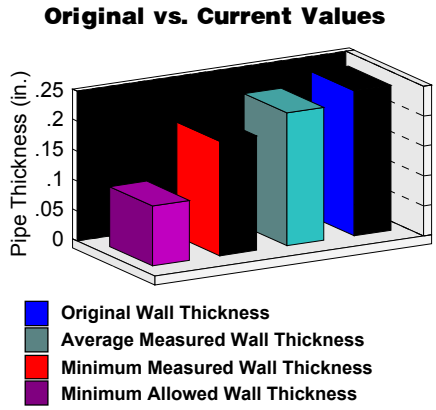
Service: Steam
Nominal Pipe Size: 4 in.
Actual Pipe Size: 4.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-4-99
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply line, near column XJ, at North wall. Test points located 30 ft. before elbow, above failed condensate line.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.242 in.
Minimum Allowable Thickness: 0.100 in. (0.002)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.020 in. / **High to Low Range:** 0.058 in.
Minimum Theoretical Wall Thickness: 0.162 in.
Pitting Index: 13.9% - Significant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.222 in.
Average Pipe Loss: 0.020 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 14.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.191 in.
Maximum Pipe Loss: 0.051 in.
Corrosion Rate: 0.8 Mils Per Year
Percent of Allowable Pipe Loss: 35.9 %
Remaining Pipe Life: 116.2 Years
Estimated Retirement **October 2133**

Testing Indicates: Pipe Condition Excellent

Comments: Testing shows some noticeable deeper pitting at this example of pipe. Wall thickness is still high, and suggests extremely long service life available.

Location No: 19

Photo File #: wes-1-01.jpg
Detail: Pipe Location
Orientation: Side View

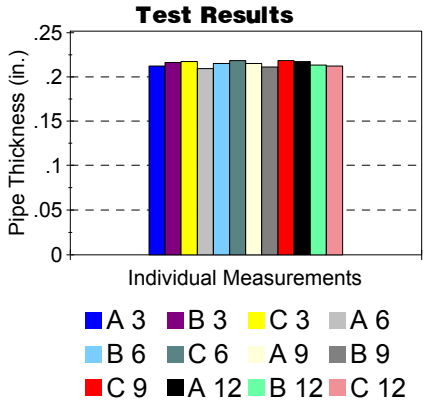
Pipe Identification and Operating Conditions

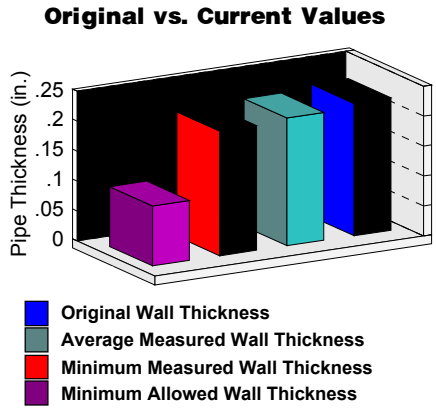
Service: Steam
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-3-01
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line, near door to MER, 1st line. Test points located 4 ft. from MER wall.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.100 in. (0.001)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.003 in. / **High to Low Range:** 0.009 in.
Minimum Theoretical Wall Thickness: 0.205 in.
Pitting Index: 2.5 % - Low Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.213 in.
Average Pipe Loss: 0.008 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 6.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.208 in.
Maximum Pipe Loss: 0.013 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 10.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We produce excellent results at this example of pipe. Corrosion is very low and uniform. Virtually unlimited service life remains.

Location No: 20

Photo File #: wes-1-31.jpg
Detail: Pipe Location
Orientation: Below Side View

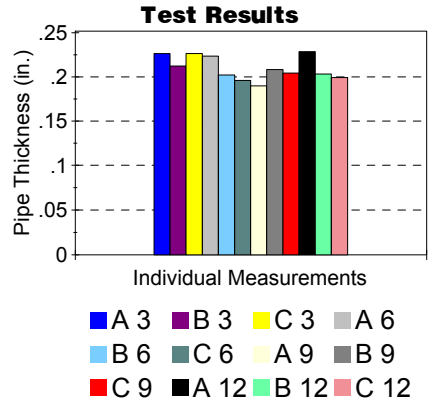
Pipe Identification and Operating Conditions

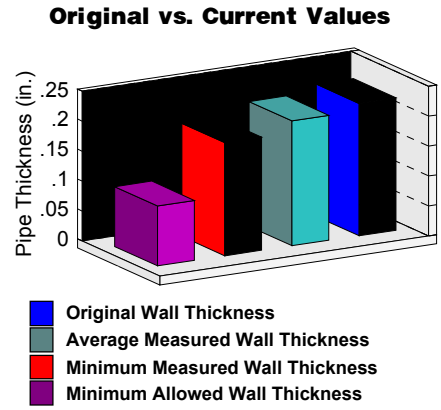
Service: Steam
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-3-10
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply line, after expansion loop, near column X36-XV. Test points located 6 ft. after expansion loop elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.100 in. (0.001)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.013 in. / **High to Low Range:** 0.038 in.
Minimum Theoretical Wall Thickness: 0.170 in.
Pitting Index: 9.5 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.209 in.
Average Pipe Loss: 0.012 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 10.1 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

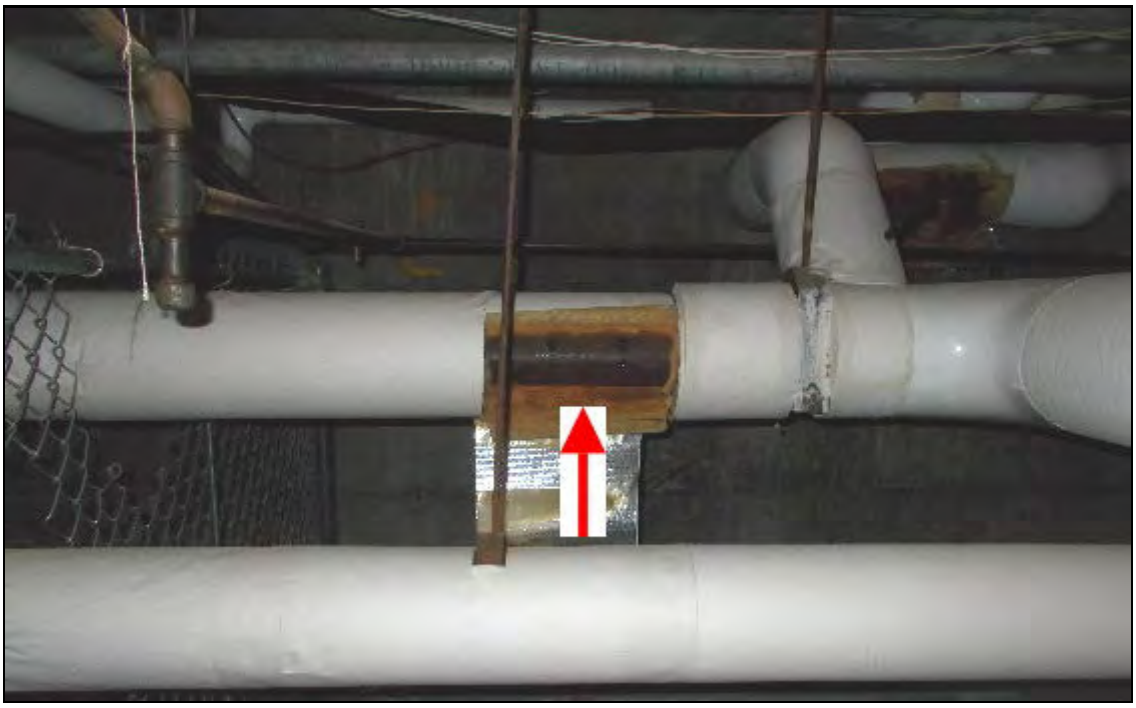
Minimum Thickness: 0.189 in.
Maximum Pipe Loss: 0.032 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 26.4 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We produce excellent results at this example of pipe. Corrosion is very low, with mild pitting. Virtually unlimited service life remains.

Location No: 21

Photo File #: wes-2-19.jpg
Detail: Pipe Location
Orientation: Side View



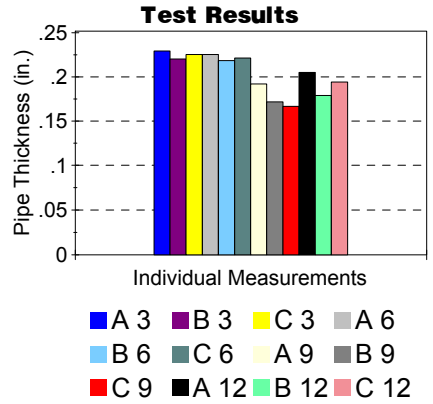
Pipe Identification and Operating Conditions

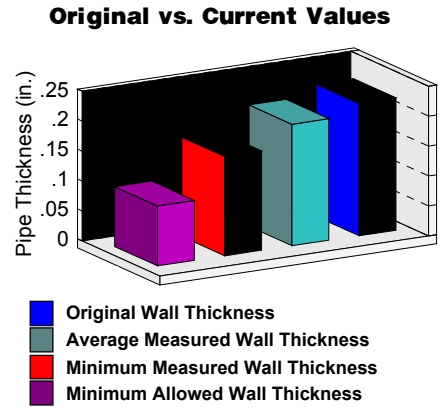
Service: Steam
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-3-28
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply line, near column XO, at South wall. Test points located 2 ft. after expansion loop.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.100 in. (0.001)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.022 in. / **High to Low Range:** 0.062 in.
Minimum Theoretical Wall Thickness: 0.136 in.
Pitting Index: 18.2% - Significant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.203 in.
Average Pipe Loss: 0.018 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 14.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

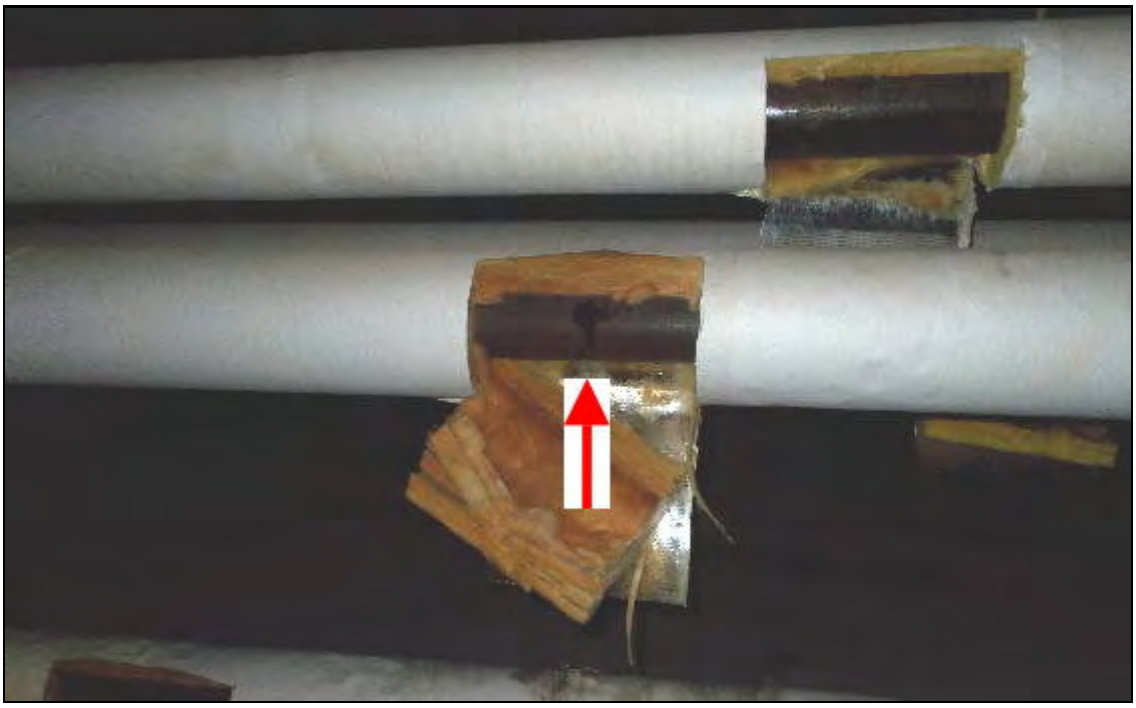
Minimum Thickness: 0.166 in.
Maximum Pipe Loss: 0.055 in.
Corrosion Rate: 0.8 Mils Per Year
Percent of Allowable Pipe Loss: 45.5 %
Remaining Pipe Life: 78.1 Years
Estimated Retirement **October 2095**

Testing Indicates: Pipe Condition Excellent

Comments: Testing shows deeper pitting at this example of pipe. Average wall thickness is high. Very long service life remains.

Location No: 22

Photo File #: wes-1-12.jpg
Detail: Pipe Location
Orientation: Side View



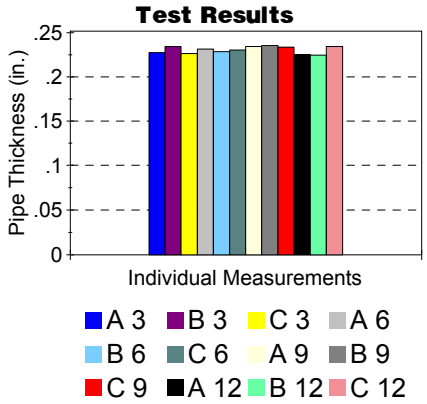
Pipe Identification and Operating Conditions

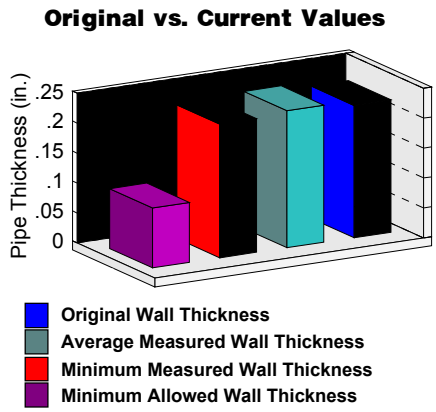
Service: Steam
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-3-80
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line. Test points located midpoint between 1st elbow and wall.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.100 in. (0.001)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.004 in. / **High to Low Range:** 0.011 in.
Minimum Theoretical Wall Thickness: 0.217 in.
Pitting Index: 2.7 % - Low Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.229 in.
Average Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.223 in.
Maximum Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Pipe In Like New Condition

Comments: Testing at this section of pipe produces excellent results. Wall thickness is extremely uniform and still exceeds new pipe specifications due to oversized pipe being installed. Virtually unlimited service life remains.

Location No: 23

Photo File #: wes-1-16.jpg
Detail: Pipe Location
Orientation: Side View

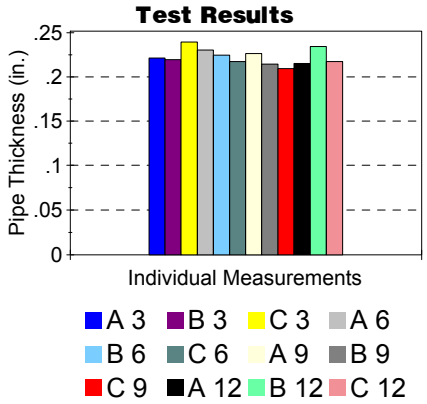
Pipe Identification and Operating Conditions

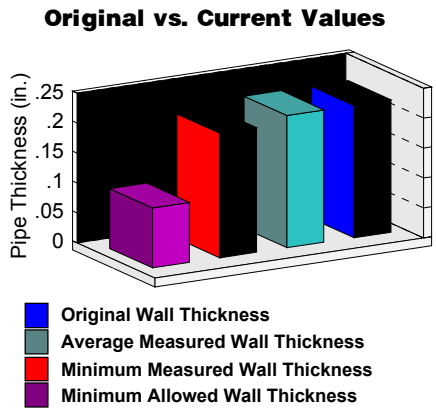
Service: Steam
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-3-83
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Low pressure steam supply line, near column X53-XAF. Test points located 8 ft. after wall.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.100 in. (0.001)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.009 in. / **High to Low Range:** 0.030 in.
Minimum Theoretical Wall Thickness: 0.195 in.
Pitting Index: 5.9 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.221 in.
Average Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.208 in.
Maximum Pipe Loss: 0.013 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 10.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Pipe In Like New Condition

Comments: Measurements show excellent results at this section of pipe. Corrosion activity is low, but pitting activity is moderate. Virtually unlimited service life remains.

Location No: 24

Photo File #: wes-1-22.jpg
Detail: Pipe Location
Orientation: Side View

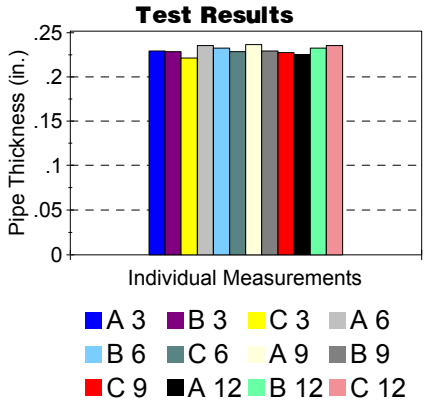
Pipe Identification and Operating Conditions

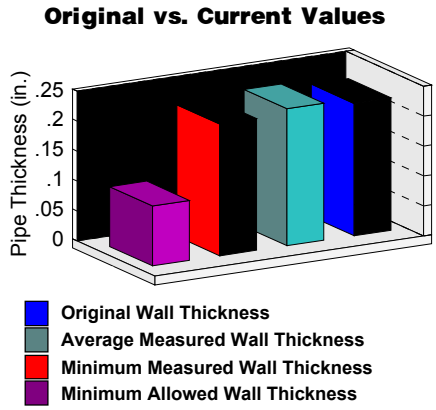
Service: Steam
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-3-86
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - South Wing Crawlspace: Low pressure steam supply line, at corner of room, near column X49-XZ. Test points located 4 ft. after elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.100 in. (0.001)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.004 in. / **High to Low Range:** 0.015 in.
Minimum Theoretical Wall Thickness: 0.215 in.
Pitting Index: 3.8 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.229 in.
Average Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

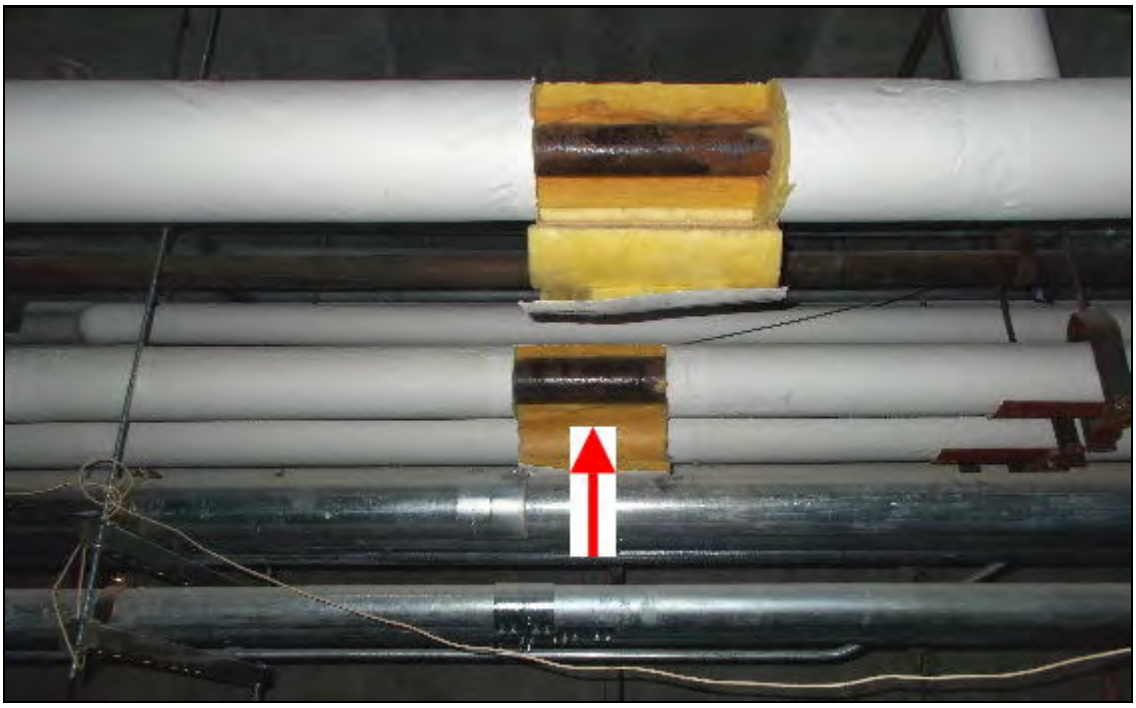
Minimum Thickness: 0.220 in.
Maximum Pipe Loss: 0.001 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.8 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Pipe In Like New Condition

Comments: Here we show another location exceeding new pipe specifications. Due to low corrosion conditions and the installation of oversized pipe, virtually unlimited service life remains.

Location No: 25

Photo File #: wes-1-36.jpg
Detail: Pipe Location
Orientation: Below Side View



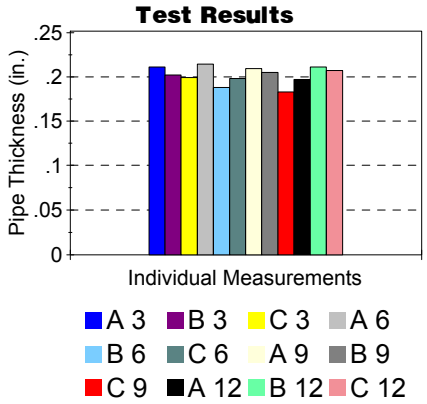
Pipe Identification and Operating Conditions

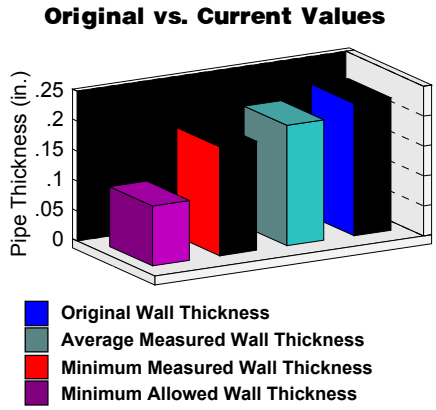
Service: Steam
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-3-92
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Low pressure steam supply line, near column X24-XAF. Test points located 40 ft. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.100 in. (0.001)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.010 in. / **High to Low Range:** 0.031 in.
Minimum Theoretical Wall Thickness: 0.172 in.
Pitting Index: 9.5 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.201 in.
Average Pipe Loss: 0.020 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 16.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

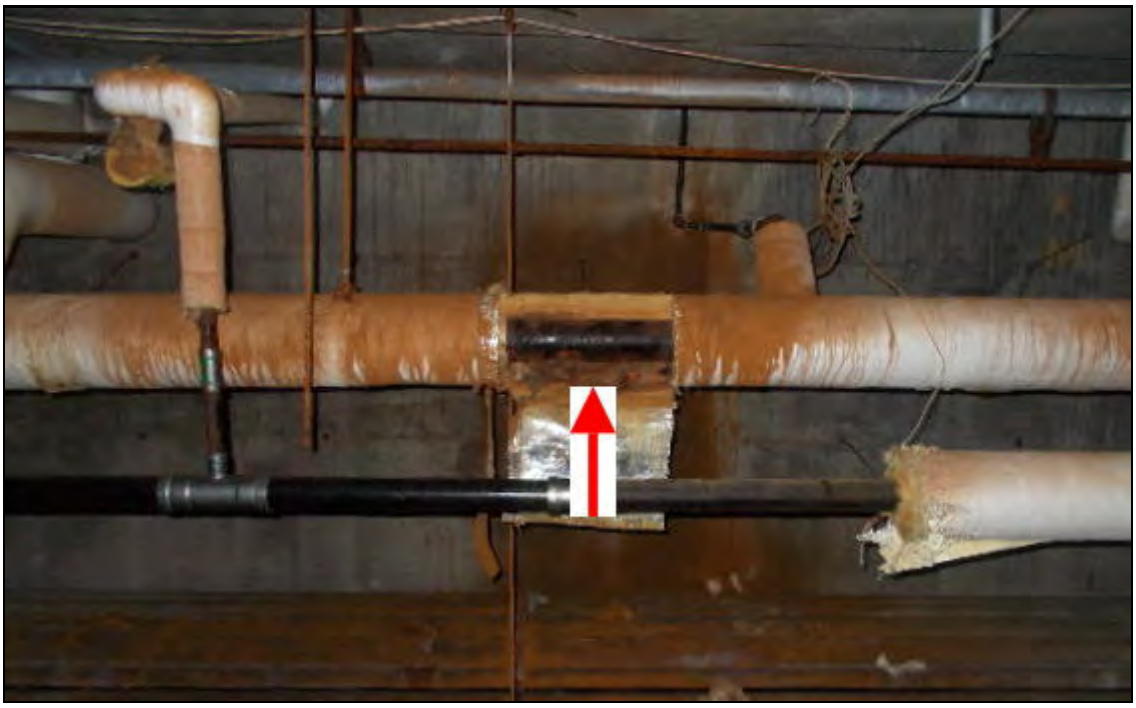
Minimum Thickness: 0.182 in.
Maximum Pipe Loss: 0.039 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 32.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing at this section of pipe shows excellent results. Corrosion activity is low and pitting activity is moderate. Virtually unlimited service life remains.

Location No: 26

Photo File #: wes-1-86.jpg
Detail: Pipe Location
Orientation: Side View



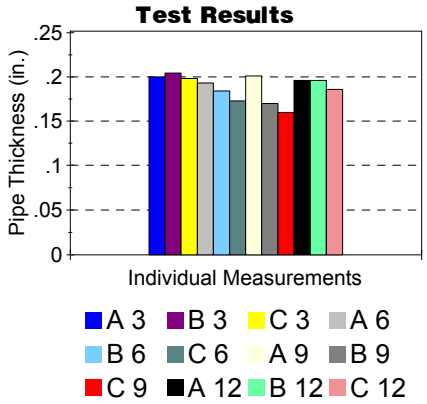
Pipe Identification and Operating Conditions

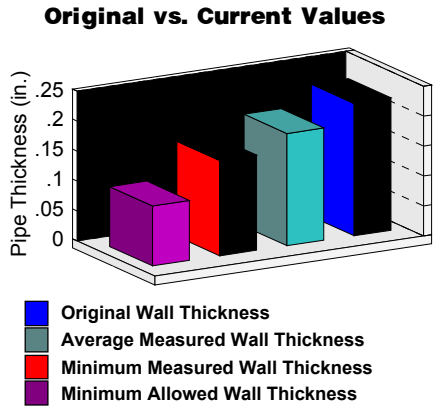
Service: Steam
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-3-95
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Low pressure steam supply line, near column XJ, at South wall. Test points located 25 ft. after expansion loop.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.100 in. (0.001)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.014 in. / **High to Low Range:** 0.044 in.
Minimum Theoretical Wall Thickness: 0.145 in.
Pitting Index: 15.2% - Significant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.187 in.
Average Pipe Loss: 0.034 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 27.8 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

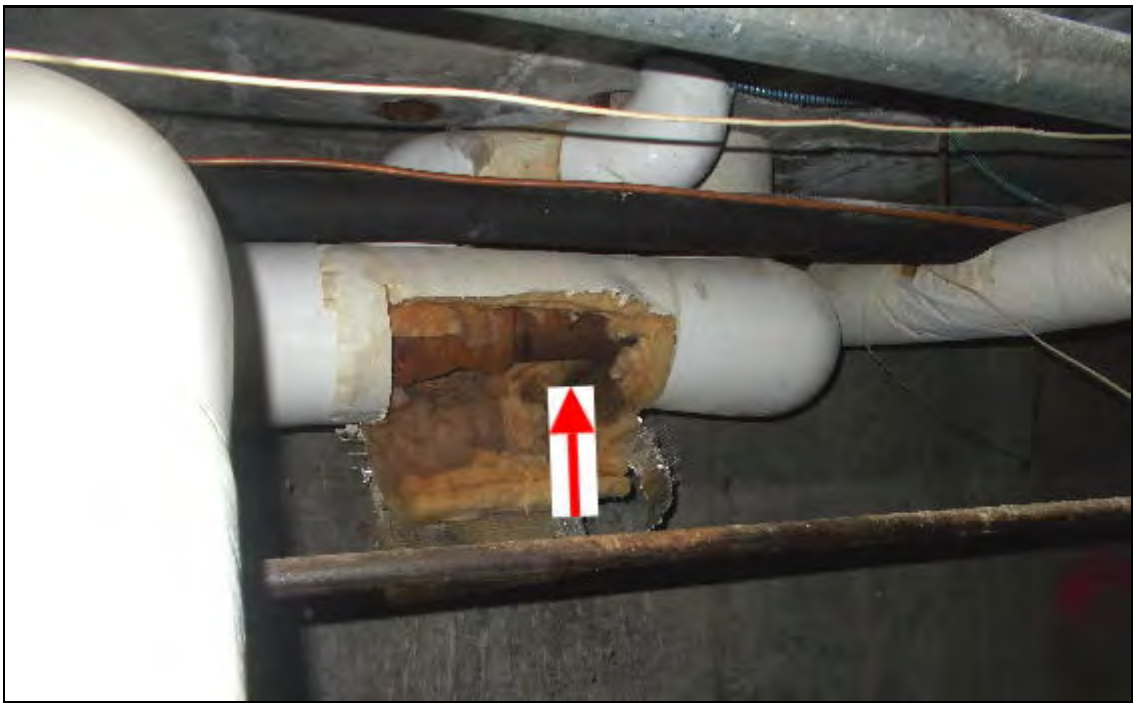
Minimum Thickness: 0.159 in.
Maximum Pipe Loss: 0.062 in.
Corrosion Rate: 1.0 Mils Per Year
Percent of Allowable Pipe Loss: 51.2 %
Remaining Pipe Life: 62.0 Years
Estimated Retirement **August 2079**

Testing Indicates: Pipe Condition Very Good

Comments: Testing at this section of pipe adjacent to the condensate line failure shows slightly less favorable results. Moderate outer surface corrosion exists possibly due to the adjacent failure. Very long service life remains.

Location No: 27

Photo File #: wes-2-21.jpg
Detail: Pipe Location
Orientation: Side View



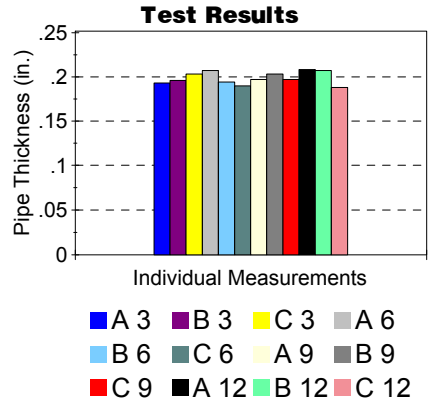
Pipe Identification and Operating Conditions

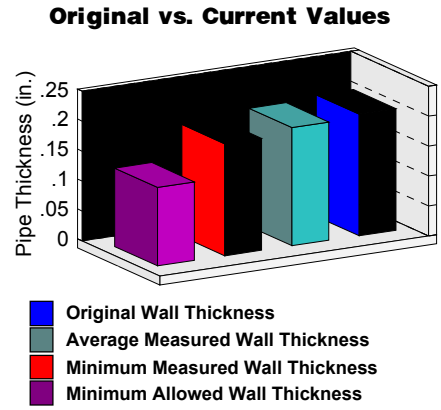
Service: Steam
Nominal Pipe Size: 2-1/2 in.
Actual Pipe Size: 2.88 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-2-1/2-29
Site Drawing Number: n/a
Depth Allowance: 0.105 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam branch line, near column XO, at South wall. Test points located 1st take-off after expansion loop, between coupling and elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.203 in.
Minimum Allowable Thickness: 0.131 in. (0.106)
Minimum Thickness Based Upon: Calculated Value
Standard Deviation: 0.007 in. / **High to Low Range:** 0.020 in.
Minimum Theoretical Wall Thickness: 0.177 in.
Pitting Index: 5.4 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.198 in.
Average Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 7.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.187 in.
Maximum Pipe Loss: 0.016 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 22.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Here we show much more favorable results. Average wall thickness is approaching new pipe specifications. Corrosion activity is very low. Virtually unlimited service life remains.

Location No: 28

Photo File #: wes-2-47.jpg
Detail: Pipe Location
Orientation: Below Side View

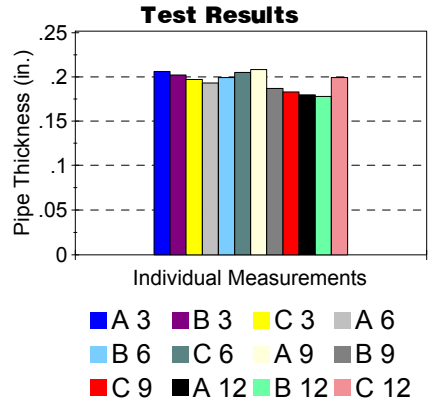
Pipe Identification and Operating Conditions

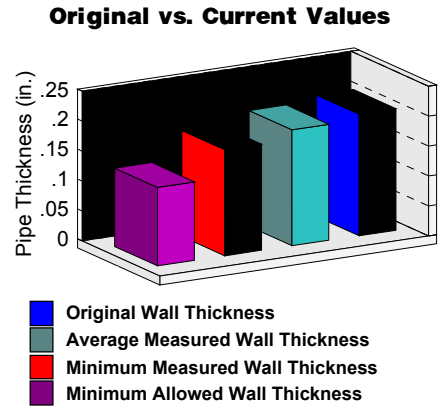
Service: Steam
Nominal Pipe Size: 2-1/2 in.
Actual Pipe Size: 2.88 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-2-1/2-116
Site Drawing Number: n/a
Depth Allowance: 0.105 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Conference Room 3: Low pressure steam supply branch line. Test points located between 45° and 90° elbows.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.203 in.
Minimum Allowable Thickness: 0.131 in. (0.106)
Minimum Thickness Based Upon: Calculated Value
Standard Deviation: 0.010 in. / **High to Low Range:** 0.030 in.
Minimum Theoretical Wall Thickness: 0.162 in.
Pitting Index: 8.6 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.194 in.
Average Pipe Loss: 0.009 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 12.8 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.177 in.
Maximum Pipe Loss: 0.026 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 36.1 %
Remaining Pipe Life: 115.3 Years
Estimated Retirement **November 2132**

Testing Indicates: Pipe Condition Excellent

Comments: Measurements show this section of pipe in excellent condition. Corrosion activity is low and pitting activity is moderate. Extremely long service life remains.

Location No: 29

Photo File #: wes-2-04.jpg
Detail: Pipe Location
Orientation: Side View

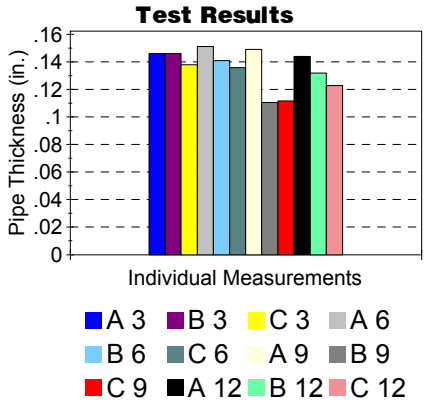
Pipe Identification and Operating Conditions

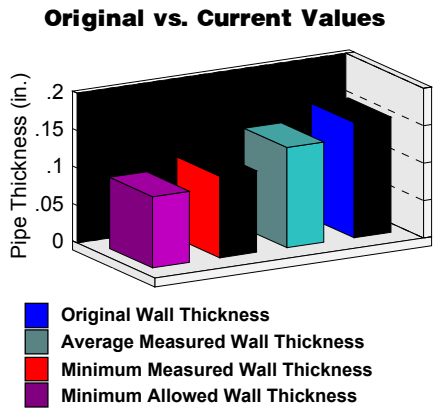
Service: Steam
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-2-24
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply line, near column XE, at rear wall. Test points located between elbow and replaced pipe.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.014 in. / **High to Low Range:** 0.040 in.
Minimum Theoretical Wall Thickness: 0.093 in.
Pitting Index: 18.5% - Significant Pitting Activity
Notes: Pipe exists 36 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.134 in.
Average Pipe Loss: 0.020 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 34.3 %
Remaining Pipe Life: 124.6 Years
Estimated Retirement **March 2142**

Worst Case Scenario

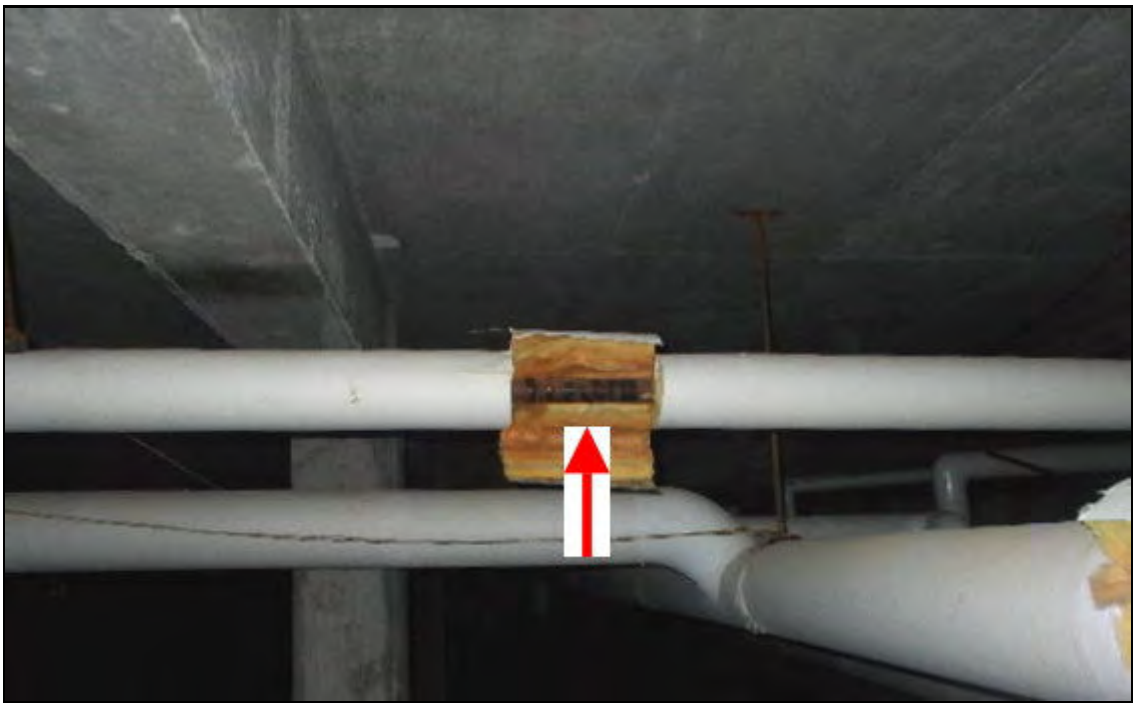
Minimum Thickness: 0.109 in.
Maximum Pipe Loss: 0.045 in.
Corrosion Rate: 0.7 Mils Per Year
Percent of Allowable Pipe Loss: 76.3 %
Remaining Pipe Life: 20.3 Years
Estimated Retirement **November 2037**

Testing Indicates: Pipe Condition Satisfactory

Comments: Testing at this 2 in. section of pipe of inherently less wall thickness identifies satisfactory results. Pitting activity is significant although highest pitting activity is still near acceptable values. Long service life remains.

Location No: 30

Photo File #: wes-1-33.jpg
Detail: Pipe Location
Orientation: Side View



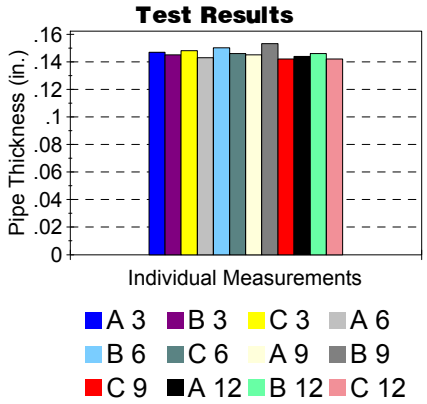
Pipe Identification and Operating Conditions

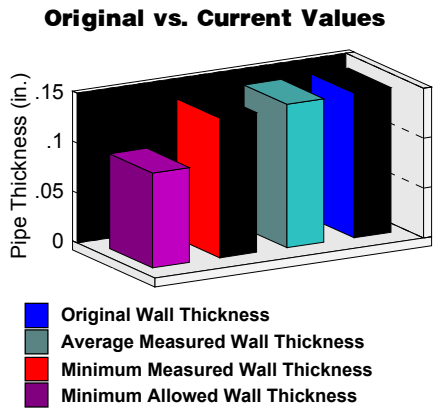
Service: Steam
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-1-1/2-11
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam branch line, after expansion loop, near column X36-XV. Test points located 8 ft. after 45° elbow to upper 3 in. steam line.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.011 in.
Minimum Theoretical Wall Thickness: 0.134 in.
Pitting Index: 2.7 % - Low Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.144 in.
Average Pipe Loss: 0.001 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 2.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

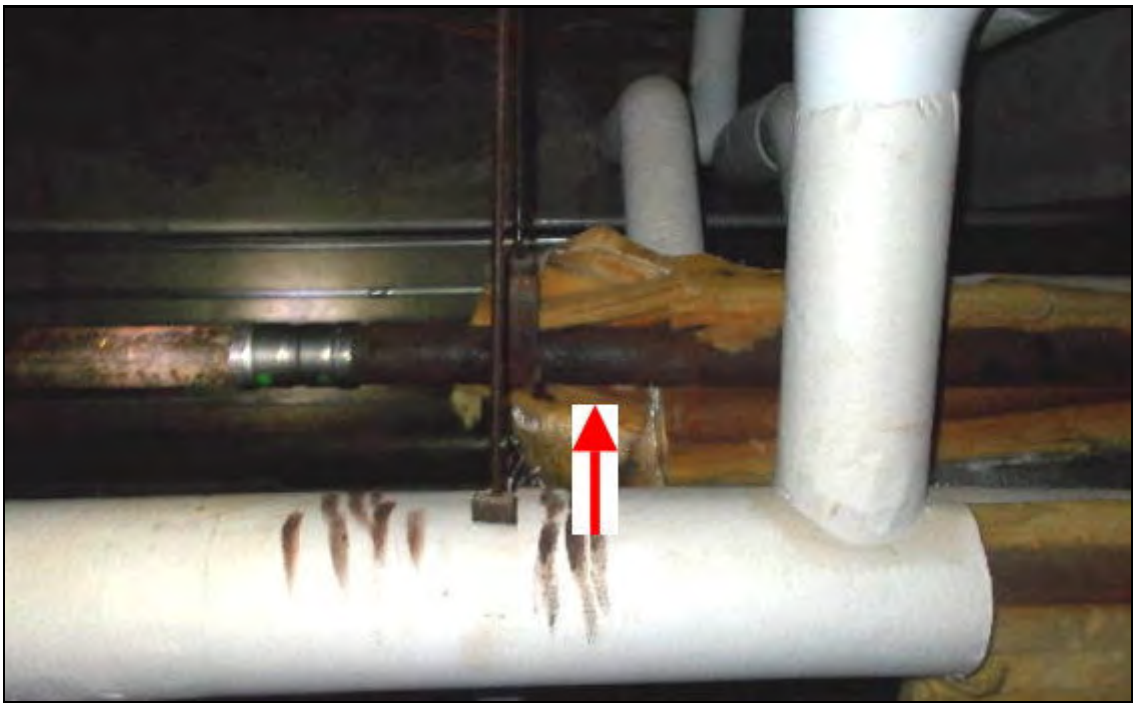
Minimum Thickness: 0.140 in.
Maximum Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 10.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Here we show ideal results for this smaller diameter section of pipe. Corrosion and pitting activity are virtually non-existant. Wall thickness exists slightly below new pipe specifications. Virtually unlimited service life remains.

Location No: 31

Photo File #: wes-1-90.jpg
Detail: Pipe Location
Orientation: Side View



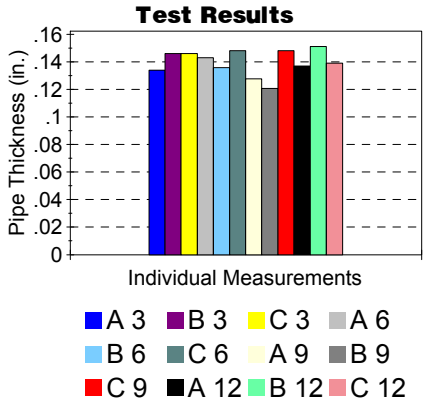
Pipe Identification and Operating Conditions

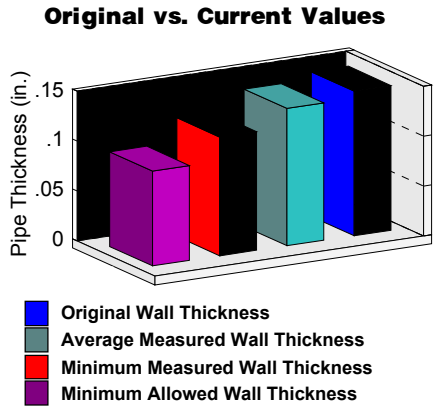
Service: Steam
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-1-1/2-19
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Low pressure steam supply line, near column XE, at rear wall. Test points located 1-18 in. after area of failure.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.009 in. / **High to Low Range:** 0.030 in.
Minimum Theoretical Wall Thickness: 0.111 in.
Pitting Index: 13.6% - Significant Pitting Activity
Notes: Pipe exists 46 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.138 in.
Average Pipe Loss: 0.007 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 14.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.119 in.
Maximum Pipe Loss: 0.026 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 52.0 %
Remaining Pipe Life: 60.1 Years
Estimated Retirement **September 2077**

Testing Indicates: Pipe Condition Very Good

Comments: Testing in this area shows higher pitting but still overall high wall loss contradictory to the nearby area which failed. Average wall thickness is high enough far below new schedule 40 specifications. Very long service life remains.

Location No: 32

Photo File #: wes-1-18.jpg
Detail: Pipe Location
Orientation: Side View

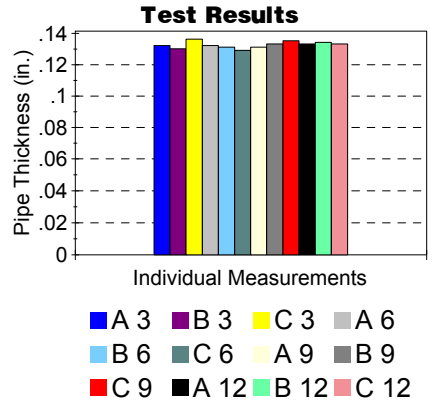
Pipe Identification and Operating Conditions

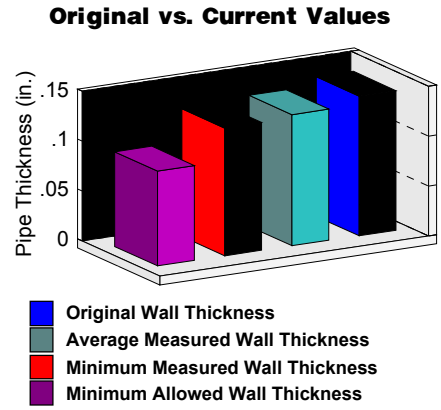
Service: Steam
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-1-1/4-07
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - South Wing Crawlspace: Low pressure steam branch line, 1st take-off in room, near column X49-XAD. Test points located 2 ft. from elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.002 in. / **High to Low Range:** 0.007 in.
Minimum Theoretical Wall Thickness: 0.125 in.
Pitting Index: 2.6 % - Low Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.131 in.
Average Pipe Loss: 0.009 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 19.1 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

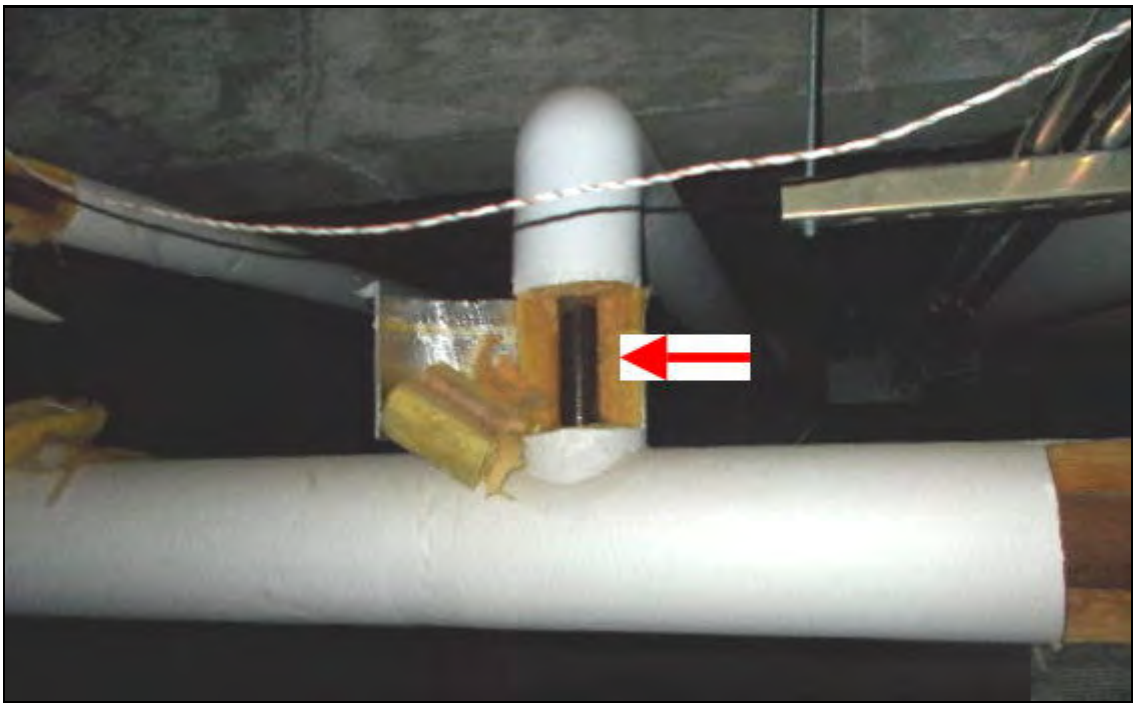
Minimum Thickness: 0.128 in.
Maximum Pipe Loss: 0.012 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 26.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We measure high and very uniform wall thickness at this example of pipe. Very consistent results suggests only minimal corrosion activity. Virtually unlimited service life remains.

Location No: 33

Photo File #: wes-1-28.jpg
Detail: Pipe Location
Orientation: Side View



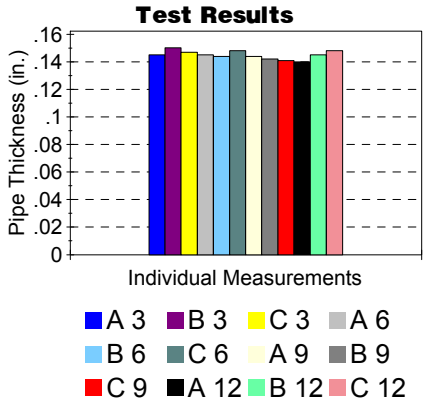
Pipe Identification and Operating Conditions

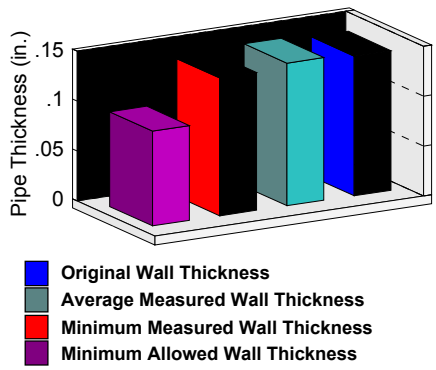
Service: Steam
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Vertical
Test Site I.D.: B-STM-1-1/4-90
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam branch line, after expansion loop, near column X36-XV. Test points located between main and elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.010 in.
Minimum Theoretical Wall Thickness: 0.134 in.
Pitting Index: 3.4 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.143 in.
Average Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

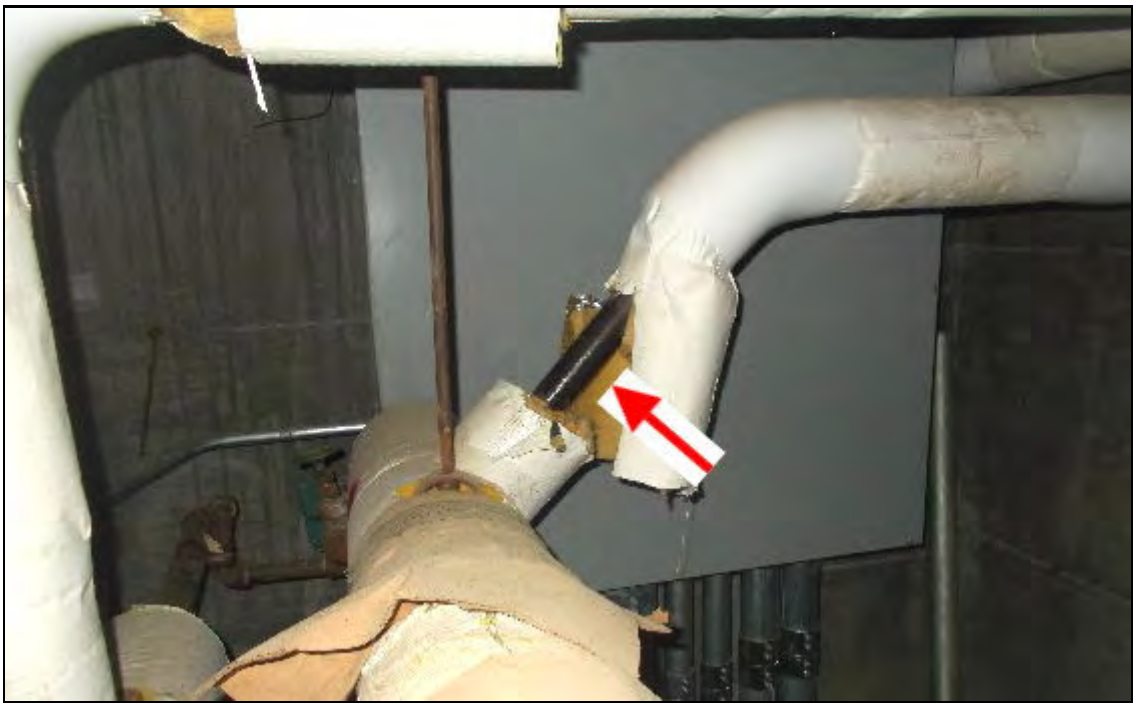
Minimum Thickness: 0.138 in.
Maximum Pipe Loss: 0.002 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 4.4 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Pipe In Like New Condition

Comments: We produce outstanding results showing this example of pipe still at or above new schedule 40 specifications. This is due to low corrosion activity in combination with oversized pipe. Virtually unlimited service life remains.

Location No: 34

Photo File #: wes-1-93.jpg
Detail: Pipe Location
Orientation: Side View



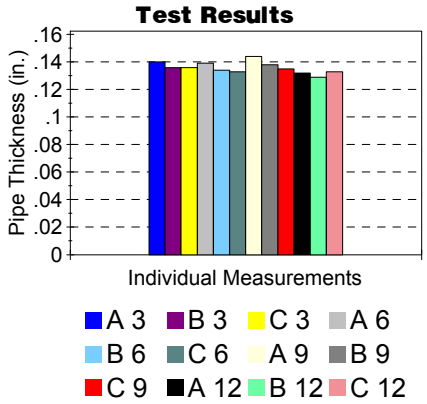
Pipe Identification and Operating Conditions

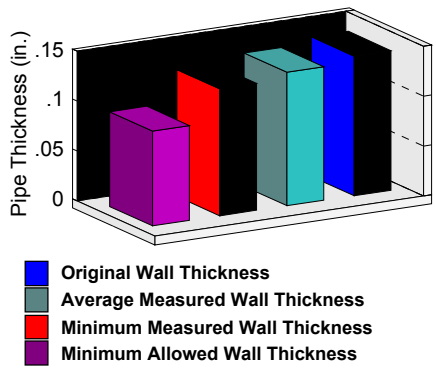
Service: Steam
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Diagonal
Test Site I.D.: B-STM-1-1/4-98
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply branch line, near column XE, at South wall. Test points located between main and 45° elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.004 in. / **High to Low Range:** 0.015 in.
Minimum Theoretical Wall Thickness: 0.122 in.
Pitting Index: 5.0 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.134 in.
Average Pipe Loss: 0.006 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 13.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

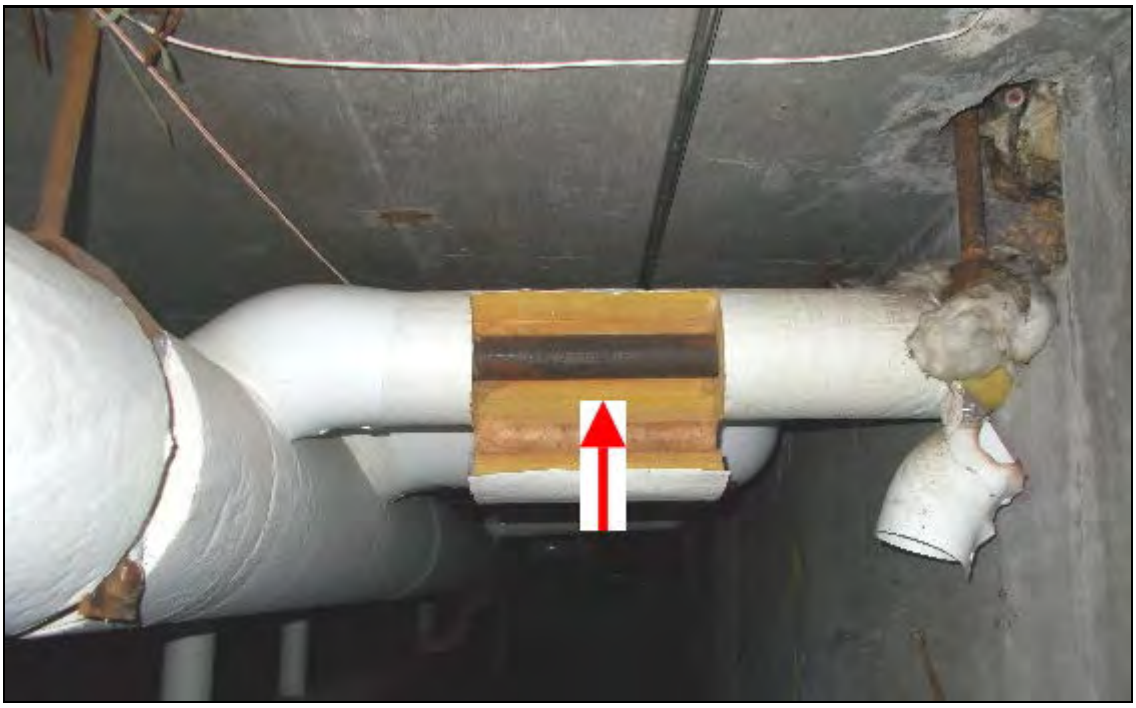
Minimum Thickness: 0.127 in.
Maximum Pipe Loss: 0.013 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 28.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows slightly higher pitting activity in this example of pipe but still excellent results defining virtually unlimited service life remaining.

Location No: 35

Photo File #: wes-2-14.jpg
Detail: Pipe Location
Orientation: Below Side View



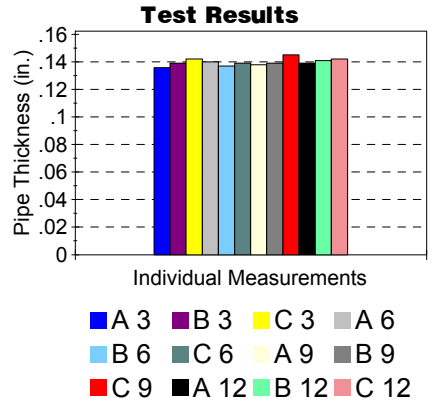
Pipe Identification and Operating Conditions

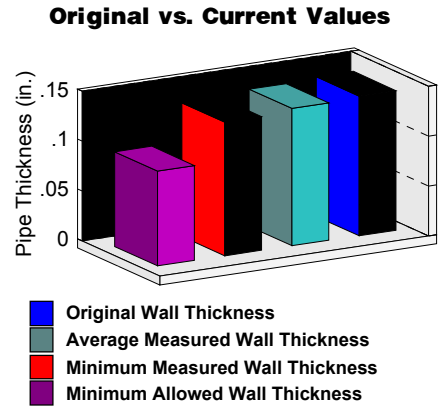
Service: Steam
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-1-1/4-105
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Low pressure steam supply branch line, near column XS, at North wall. Test points located 1-12 in. before elbow from main, first branch line from chainlink fence, behind stonewall offset.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.002 in. / **High to Low Range:** 0.009 in.
Minimum Theoretical Wall Thickness: 0.130 in.
Pitting Index: 2.7 % - Low Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.138 in.
Average Pipe Loss: 0.002 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 5.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

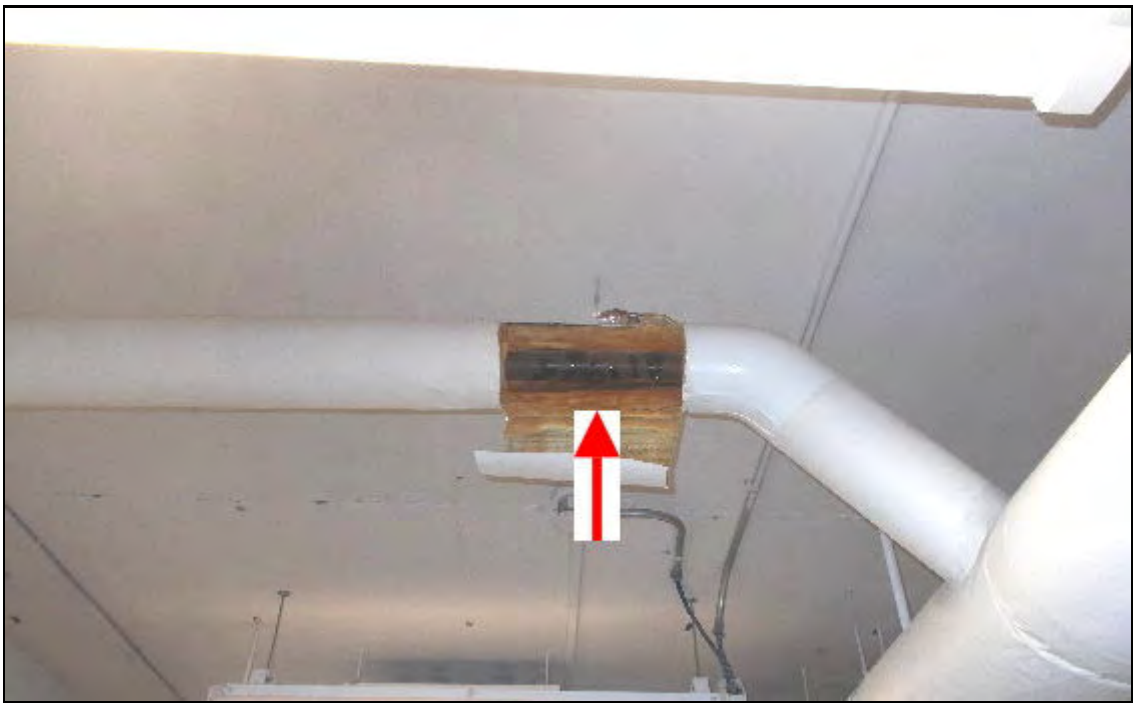
Minimum Thickness: 0.134 in.
Maximum Pipe Loss: 0.006 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 13.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We produce outstanding results showing this example of pipe very near new schedule 40 specifications. This is due to low corrosion activity. Virtually unlimited service life remains.

Location No: 36

Photo File #: wes-2-52.jpg
Detail: Pipe Location
Orientation: Below Side View



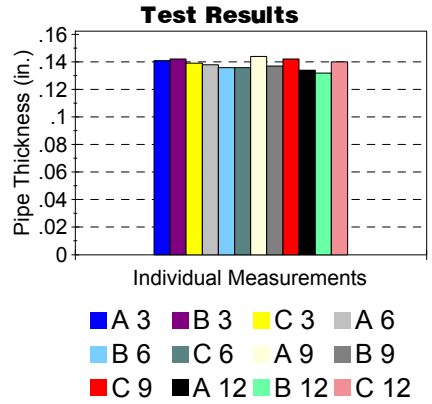
Pipe Identification and Operating Conditions

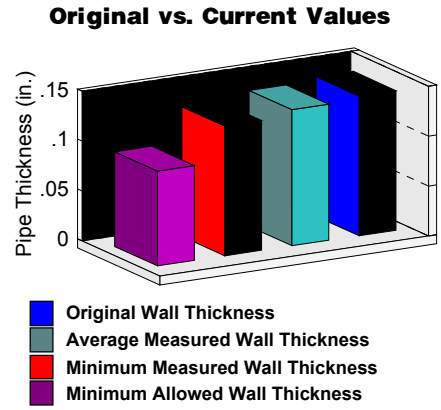
Service: Steam
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Supply To Building
Pipe Pressure: 10 PSIG
Temperature: 275 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-STM-1-1/4-119
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Production Center: Low pressure steam supply branch line. Test points located 1 ft. before 45° elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.004 in. / **High to Low Range:** 0.012 in.
Minimum Theoretical Wall Thickness: 0.126 in.
Pitting Index: 4.7 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.136 in.
Average Pipe Loss: 0.004 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 8.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

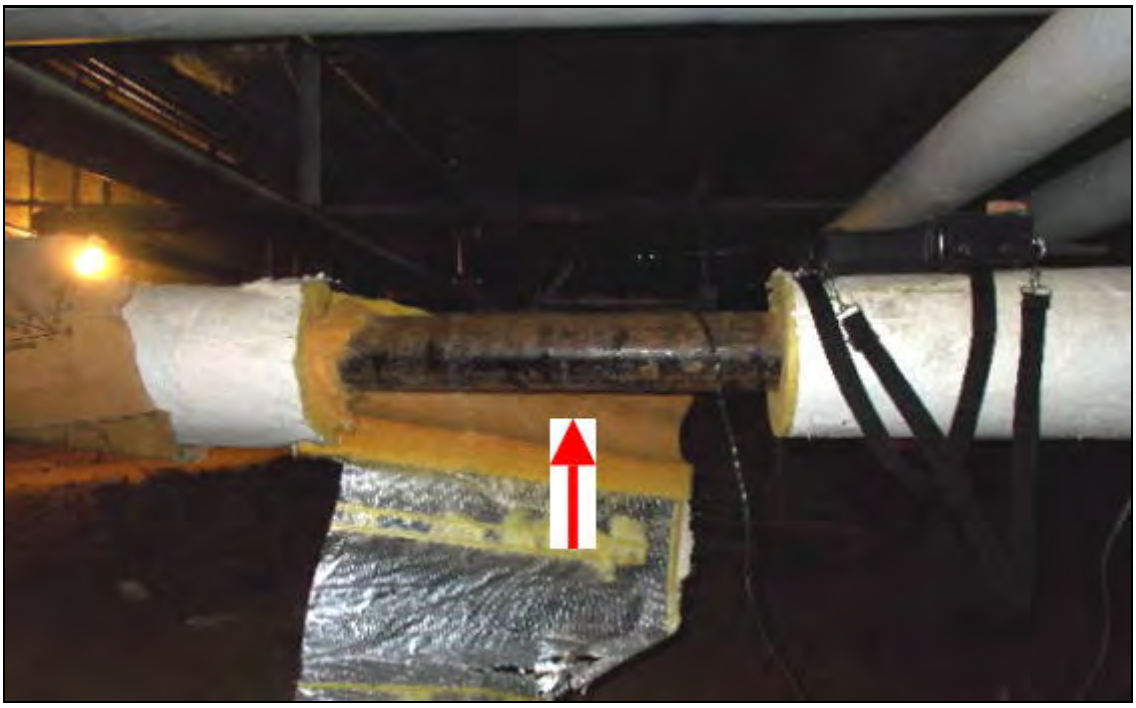
Minimum Thickness: 0.130 in.
Maximum Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 22.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: testing shows another example of high and uniform wall thickness approaching new schedule 40 specifications. Virtually unlimited service life remains.

Location No: 37

Photo File #: wes-1-13.jpg
Detail: Pipe Location
Orientation: Side View



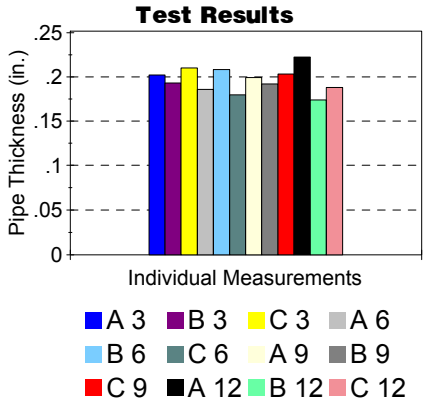
Pipe Identification and Operating Conditions

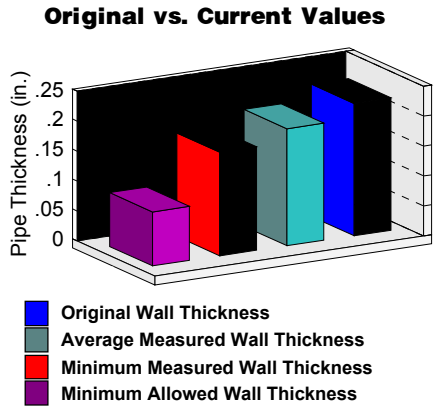
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-05
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - South Wing Crawlspace: Steam condensate main return line, near column X53-XAF. Test points located 12 ft. before wall.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.014 in. / **High to Low Range:** 0.048 in.
Minimum Theoretical Wall Thickness: 0.155 in.
Pitting Index: 11.5% - Significant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.195 in.
Average Pipe Loss: 0.026 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 19.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.173 in.
Maximum Pipe Loss: 0.048 in.
Corrosion Rate: 0.7 Mils Per Year
Percent of Allowable Pipe Loss: 36.6 %
Remaining Pipe Life: 112.6 Years
Estimated Retirement **March 2130**

Testing Indicates: Pipe Condition Excellent

Comments: Testing at this steam condensate line shows excellent results. Corrosion activity is low, but the pipe also shows higher pitting activity. Approximately 40 % of allowable pipe loss has occured. Extremely long service life remains.

Location No: 38

Photo File #: wes-2-25.jpg
Detail: Pipe Location
Orientation: Above Side View

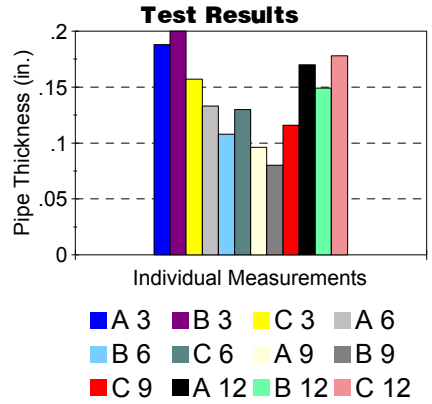
Pipe Identification and Operating Conditions

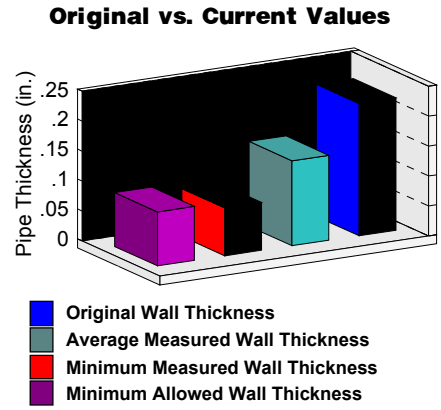
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-31
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - Basement Mechanical Room: Steam condensate main return line, behind Johnson Control unit. Test points located 10 ft. before elbow to condensate tank.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.038 in. / **High to Low Range:** 0.120 in.
Minimum Theoretical Wall Thickness: 0.028 in.
Pitting Index: 43.7% - Severe Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.142 in.
Average Pipe Loss: 0.079 in.
Corrosion Rate: 1.2 Mils Per Year
Percent of Allowable Pipe Loss: 60.2 %
Remaining Pipe Life: 43.0 Years
Estimated Retirement **August 2060**

Worst Case Scenario

Minimum Thickness: 0.080 in.
Maximum Pipe Loss: 0.141 in.
Corrosion Rate: 2.2 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Pipe Replacement Indicated

Comments: Here we show dramatically worse results for this section of pipe due to the collection of condensation. Wall thickness is far below the minimum allowable limit. No reliable service life remains. Pipe replacement recommended.

Location No: 39

Photo File #: wes-2-26.jpg
Detail: Pipe Location
Orientation: Above Side View

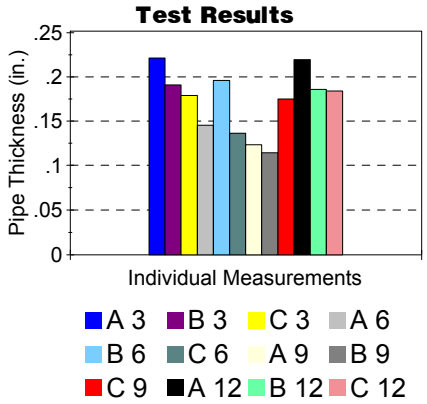
Pipe Identification and Operating Conditions

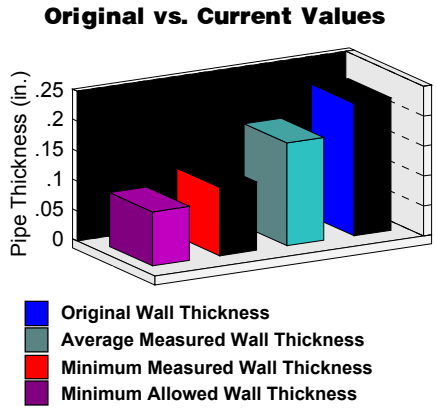
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-32
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - Basement Mechanical Room: Steam condensate main return line, right of fan unit. Test points located 4-5 ft. after elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.035 in. / **High to Low Range:** 0.106 in.
Minimum Theoretical Wall Thickness: 0.067 in.
Pitting Index: 33.6% - Heavy Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.172 in.
Average Pipe Loss: 0.049 in.
Corrosion Rate: 0.8 Mils Per Year
Percent of Allowable Pipe Loss: 37.6 %
Remaining Pipe Life: 108.1 Years
Estimated Retirement **September 2125**

Worst Case Scenario

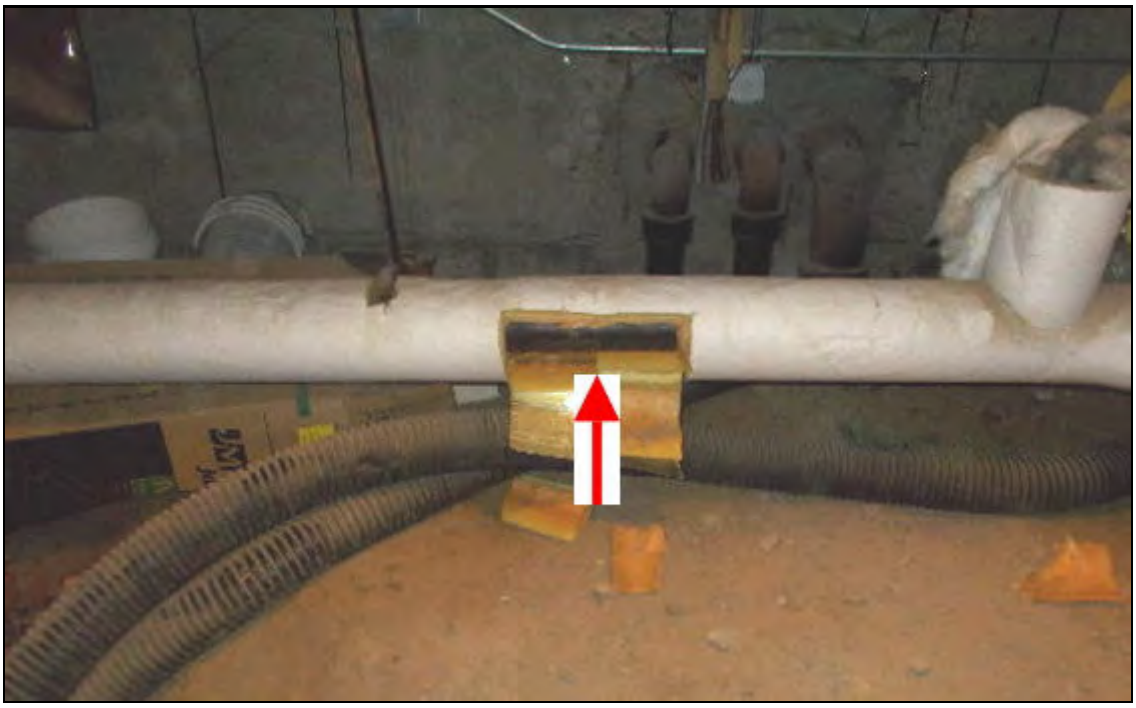
Minimum Thickness: 0.114 in.
Maximum Pipe Loss: 0.107 in.
Corrosion Rate: 1.6 Mils Per Year
Percent of Allowable Pipe Loss: 81.7 %
Remaining Pipe Life: 14.6 Years
Estimated Retirement **April 2032**

Testing Indicates: Pipe Condition Satisfactory

Comments: Testing shows this section of pipe approaching retirement. Wall thickness measurements are approaching the minimum allowable limit. Pitting activity is heavy. Acceptable but potentially limited service life remains.

Location No: 40

Photo File #: wes-1-03.jpg
Detail: Pipe Location
Orientation: Above Side View



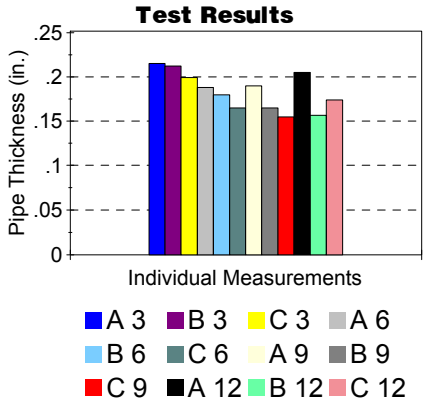
Pipe Identification and Operating Conditions

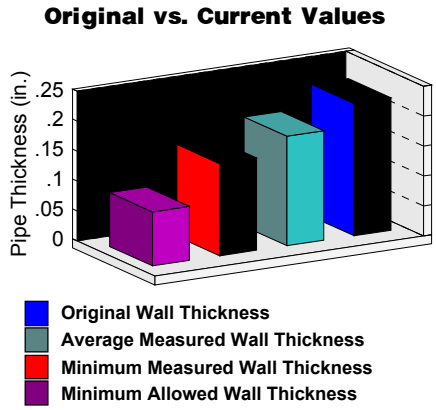
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-75
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Steam condensate main return line, near door to MER. Test points located 8 ft. before downward elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.021 in. / **High to Low Range:** 0.060 in.
Minimum Theoretical Wall Thickness: 0.120 in.
Pitting Index: 15.7% - Significant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.183 in.
Average Pipe Loss: 0.038 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 29.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

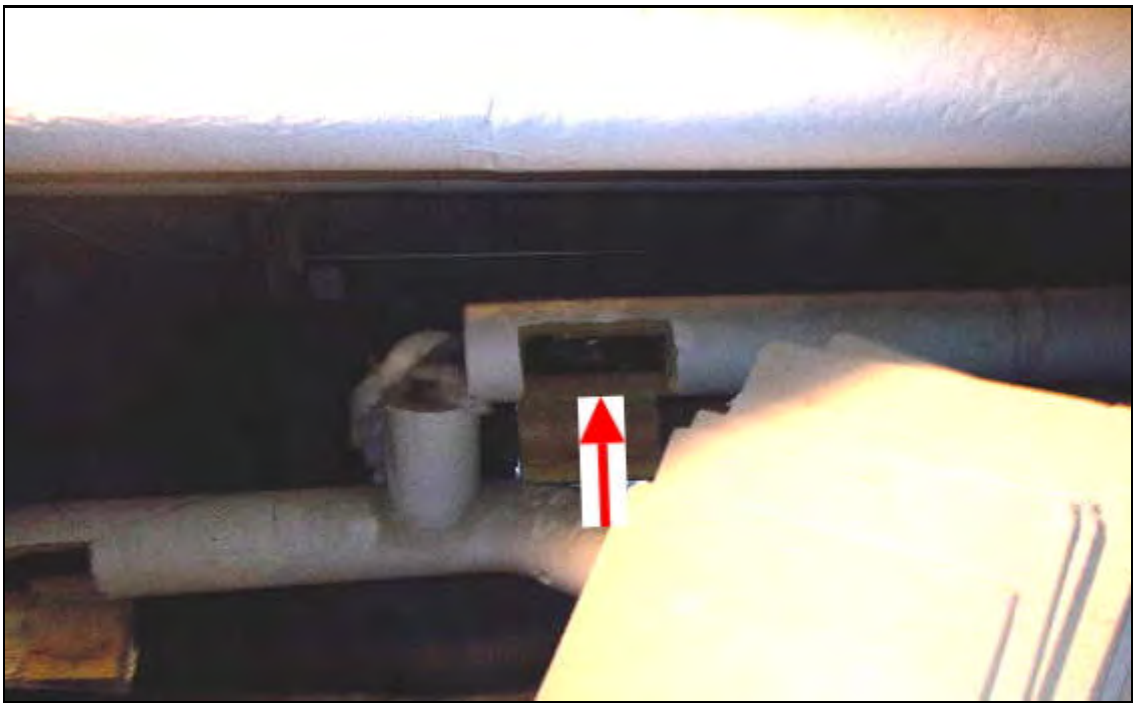
Minimum Thickness: 0.154 in.
Maximum Pipe Loss: 0.067 in.
Corrosion Rate: 1.0 Mils Per Year
Percent of Allowable Pipe Loss: 51.1 %
Remaining Pipe Life: 62.2 Years
Estimated Retirement **October 2079**

Testing Indicates: Pipe Condition Very Good

Comments: We measure more favorable results at this example of pipe but still show higher pitting activity along its bottom surface. Average wall thickness is high. Very long service life remains.

Location No: 41

Photo File #: wes-1-04.jpg
Detail: Pipe Location
Orientation: Above Side View



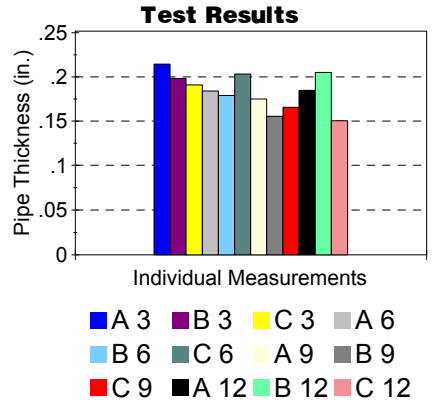
Pipe Identification and Operating Conditions

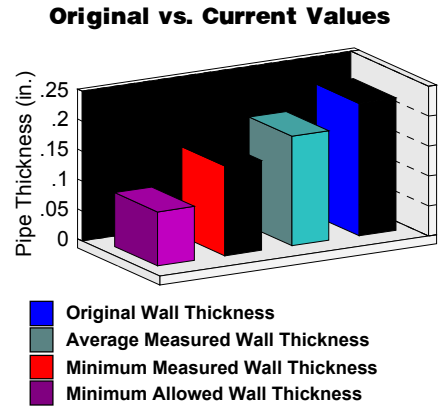
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-76
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Steam condensate main return line, near door to MER. Test points located 1-12 in. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.020 in. / **High to Low Range:** 0.063 in.
Minimum Theoretical Wall Thickness: 0.124 in.
Pitting Index: 18.0% - Significant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.183 in.
Average Pipe Loss: 0.038 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 29.1 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.150 in.
Maximum Pipe Loss: 0.071 in.
Corrosion Rate: 1.1 Mils Per Year
Percent of Allowable Pipe Loss: 54.2 %
Remaining Pipe Life: 55.0 Years
Estimated Retirement **August 2072**

Testing Indicates: Pipe Condition Very Good

Comments: Testing shows similar corrosion and pitting activity at this example of pipe at rates which would be considered normal for steam condensate piping. Very long service life remains.

Location No: 42

Photo File #: wes-1-10.jpg
Detail: Pipe Location
Orientation: Side View

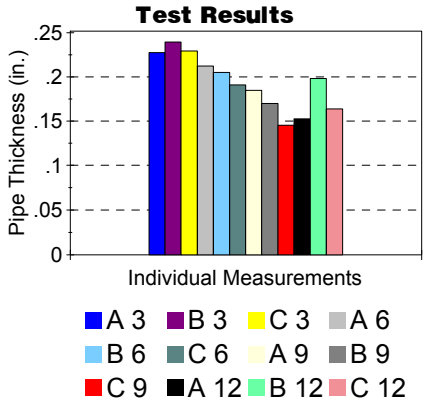
Pipe Identification and Operating Conditions

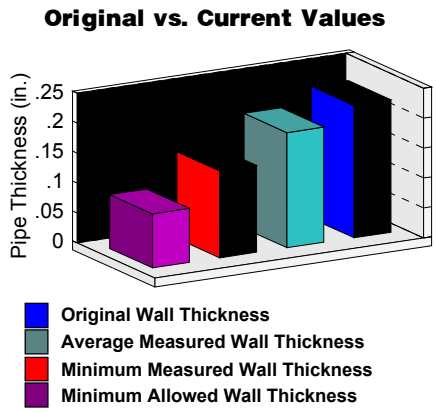
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-78
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Steam condensate main return line. Test points located 25 ft. before 45° elbow to MER.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.031 in. / **High to Low Range:** 0.093 in.
Minimum Theoretical Wall Thickness: 0.100 in.
Pitting Index: 24.6% - High Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.192 in.
Average Pipe Loss: 0.029 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 21.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

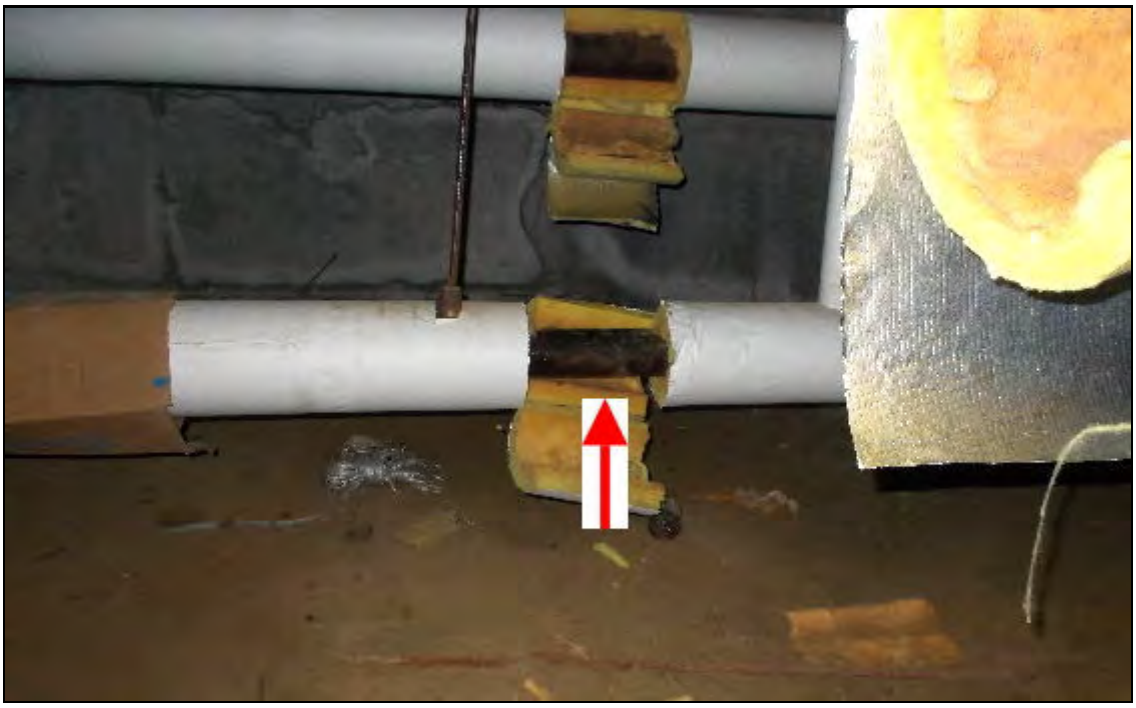
Minimum Thickness: 0.145 in.
Maximum Pipe Loss: 0.076 in.
Corrosion Rate: 1.2 Mils Per Year
Percent of Allowable Pipe Loss: 58.0 %
Remaining Pipe Life: 47.1 Years
Estimated Retirement **October 2064**

Testing Indicates: Pipe Condition Good

Comments: Testing again shows the highest pitting activity along the bottom surface, which is common for steam condensate lines. Average wall thickness remains high. Very long service life remains.

Location No: 43

Photo File #: wes-1-20.jpg
Detail: Pipe Location
Orientation: Side View



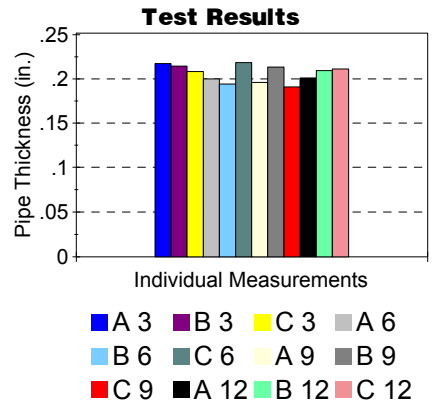
Pipe Identification and Operating Conditions

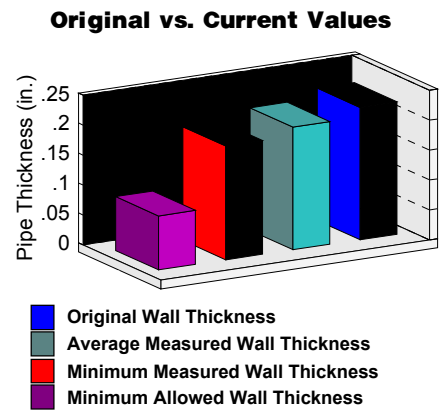
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-85
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - South Wing Crawlspace: Steam condensate main return line, at corner of room, near column X49-XZ. Test points located 4 ft. after elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.009 in. / **High to Low Range:** 0.027 in.
Minimum Theoretical Wall Thickness: 0.177 in.
Pitting Index: 7.3 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.205 in.
Average Pipe Loss: 0.016 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 12.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

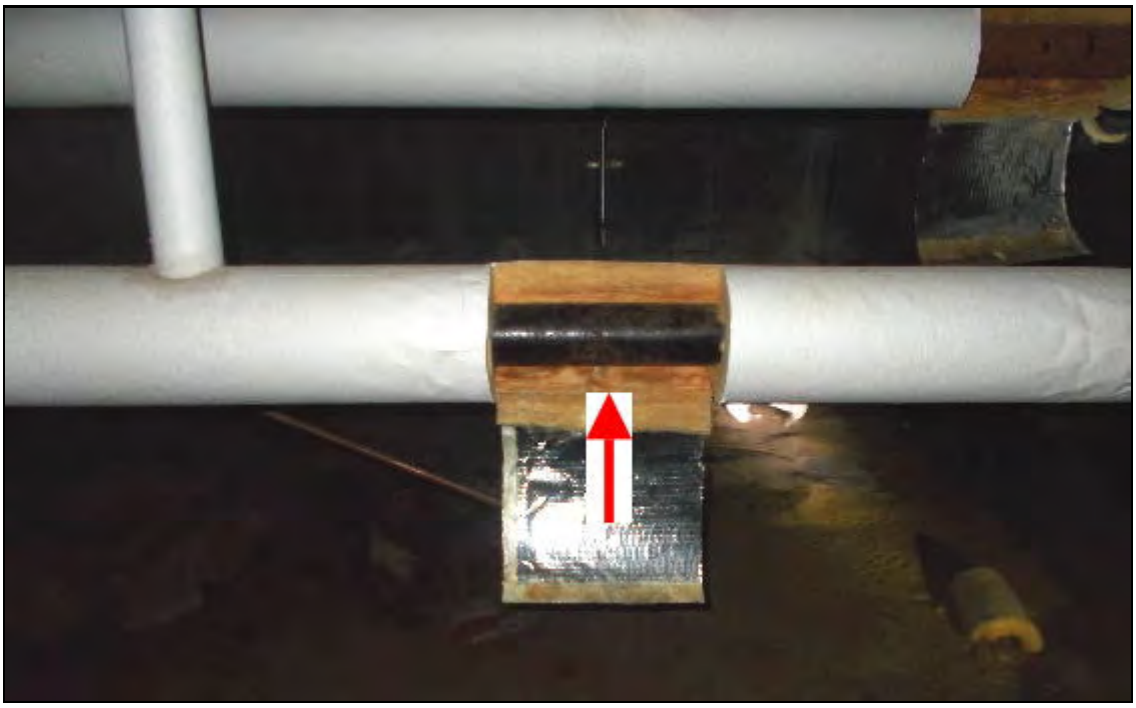
Minimum Thickness: 0.190 in.
Maximum Pipe Loss: 0.031 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 23.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We measure far better results and more uniform wall thickness at this example of pipe. Average wall thickness approaches new pipe specifications. Virtually unlimited service life remains.

Location No: 44

Photo File #: wes-1-26.jpg
Detail: Pipe Location
Orientation: Side View



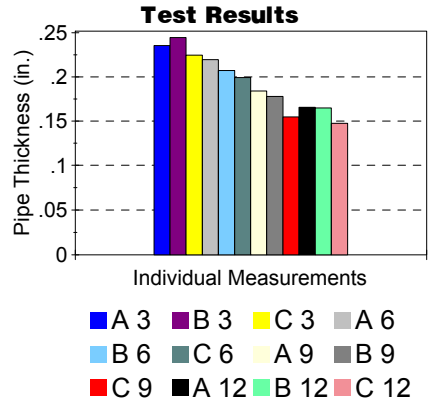
Pipe Identification and Operating Conditions

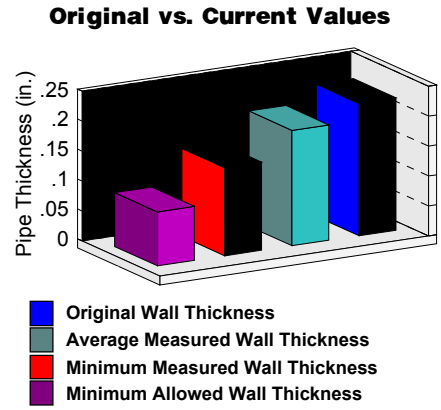
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-88
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Steam condensate main return line, after expansion loop, near column X36-XV. Test points located 8 ft. before expansion loop, 2 ft. after take-off.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.032 in. / **High to Low Range:** 0.096 in.
Minimum Theoretical Wall Thickness: 0.096 in.
Pitting Index: 23.7% - High Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.193 in.
Average Pipe Loss: 0.028 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 21.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.147 in.
Maximum Pipe Loss: 0.074 in.
Corrosion Rate: 1.1 Mils Per Year
Percent of Allowable Pipe Loss: 56.5 %
Remaining Pipe Life: 50.2 Years
Estimated Retirement **October 2067**

Testing Indicates: Pipe Condition Very Good

Comments: We again identify high average wall thickness but lower measurements due to pitting activity along the bottom. Very long service life remains.

Location No: 45

Photo File #: wes-2-27.jpg
Detail: Pipe Location
Orientation: Side View

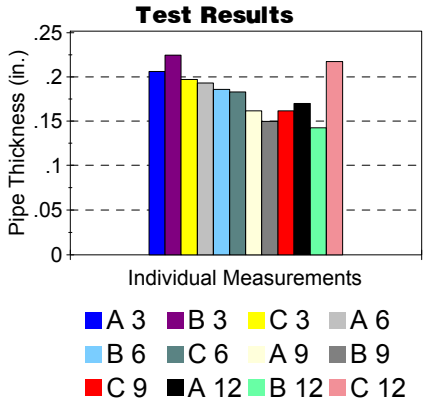
Pipe Identification and Operating Conditions

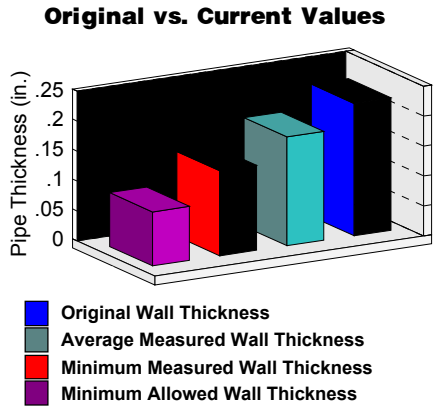
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-108
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Steam condensate main return line, inside gated area outside MER, near column XBQ-X41. Test points located 8 ft. before gate.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.026 in. / **High to Low Range:** 0.081 in.
Minimum Theoretical Wall Thickness: 0.104 in.
Pitting Index: 21.9% - High Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.182 in.
Average Pipe Loss: 0.039 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 30.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.142 in.
Maximum Pipe Loss: 0.079 in.
Corrosion Rate: 1.2 Mils Per Year
Percent of Allowable Pipe Loss: 60.3 %
Remaining Pipe Life: 42.9 Years
Estimated Retirement **July 2060**

Testing Indicates: Pipe Condition Good

Comments: Testing shows moderate to high pitting activity at this example of pipe. Average corrosion activity would be considered low for steam condensate service. Very long service life remains.

Location No: 46

Photo File #: wes-2-37.jpg
Detail: Pipe Location
Orientation: Above Side View

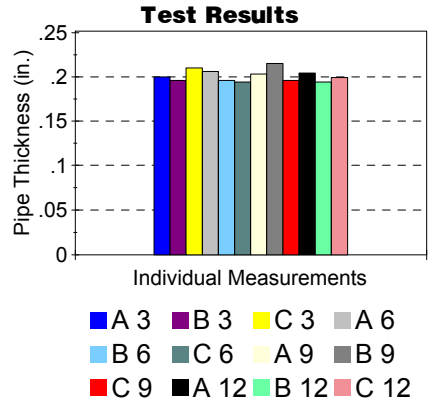
Pipe Identification and Operating Conditions

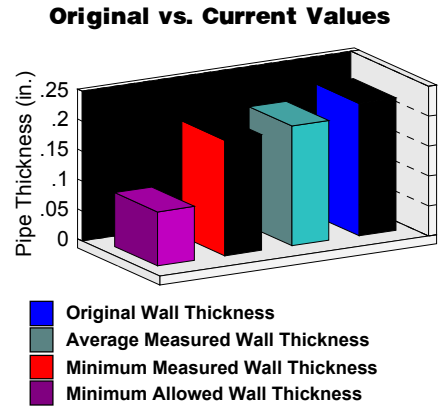
Service: Steam Condensate
Nominal Pipe Size: 3 in.
Actual Pipe Size: 3.50 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3-111
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - Lower Level Gym Storage Room 246-1: Steam condensate main return line, inside access hatch. Test points located 1-3 ft. before elbow.

Placed In Service: August 1, 1958
Date of Test: August 30, 2017
Time In Service: 59.1 Years
Original Wall Thickness: 0.221 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.007 in. / **High to Low Range:** 0.021 in.
Minimum Theoretical Wall Thickness: 0.180 in.
Pitting Index: 3.5 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.200 in.
Average Pipe Loss: 0.021 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 16.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

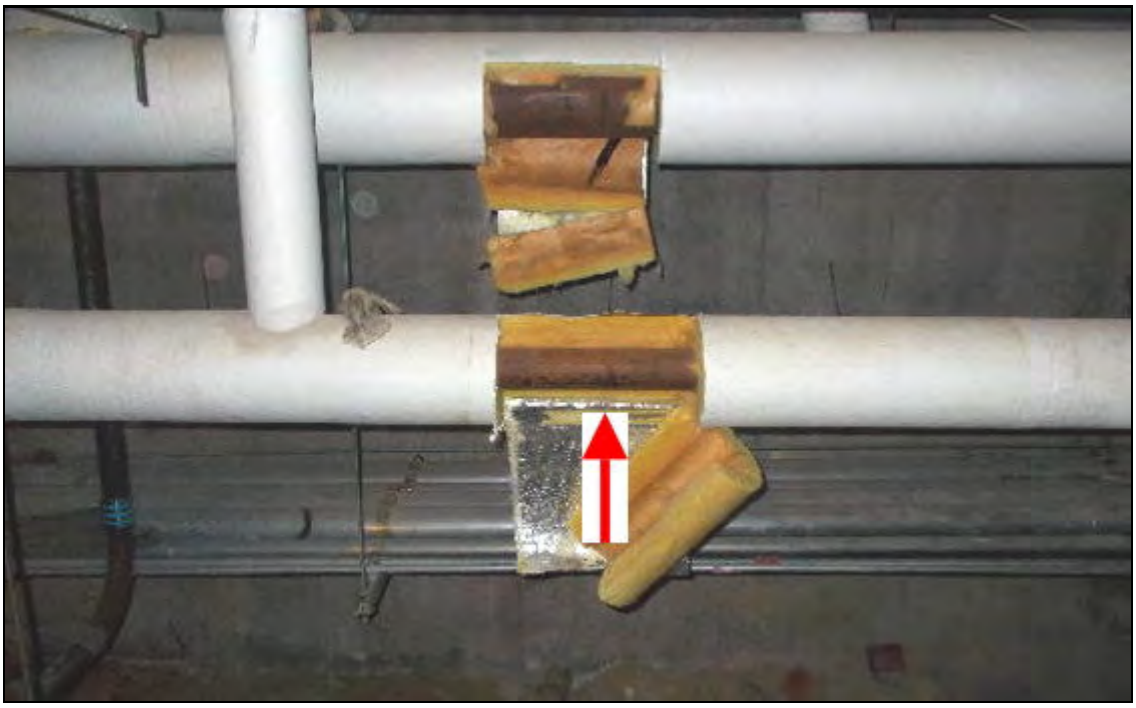
Minimum Thickness: 0.193 in.
Maximum Pipe Loss: 0.028 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 21.4 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We measure very high and uniform wall thickness approaching new standard pipe specifications. Such results began contradict the expectation that extra heavy pipe would have been installed. Virtually unlimited service life remains.

Location No: 47

Photo File #: wes-1-38.jpg
Detail: Pipe Location
Orientation: Side View



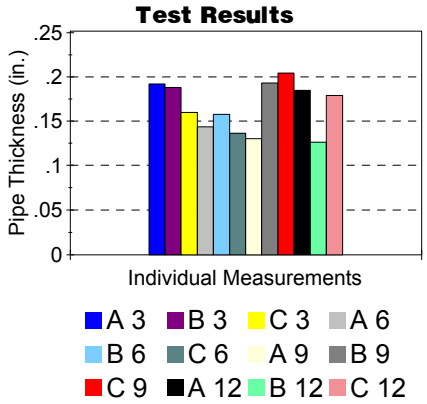
Pipe Identification and Operating Conditions

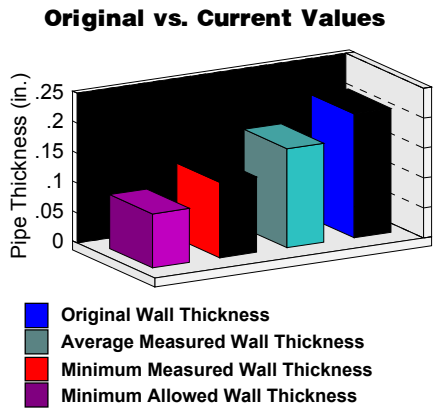
Service: Steam Condensate
Nominal Pipe Size: 2-1/2 in.
Actual Pipe Size: 2.88 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-1/2-12
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, at corner, near column XX at South wall. Test points located 20 ft. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.207 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.027 in. / **High to Low Range:** 0.077 in.
Minimum Theoretical Wall Thickness: 0.084 in.
Pitting Index: 23.9% - High Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.166 in.
Average Pipe Loss: 0.041 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 35.5 %
Remaining Pipe Life: 118.5 Years
Estimated Retirement **January 2136**

Worst Case Scenario

Minimum Thickness: 0.126 in.
Maximum Pipe Loss: 0.081 in.
Corrosion Rate: 1.2 Mils Per Year
Percent of Allowable Pipe Loss: 69.2 %
Remaining Pipe Life: 28.9 Years
Estimated Retirement **August 2046**

Testing Indicates: Pipe Condition Good

Comments: We measure noticeably higher pitting activity at this example of pipe, with deepest losses along the bottom. Long service life still remains.

Location No: 48

Photo File #: wes-2-23.jpg
Detail: Pipe Location
Orientation: Side View

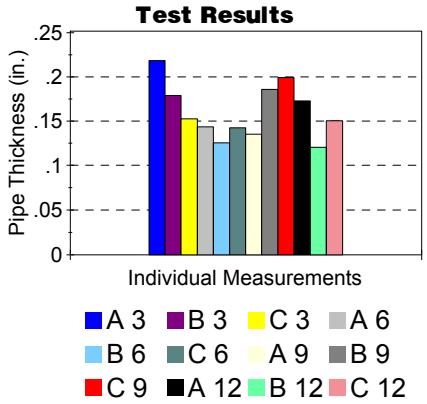
Pipe Identification and Operating Conditions

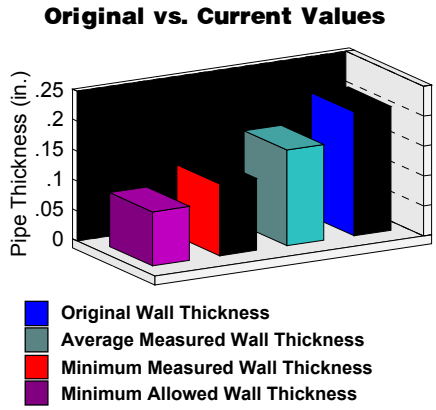
Service: Steam Condensate
Nominal Pipe Size: 2-1/2 in.
Actual Pipe Size: 2.88 in.
Schedule/Type: Standard
Material: Wrought Iron
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-1/2-30
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XO, at South wall. Test points located 1-12 in. after reducer.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.207 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.030 in. / **High to Low Range:** 0.097 in.
Minimum Theoretical Wall Thickness: 0.069 in.
Pitting Index: 24.9% - High Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.160 in.
Average Pipe Loss: 0.047 in.
Corrosion Rate: 0.7 Mils Per Year
Percent of Allowable Pipe Loss: 40.4 %
Remaining Pipe Life: 96.1 Years
Estimated Retirement **September 2113**

Worst Case Scenario

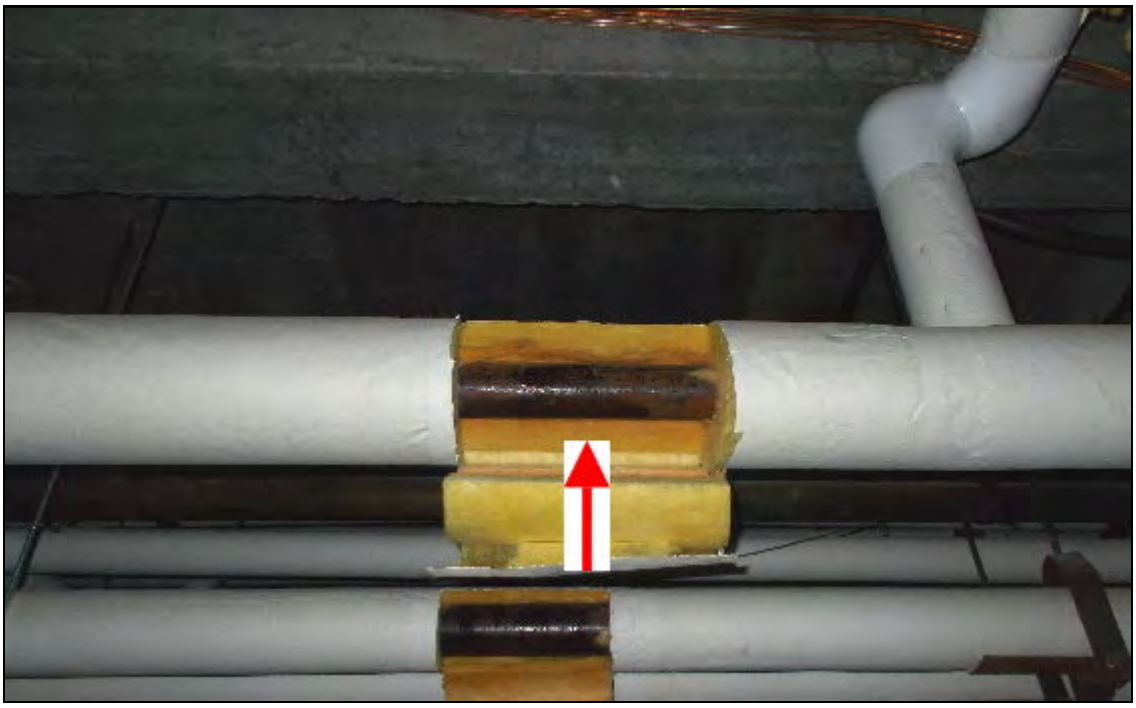
Minimum Thickness: 0.120 in.
Maximum Pipe Loss: 0.087 in.
Corrosion Rate: 1.3 Mils Per Year
Percent of Allowable Pipe Loss: 74.4 %
Remaining Pipe Life: 22.5 Years
Estimated Retirement **February 2040**

Testing Indicates: Pipe Condition Satisfactory

Comments: Testing shows the same corrosion signature at this example of pipe, with deepest pitting on the bottom surface. Long service life remains.

Location No: 49

Photo File #: wes-1-34.jpg
Detail: Pipe Location
Orientation: Below Side View



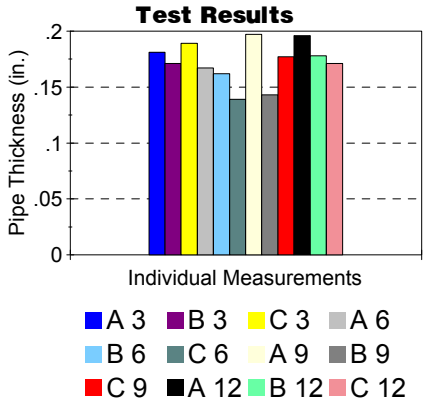
Pipe Identification and Operating Conditions

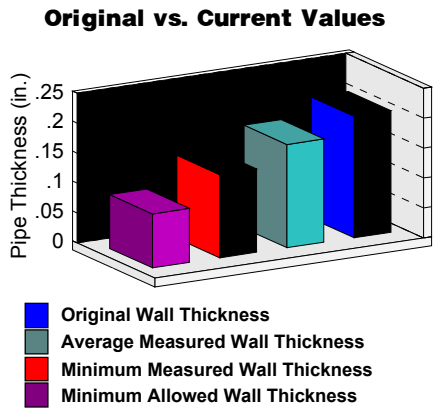
Service: Steam Condensate
Nominal Pipe Size: 2-1/2 in.
Actual Pipe Size: 2.88 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-1/2-91
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column X24-XAF. Test points located 15 ft. after elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.203 in.
Minimum Allowable Thickness: 0.090 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.018 in. / **High to Low Range:** 0.058 in.
Minimum Theoretical Wall Thickness: 0.118 in.
Pitting Index: 19.5% - Significant Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.173 in.
Average Pipe Loss: 0.030 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 26.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.139 in.
Maximum Pipe Loss: 0.064 in.
Corrosion Rate: 1.0 Mils Per Year
Percent of Allowable Pipe Loss: 56.6 %
Remaining Pipe Life: 49.9 Years
Estimated Retirement **June 2067**

Testing Indicates: Pipe Condition Good

Comments: Testing shows more favorable results at this example of pipe, but still the same high pitting condition. Corrosion activity would be considered low and well within normal limits. Very long service life remains.

Location No: 50

Photo File #: wes-1-84.jpg
Detail: Pipe Location
Orientation: Side View

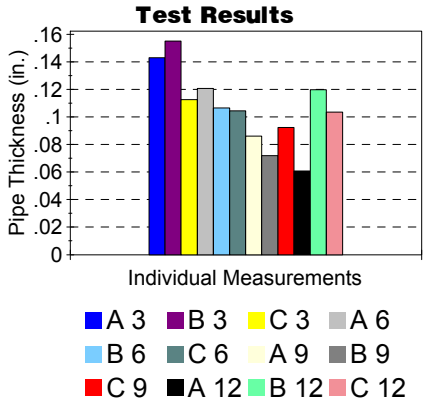
Pipe Identification and Operating Conditions

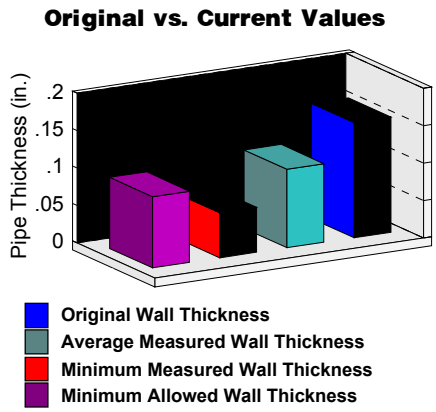
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-15
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XJ, at South wall. Test points located 1-24 in. after area of failure.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.027 in. / **High to Low Range:** 0.093 in.
Minimum Theoretical Wall Thickness: 0.025 in.
Pitting Index: 42.8% - Severe Pitting Activity
Notes: Pipe exists 0 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.105 in.
Average Pipe Loss: 0.049 in.
Corrosion Rate: 0.8 Mils Per Year
Percent of Allowable Pipe Loss: 83.2 %
Remaining Pipe Life: 13.2 Years
Estimated Retirement **October 2030**

Worst Case Scenario

Minimum Thickness: 0.060 in.
Maximum Pipe Loss: 0.094 in.
Corrosion Rate: 1.4 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Potential For Leak Exists

Comments: Testing adjacent to a previous failure identifies this pipe section in similar condition. Wall thickness is extremely low and has the potential for another failure. No reliable service life remains. Pipe replacement is required.

Location No: 51

Photo File #: wes-2-16.jpg
Detail: Pipe Location
Orientation: Side View

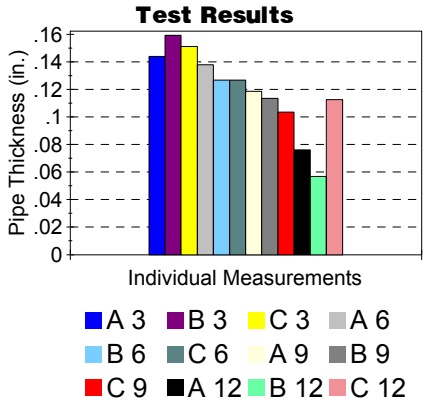
Pipe Identification and Operating Conditions

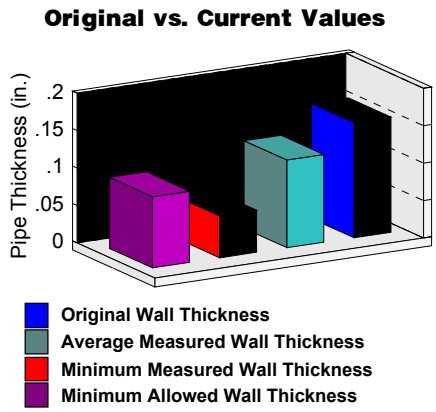
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-25
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XO, at South wall. Test points located 8 ft. after fence, in center of expansion loop.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.029 in. / **High to Low Range:** 0.101 in.
Minimum Theoretical Wall Thickness: 0.029 in.
Pitting Index: 52.2% - Severe Pitting Activity
Notes: Pipe exists 0 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.117 in.
Average Pipe Loss: 0.037 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 62.3 %
Remaining Pipe Life: 39.4 Years
Estimated Retirement **January 2057**

Worst Case Scenario

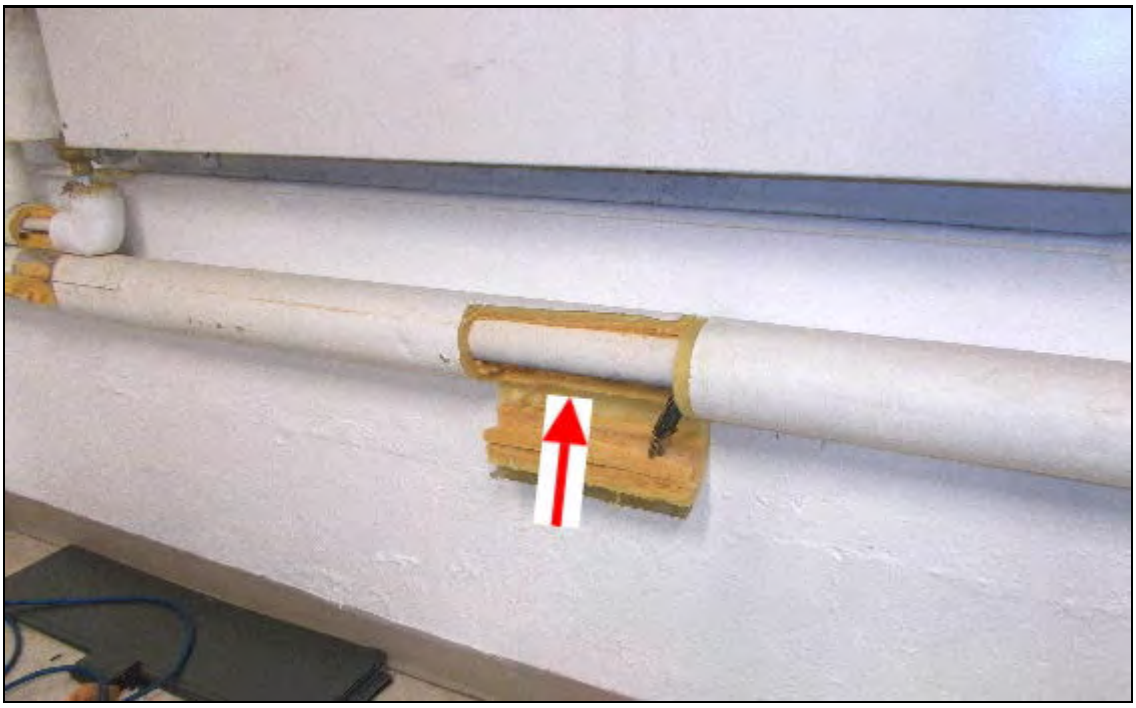
Minimum Thickness: 0.056 in.
Maximum Pipe Loss: 0.098 in.
Corrosion Rate: 1.5 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Potential For Leak Exists

Comments: Testing shows almost identical results compared to the previous location. Corrosion is moderate, but pitting activity is severe. No reliable service life remains. Pipe replacement is required.

Location No: 52

Photo File #: wes-2-44.jpg
Detail: Pipe Location
Orientation: Above Side View



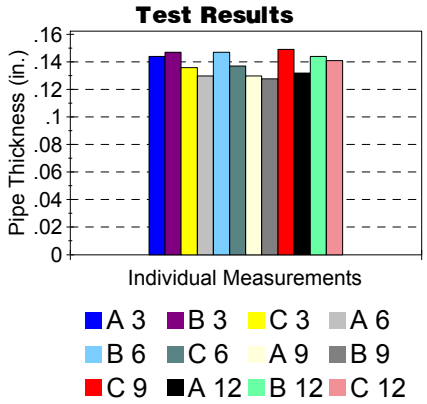
Pipe Identification and Operating Conditions

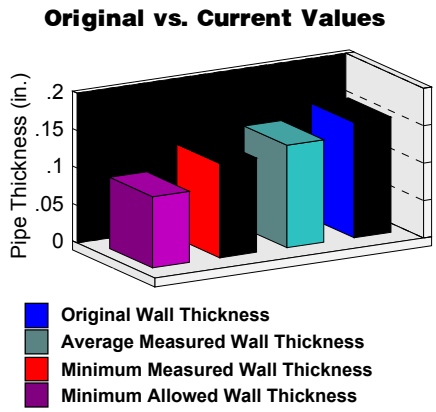
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-36
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Conference Room 3: Steam condensate main return line. Test points located 6-7 ft. before wall.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.008 in. / **High to Low Range:** 0.021 in.
Minimum Theoretical Wall Thickness: 0.114 in.
Pitting Index: 7.9 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.137 in.
Average Pipe Loss: 0.017 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 29.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.126 in.
Maximum Pipe Loss: 0.028 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 47.5 %
Remaining Pipe Life: 72.1 Years
Estimated Retirement **September 2089**

Testing Indicates: Pipe Condition Very Good

Comments: We produce dramatically better results at this example of pipe. Testing shows high average wall thickness not far below new schedule 40 specifications. Very long service life remains.

Location No: 53

Photo File #: wes-2-51.jpg
Detail: Pipe Location
Orientation: Above Side View

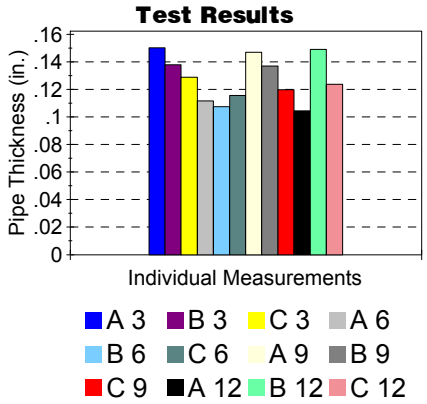
Pipe Identification and Operating Conditions

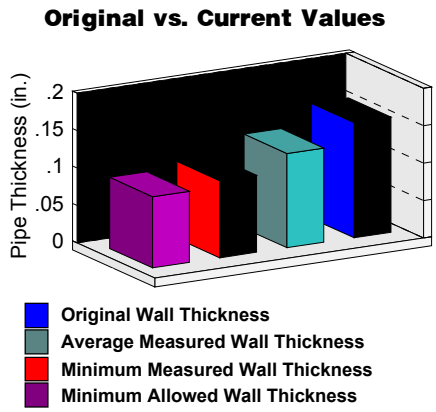
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-40
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Production Center: Steam condensate main return line, right of copy machine. Test points located between elbows.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.016 in. / **High to Low Range:** 0.045 in.
Minimum Theoretical Wall Thickness: 0.077 in.
Pitting Index: 18.2% - Significant Pitting Activity
Notes: Pipe exists 30 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.126 in.
Average Pipe Loss: 0.028 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 47.6 %
Remaining Pipe Life: 71.7 Years
Estimated Retirement **April 2089**

Worst Case Scenario

Minimum Thickness: 0.103 in.
Maximum Pipe Loss: 0.051 in.
Corrosion Rate: 0.8 Mils Per Year
Percent of Allowable Pipe Loss: 86.4 %
Remaining Pipe Life: 10.2 Years
Estimated Retirement **November 2027**

Testing Indicates: Pipe Condition Satisfactory

Comments: Much deeper pitting activity is identified at this example of pipe, with lowest wall thickness values now approaching minimum standards. Acceptable service life remains.

Location No: 54

Photo File #: wes-2-54.jpg
Detail: Pipe Location
Orientation: Above Side View

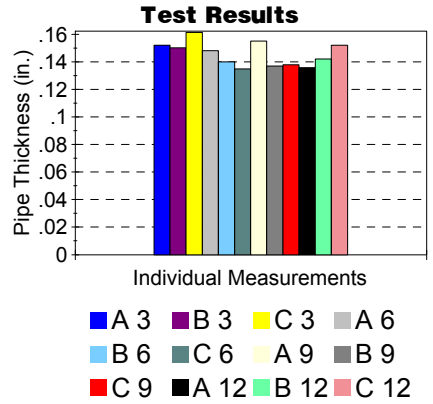
Pipe Identification and Operating Conditions

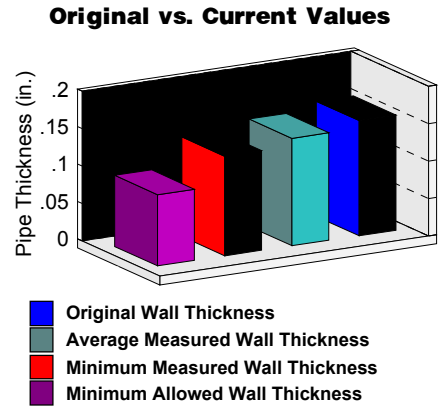
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-41
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Production Center: Steam condensate main return line, left of copy machine. Test points located 12 ft. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.009 in. / **High to Low Range:** 0.026 in.
Minimum Theoretical Wall Thickness: 0.118 in.
Pitting Index: 7.3 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.144 in.
Average Pipe Loss: 0.011 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 17.8 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

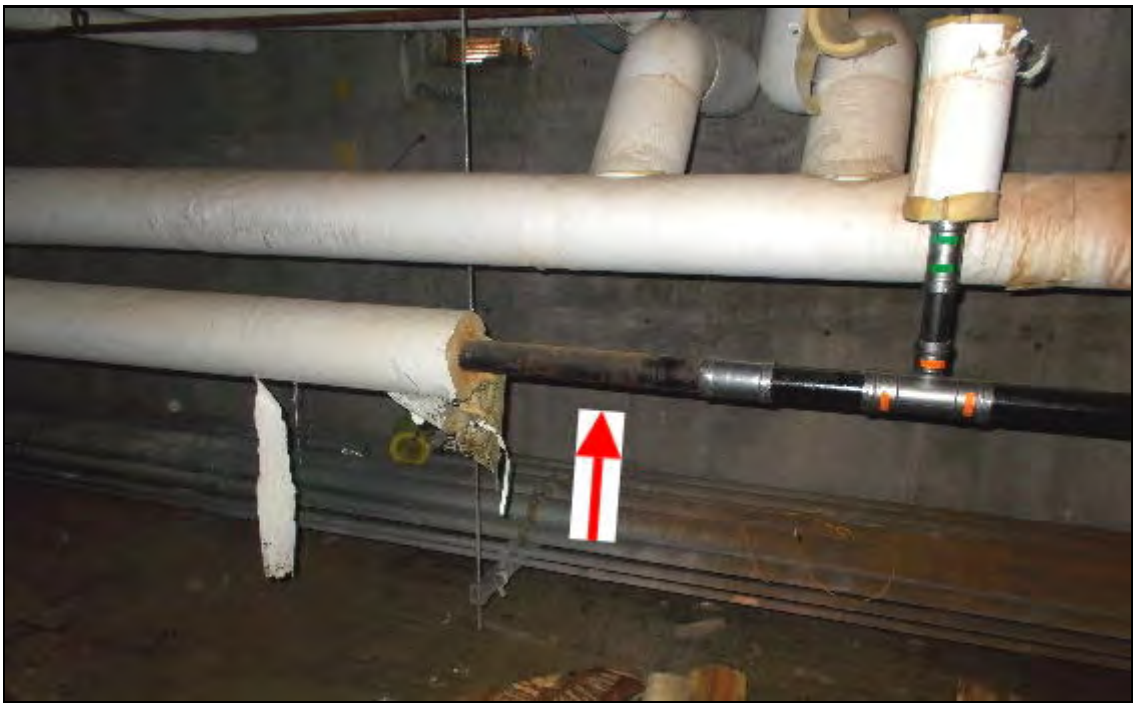
Minimum Thickness: 0.133 in.
Maximum Pipe Loss: 0.021 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 35.6 %
Remaining Pipe Life: 117.8 Years
Estimated Retirement **June 2135**

Testing Indicates: Pipe Condition Excellent

Comments: Once again, our testing demonstrates the wide difference in conditions present within this steam condensate system. Here, average wall thickness is high and more uniform. Extremely long service life remains.

Location No: 55

Photo File #: wes-1-85.jpg
Detail: Pipe Location
Orientation: Side View



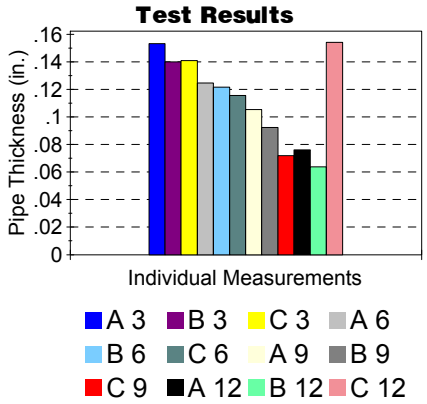
Pipe Identification and Operating Conditions

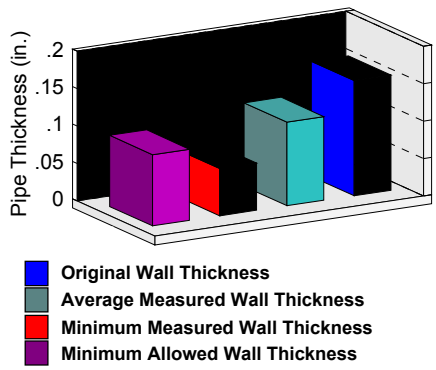
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-94
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XJ, at South wall. Test points located 1-24 in. before area of failure.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.031 in. / **High to Low Range:** 0.089 in.
Minimum Theoretical Wall Thickness: 0.018 in.
Pitting Index: 43.6% - Severe Pitting Activity
Notes: Pipe exists 0 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.112 in.
Average Pipe Loss: 0.042 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 71.6 %
Remaining Pipe Life: 25.8 Years
Estimated Retirement **June 2043**

Worst Case Scenario

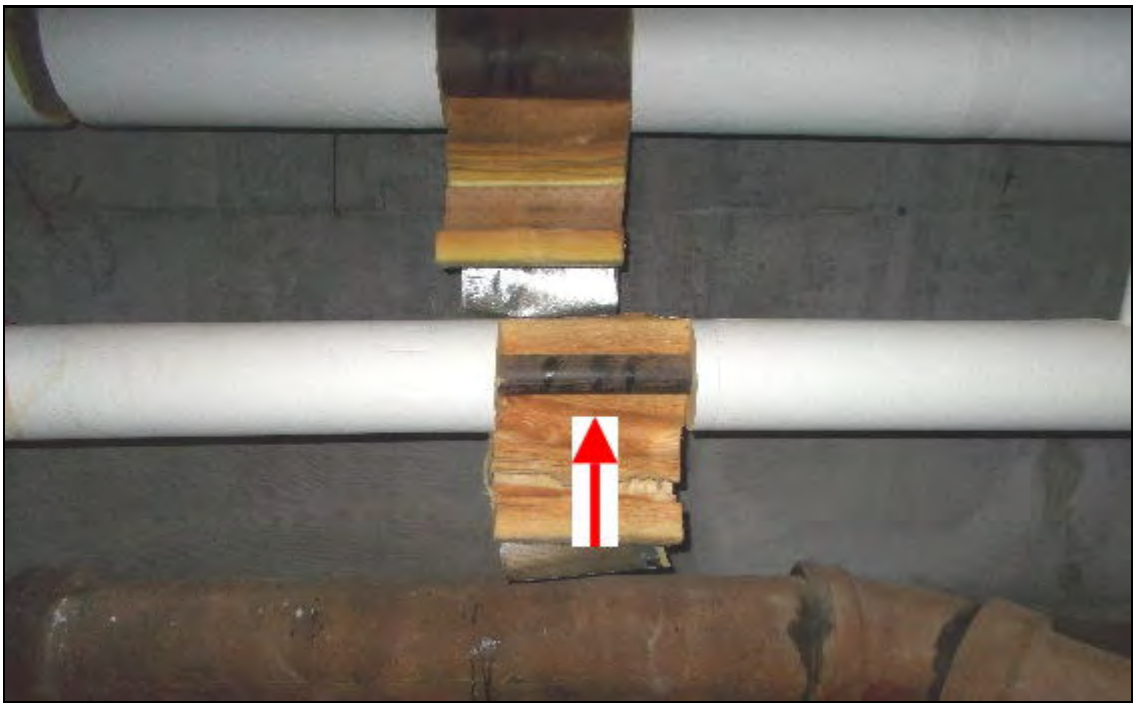
Minimum Thickness: 0.063 in.
Maximum Pipe Loss: 0.091 in.
Corrosion Rate: 1.4 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Potential For Leak Exists

Comments: Testing adjacent to a previous failure and location No. 52 identifies this section of pipe in need of replacement. Wall thickness is extremely low and has the potential for failure. No reliable service life remains.

Location No: 56

Photo File #: wes-2-12.jpg
Detail: Pipe Location
Orientation: Side View



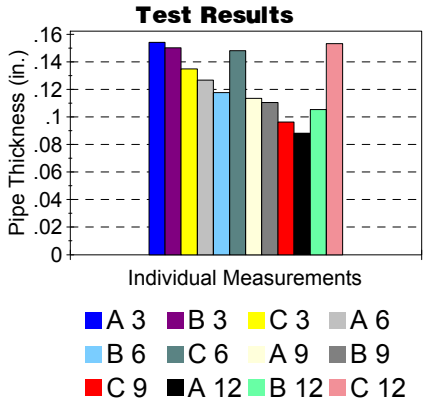
Pipe Identification and Operating Conditions

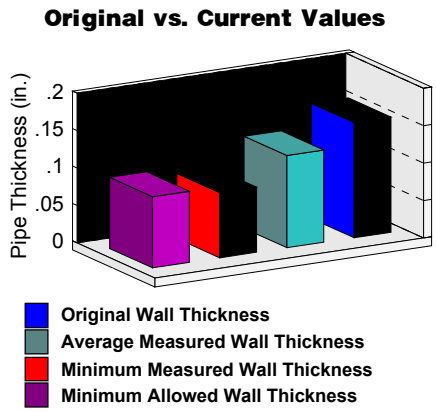
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-103
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XS, at North wall. Test points located 25 ft. from chainlink fence, behind stonewall offset.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.023 in. / **High to Low Range:** 0.065 in.
Minimum Theoretical Wall Thickness: 0.055 in.
Pitting Index: 29.4% - High Pitting Activity
Notes: Pipe exists 14 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.123 in.
Average Pipe Loss: 0.031 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 52.3 %
Remaining Pipe Life: 59.5 Years
Estimated Retirement **February 2077**

Worst Case Scenario

Minimum Thickness: 0.087 in.
Maximum Pipe Loss: 0.067 in.
Corrosion Rate: 1.0 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Pipe Replacement Indicated

Comments: Here we show another section of pipe in need of replacement. Wall thickness exists below the minimum allowable limit. Pitting activity is high. No reliable service life remains.

Location No: 57

Photo File #: wes-2-22.jpg
Detail: Pipe Location
Orientation: Above Side View

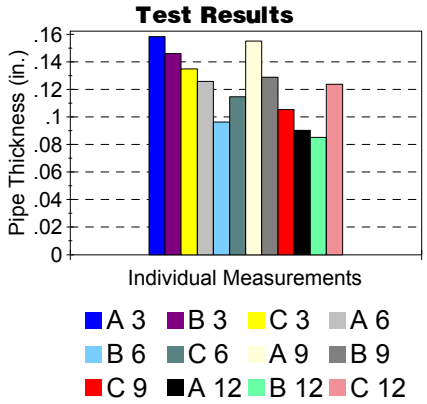
Pipe Identification and Operating Conditions

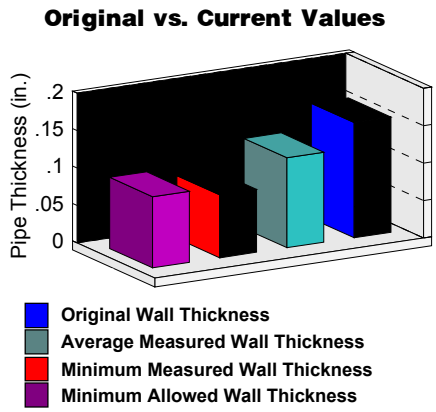
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-106
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, behind stonewall offset. Test points located 4 ft. before tie-in.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.024 in. / **High to Low Range:** 0.072 in.
Minimum Theoretical Wall Thickness: 0.048 in.
Pitting Index: 30.2% - Heavy Pitting Activity
Notes: Pipe exists 11 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.120 in.
Average Pipe Loss: 0.034 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 57.1 %
Remaining Pipe Life: 49.0 Years
Estimated Retirement **August 2066**

Worst Case Scenario

Minimum Thickness: 0.084 in.
Maximum Pipe Loss: 0.070 in.
Corrosion Rate: 1.1 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Pipe Replacement Indicated

Comments: Again, testing identifies this small diameter section of pipe in need of replacement. Corrosion activity is within the acceptable limit, indicating that this section of pipe has simply reached the end of its useful service life.

Location No: 58

Photo File #: wes-2-43.jpg
Detail: Pipe Location
Orientation: Above Side View

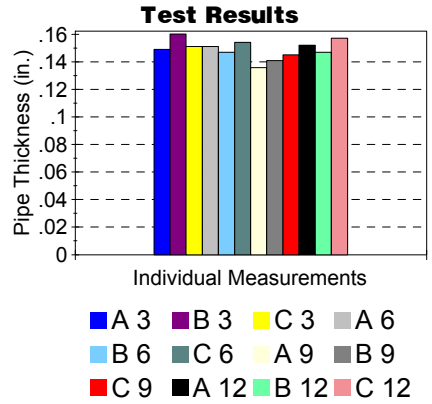
Pipe Identification and Operating Conditions

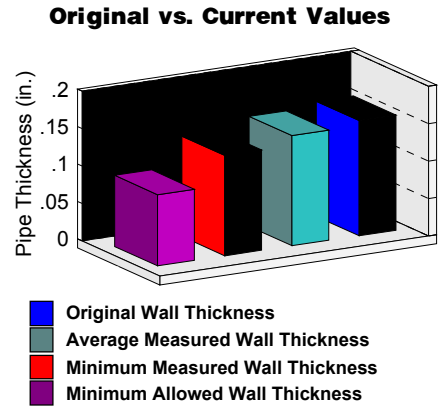
Service: Steam Condensate
Nominal Pipe Size: 2 in.
Actual Pipe Size: 2.38 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-2-115
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Storage Room: Steam condensate main return line, in corner of room. Test points located 1-12 in. from 45° elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.154 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.007 in. / **High to Low Range:** 0.024 in.
Minimum Theoretical Wall Thickness: 0.127 in.
Pitting Index: 8.9 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.147 in.
Average Pipe Loss: 0.007 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 11.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

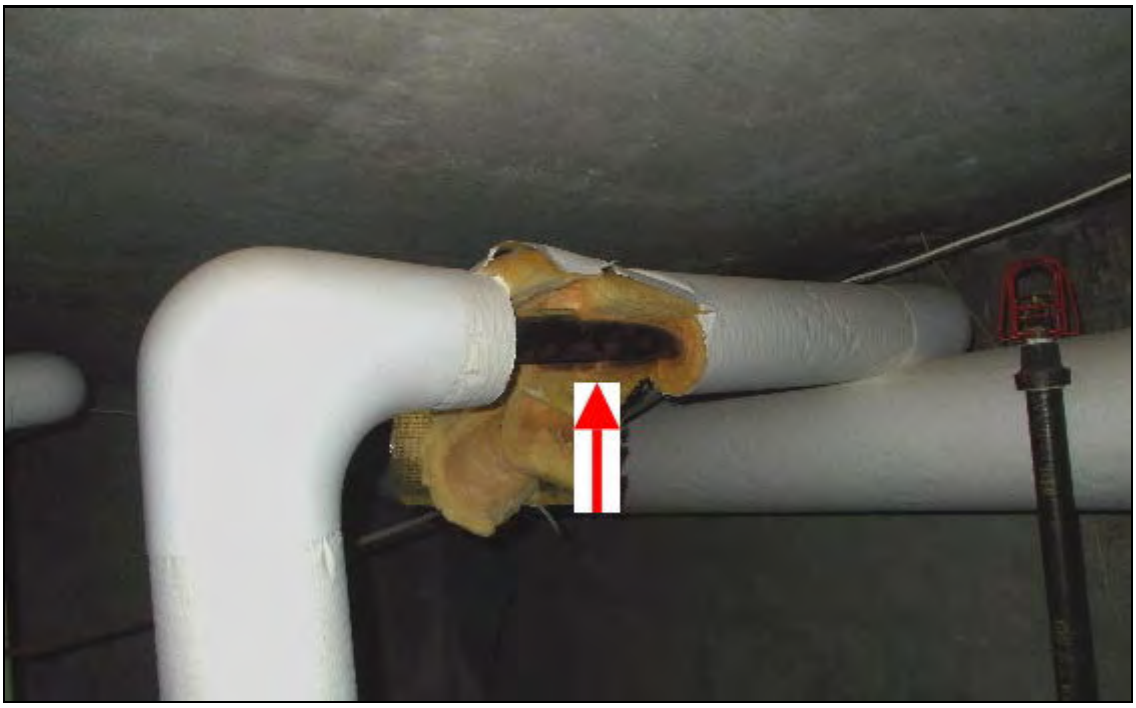
Minimum Thickness: 0.134 in.
Maximum Pipe Loss: 0.020 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 33.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We measure high and far more uniform wall thickness at this example of pipe due to extremely low corrosion activity for a steam condensate system. Virtually unlimited service life remains under current low corrosion conditions.

Location No: 59

Photo File #: wes-1-23.jpg
Detail: Pipe Location
Orientation: Below Side View



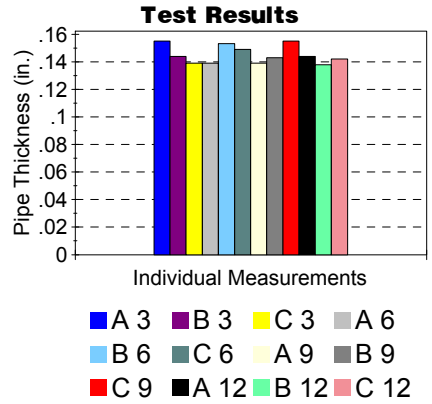
Pipe Identification and Operating Conditions

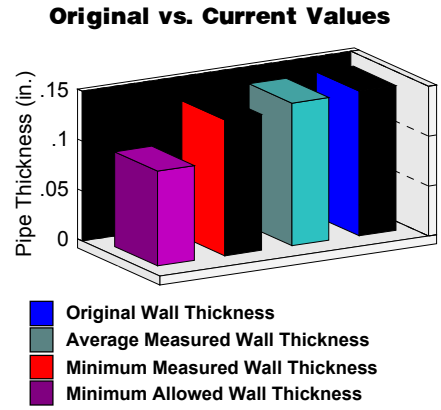
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-08
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - South Wing Crawlspace: Steam condensate return line to main, at corner of room, near column X49-XZ. Test points located 1 ft. from elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.006 in. / **High to Low Range:** 0.017 in.
Minimum Theoretical Wall Thickness: 0.124 in.
Pitting Index: 4.9 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.143 in.
Average Pipe Loss: 0.002 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 4.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

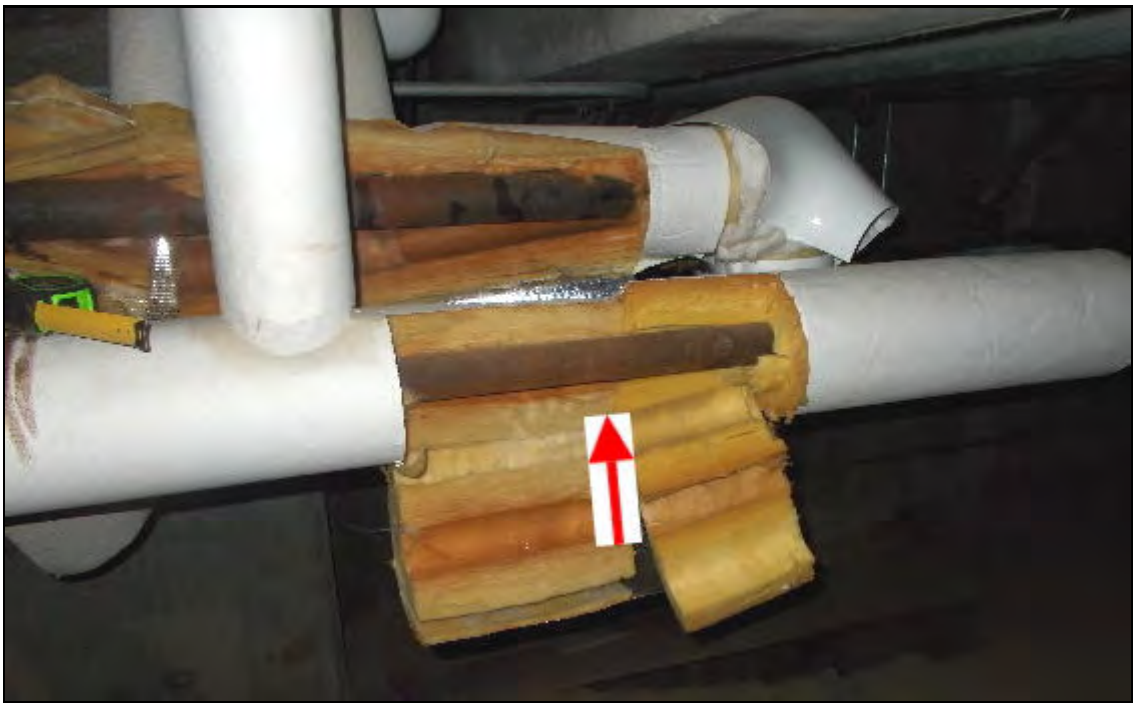
Minimum Thickness: 0.136 in.
Maximum Pipe Loss: 0.009 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 18.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows another example where corrosion activity has been minimal and where current wall thickness is still near new pipe specifications. Virtually unlimited service life remains.

Location No: 60

Photo File #: wes-1-89.jpg
Detail: Pipe Location
Orientation: Side View



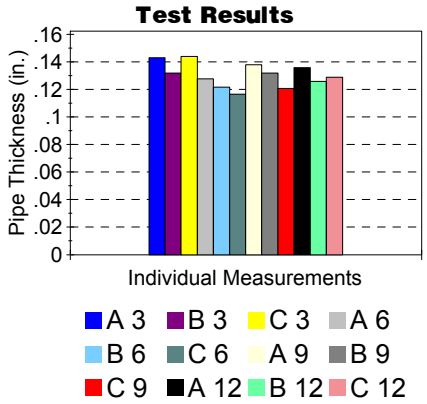
Pipe Identification and Operating Conditions

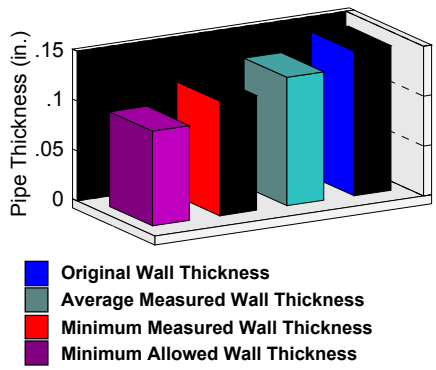
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-18
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XE, at rear wall. Test points located between steam trap and take-off.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.009 in. / **High to Low Range:** 0.027 in.
Minimum Theoretical Wall Thickness: 0.103 in.
Pitting Index: 10.6% - Significant Pitting Activity
Notes: Pipe exists 42 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.129 in.
Average Pipe Loss: 0.016 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 32.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

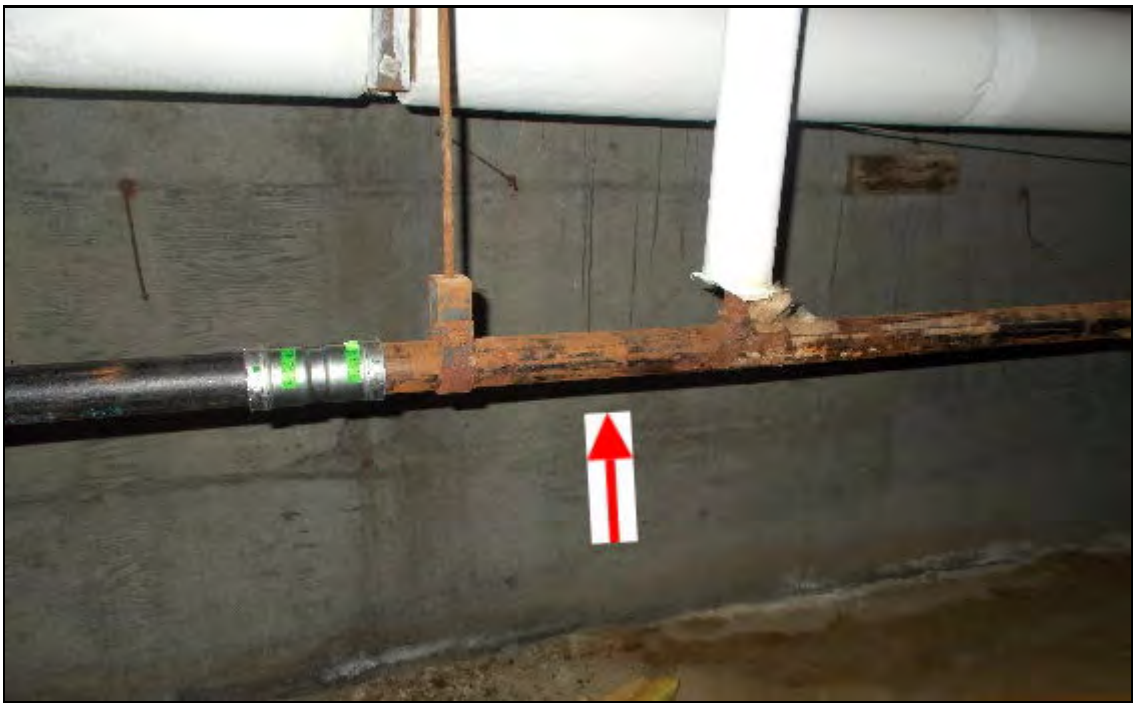
Minimum Thickness: 0.115 in.
Maximum Pipe Loss: 0.030 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 60.0 %
Remaining Pipe Life: 43.4 Years
Estimated Retirement **January 2061**

Testing Indicates: Pipe Condition Good

Comments: We measure what would be considered low corrosion activity for steam condensate service by any corrosion authority. Average wall thickness is high, with very long service life remaining.

Location No: 61

Photo File #: wes-1-112.jpg
Detail: Pipe Location
Orientation: Side View



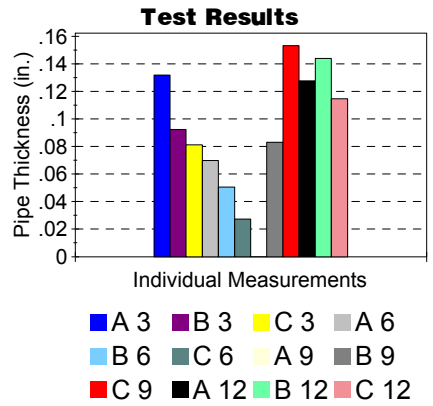
Pipe Identification and Operating Conditions

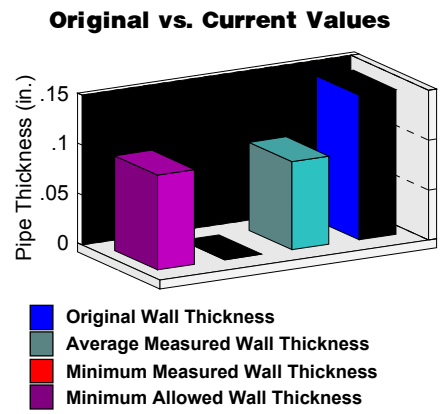
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-20
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XJ, at North wall. Test points located between area of failure and take-off, leak is currently present.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.047 in. / **High to Low Range:** 0.151 in.
Minimum Theoretical Wall Thickness: 0.000 in.
Pitting Index: 100.0% - Very Extreme Pitting Activity
Notes: Pipe exists 0 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.088 in.
Average Pipe Loss: 0.057 in.
Corrosion Rate: 0.9 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Worst Case Scenario

Minimum Thickness: 0.000 in.
Maximum Pipe Loss: 0.145 in.
Corrosion Rate: 2.2 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Potential For Leak Exists

Comments: Testing identifies this section of pipe in need of replacement. Wall thickness is extrememly low, with an active leak currently present. No reliable service life remains.

Location No: 62

Photo File #: wes-1-113.jpg
Detail: Pipe Location
Orientation: Side View

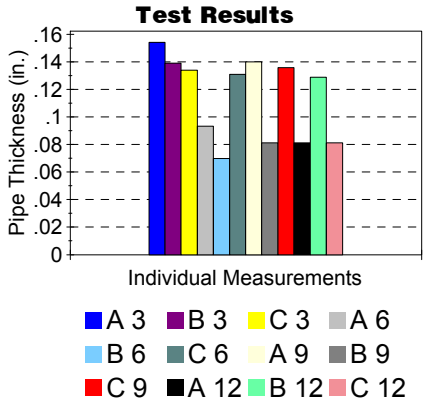
Pipe Identification and Operating Conditions

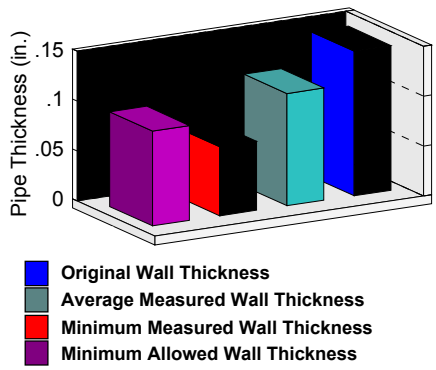
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-21
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XJ, at North wall. Test points located 8-10 ft. before area of failure.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.030 in. / **High to Low Range:** 0.083 in.
Minimum Theoretical Wall Thickness: 0.024 in.
Pitting Index: 38.7% - Heavy Pitting Activity
Notes: Pipe exists 0 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.113 in.
Average Pipe Loss: 0.032 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 65.0 %
Remaining Pipe Life: 35.1 Years
Estimated Retirement **September 2052**

Worst Case Scenario

Minimum Thickness: 0.069 in.
Maximum Pipe Loss: 0.076 in.
Corrosion Rate: 1.2 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Potential For Leak Exists

Comments: The top bar graph of our wall thickness measurements clearly illustrates the severity of pitting activity at this example of steam condensate pipe. Replacement is required.

Location No: 63

Photo File #: wes-1-114.jpg
Detail: Pipe Location
Orientation: Side View

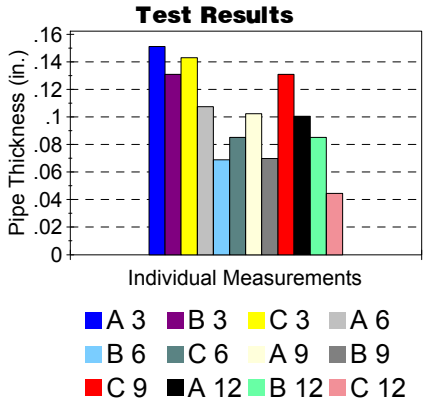
Pipe Identification and Operating Conditions

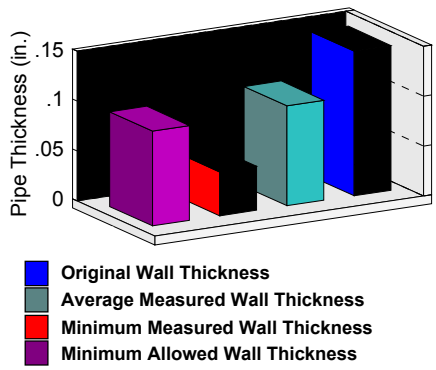
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-22
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate main return line, near column XJ, at North wall. Test points located 2-3 ft. after area of failure.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.032 in. / **High to Low Range:** 0.105 in.
Minimum Theoretical Wall Thickness: 0.004 in.
Pitting Index: 56.1% - Severe Pitting Activity
Notes: Pipe exists 0 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.100 in.
Average Pipe Loss: 0.045 in.
Corrosion Rate: 0.7 Mils Per Year
Percent of Allowable Pipe Loss: 89.5 %
Remaining Pipe Life: 7.6 Years
Estimated Retirement **April 2025**

Worst Case Scenario

Minimum Thickness: 0.044 in.
Maximum Pipe Loss: 0.101 in.
Corrosion Rate: 1.6 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Potential For Leak Exists

Comments: Testing shows another example of very severe pitting activity well below minimum standards. No reliable service life exists, with pipe replacement now required.

Location No: 64

Photo File #: wes-2-05.jpg
Detail: Pipe Location
Orientation: Side View

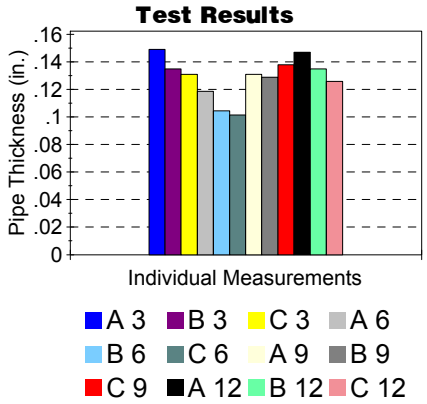
Pipe Identification and Operating Conditions

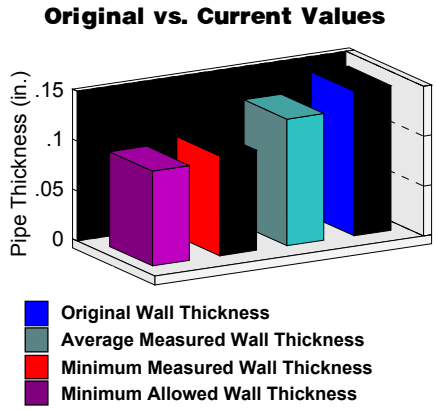
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-23
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Steam condensate main return line, near column XE, at rear wall. Test points located 1 ft. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.014 in. / **High to Low Range:** 0.047 in.
Minimum Theoretical Wall Thickness: 0.084 in.
Pitting Index: 21.2% - High Pitting Activity
Notes: Pipe exists 27 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.127 in.
Average Pipe Loss: 0.018 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 36.2 %
Remaining Pipe Life: 114.9 Years
Estimated Retirement **July 2132**

Worst Case Scenario

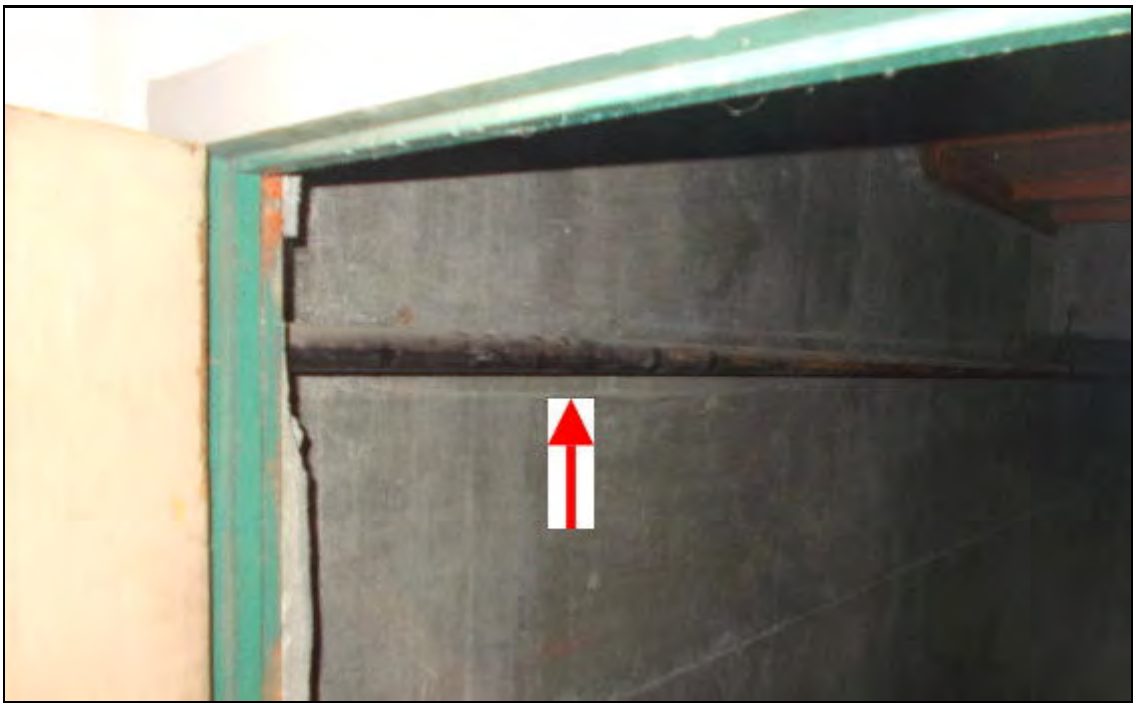
Minimum Thickness: 0.100 in.
Maximum Pipe Loss: 0.045 in.
Corrosion Rate: 0.7 Mils Per Year
Percent of Allowable Pipe Loss: 90.0 %
Remaining Pipe Life: 7.2 Years
Estimated Retirement **November 2024**

Testing Indicates: Pipe Approaching Retirement

Comments: We measure slightly better results at this example of pipe but still show very low wall thickness approaching minimum standards. Acceptable but only limited reliable service life remains.

Location No: 65

Photo File #: wes-2-55.jpg
Detail: Pipe Location
Orientation: Side View



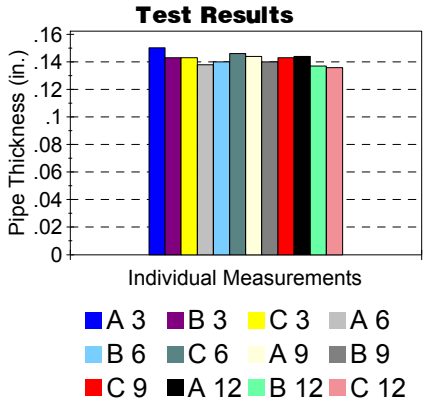
Pipe Identification and Operating Conditions

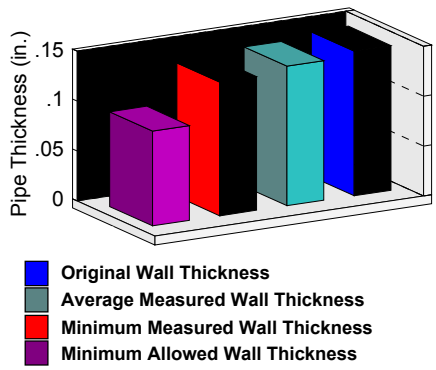
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-42
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Stair 5: Steam condensate main return line, inside storage hatch. Test points located 1-2 ft. inside storage area.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.004 in. / **High to Low Range:** 0.014 in.
Minimum Theoretical Wall Thickness: 0.128 in.
Pitting Index: 4.3 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.140 in.
Average Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 10.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

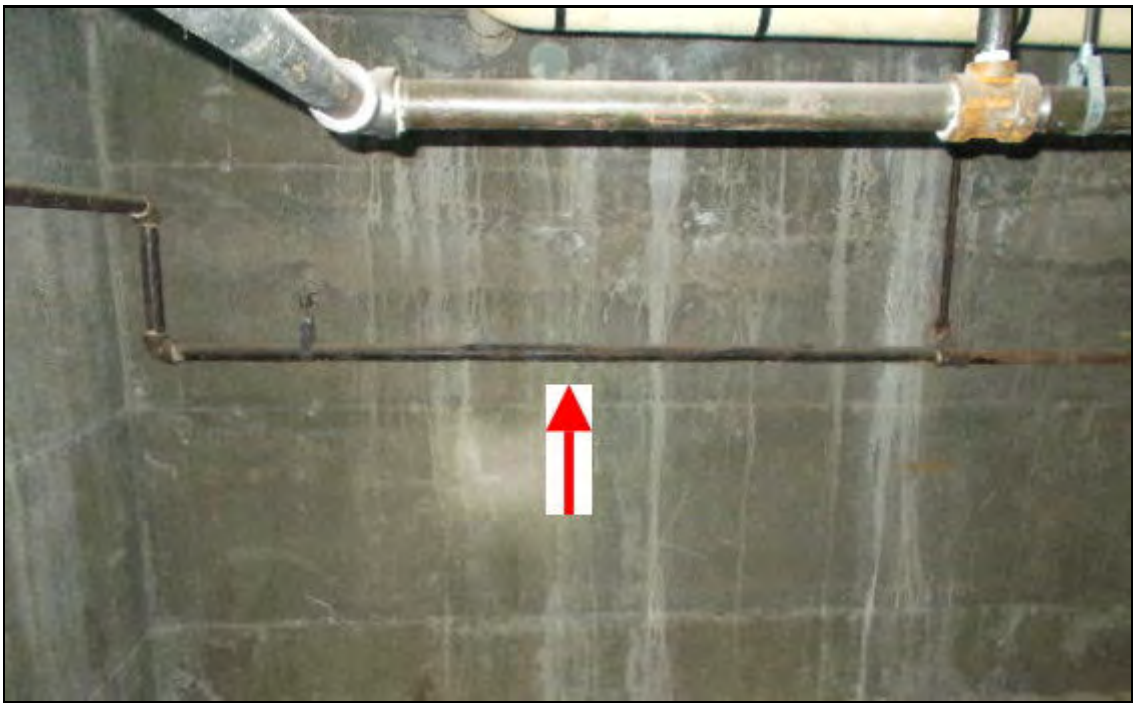
Minimum Thickness: 0.134 in.
Maximum Pipe Loss: 0.011 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 22.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows excellent results at this example of pipe. The very high uniformity of wall thickness right at standard pipe specifications again reinforces our assumption that standard pipe was installed. Virtually unlimited service life remains.

Location No: 66

Photo File #: wes-2-56.jpg
Detail: Pipe Location
Orientation: Side View



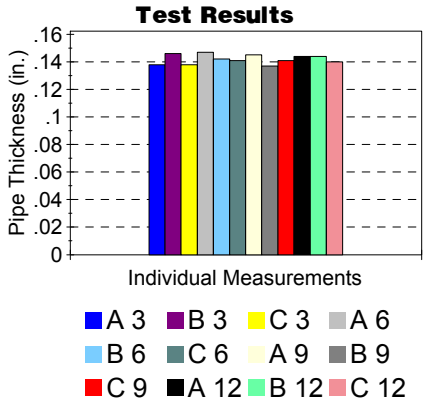
Pipe Identification and Operating Conditions

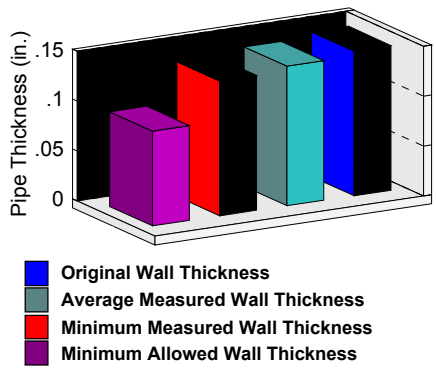
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-121
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Stair 5: Steam condensate return line, inside storage hatch. Test points located between elbow and tee.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.010 in.
Minimum Theoretical Wall Thickness: 0.130 in.
Pitting Index: 3.5 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.140 in.
Average Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 10.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.135 in.
Maximum Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 20.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We produce another example showing high and very uniform wall thickness at this example of pipe. Corrosion activity is almost nonexistent. Virtually unlimited service life remains.

Location No: 67

Photo File #: wes-2-57.jpg
Detail: Pipe Location
Orientation: Side View

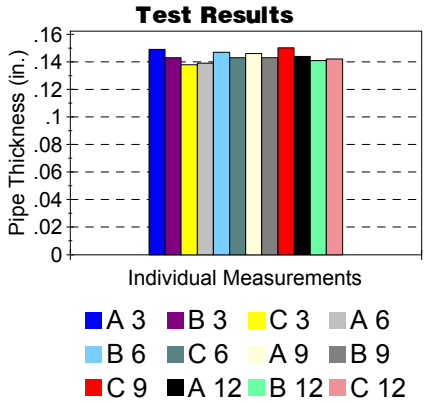
Pipe Identification and Operating Conditions

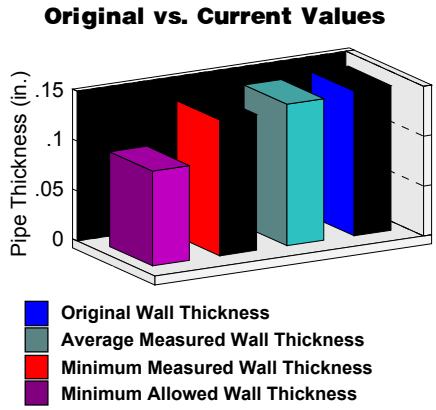
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-122
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Stair 5: Steam condensate return line, inside storage hatch. Test points located between tee and wall.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.004 in. / **High to Low Range:** 0.012 in.
Minimum Theoretical Wall Thickness: 0.131 in.
Pitting Index: 4.1 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.142 in.
Average Pipe Loss: 0.003 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 6.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.136 in.
Maximum Pipe Loss: 0.009 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 18.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We produce the same results at this nearby example of pipe. Current wall thickness remains near new pipe specifications due to minimal corrosion activity. Virtually unlimited service life remains.

Location No: 68

Photo File #: wes-1-91.jpg
Detail: Pipe Location
Orientation: Above Side View

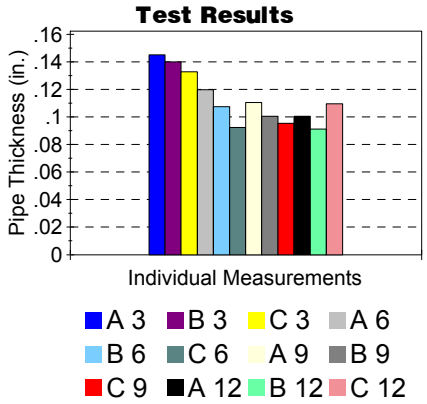
Pipe Identification and Operating Conditions

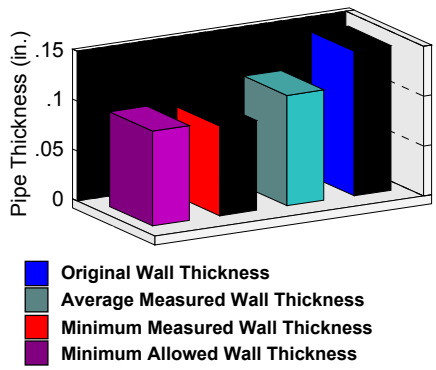
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-96
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Steam condensate main return line, near column XE, at South wall. Test points located 1-18 in. from end cap.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.018 in. / **High to Low Range:** 0.053 in.
Minimum Theoretical Wall Thickness: 0.056 in.
Pitting Index: 18.6% - Significant Pitting Activity
Notes: Pipe exists 17 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.111 in.
Average Pipe Loss: 0.034 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 69.0 %
Remaining Pipe Life: 29.3 Years
Estimated Retirement **November 2046**

Worst Case Scenario

Minimum Thickness: 0.090 in.
Maximum Pipe Loss: 0.055 in.
Corrosion Rate: 0.8 Mils Per Year
Percent of Allowable Pipe Loss: 100.0 %
Remaining Pipe Life: 0.0 Years
Estimated Retirement **August 2017**

Testing Indicates: Pipe Replacement Indicated

Comments: Dramatically different results are shown at this example of pipe. We measure low wall thickness now having reached to below minimum acceptable standards. No reliable service life remains.

Location No: 69

Photo File #: wes-2-39.jpg
Detail: Pipe Location
Orientation: Above Side View

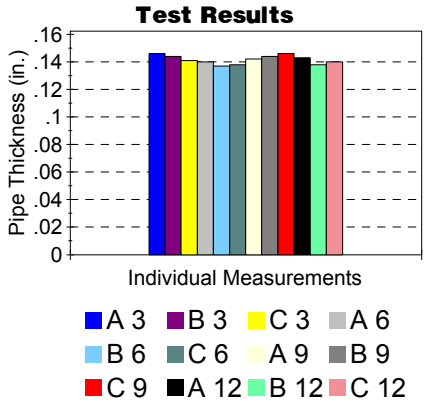
Pipe Identification and Operating Conditions

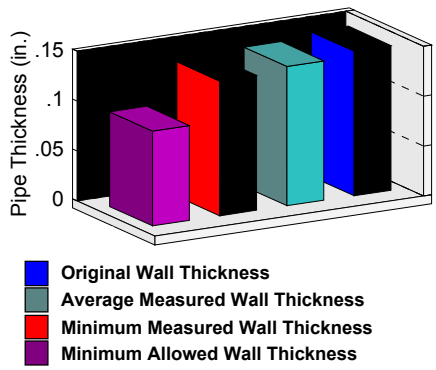
Service: Steam Condensate
Nominal Pipe Size: 1-1/2 in.
Actual Pipe Size: 1.90 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/2-112
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - Lower Level Gym Storage Room 246-1: Steam condensate return line to main, inside access hatch. Test points located 1-12 in. before 45° elbow to main.

Placed In Service: August 1, 1958
Date of Test: August 30, 2017
Time In Service: 59.1 Years
Original Wall Thickness: 0.145 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.009 in.
Minimum Theoretical Wall Thickness: 0.130 in.
Pitting Index: 3.3 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.140 in.
Average Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 10.8 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.135 in.
Maximum Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 20.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Outstanding results are shown at this example of pipe, with high and very uniform wall thickness near new standard pipe specifications. Virtually unlimited service life remains.

Location No: 70

Photo File #: wes-1-40.jpg
Detail: Pipe Location
Orientation: Below Side View

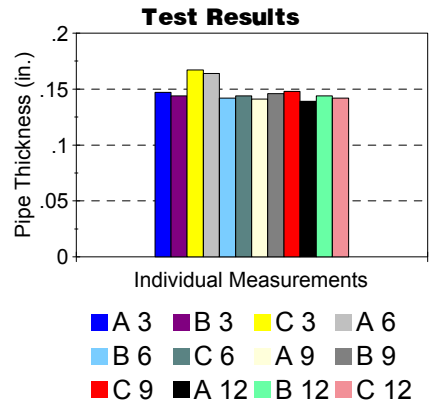
Pipe Identification and Operating Conditions

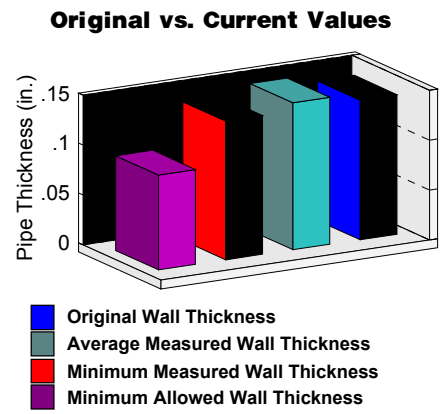
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-13
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate return line to main, at corner, near column XX at South wall. Test points located 1 ft. from elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.009 in. / **High to Low Range:** 0.028 in.
Minimum Theoretical Wall Thickness: 0.121 in.
Pitting Index: 5.7 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.147 in.
Average Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

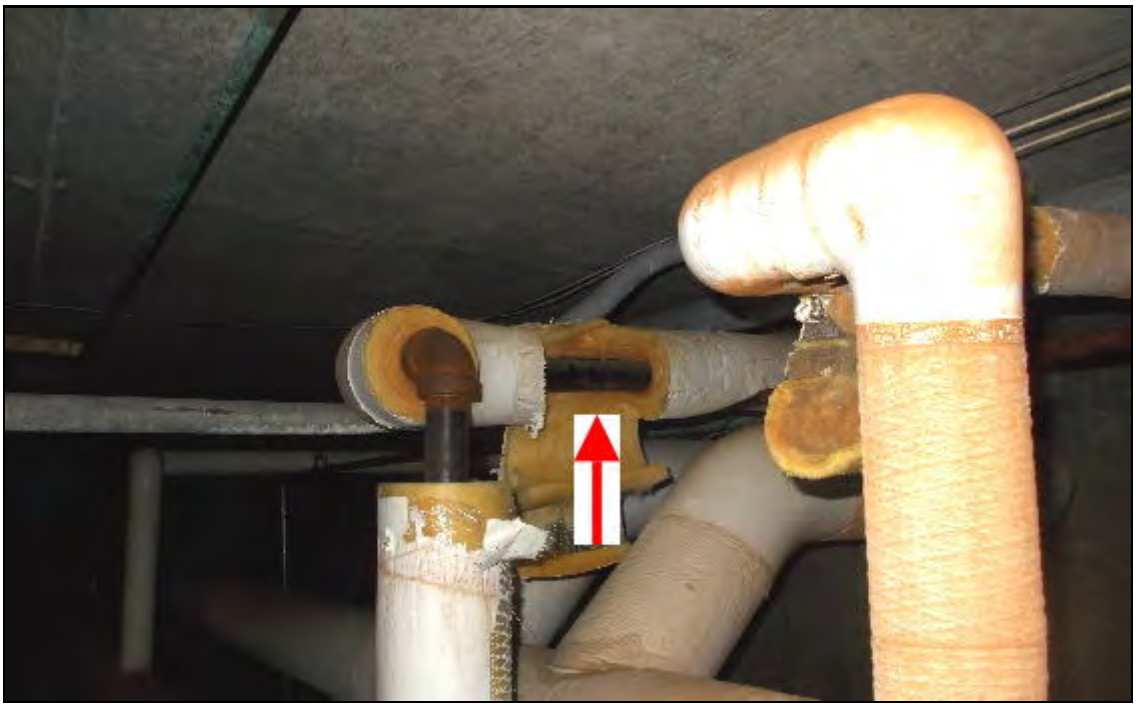
Minimum Thickness: 0.139 in.
Maximum Pipe Loss: 0.001 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 2.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Pipe In Like New Condition

Comments: This example of pipe shows very high wall thickness at or above new pipe specifications. Virtually unlimited service life remains.

Location No: 71

Photo File #: wes-1-87.jpg
Detail: Pipe Location
Orientation: Below Side View



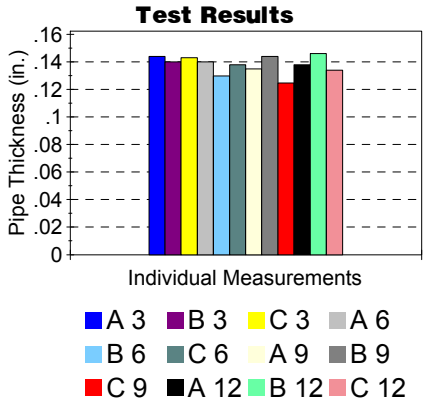
Pipe Identification and Operating Conditions

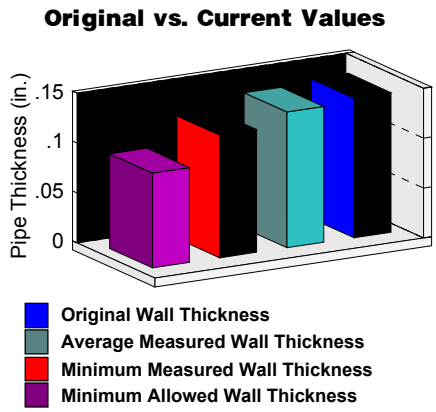
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-16
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate return line to main, near column XJ, at South wall. Test points located 1 ft. from elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.006 in. / **High to Low Range:** 0.021 in.
Minimum Theoretical Wall Thickness: 0.117 in.
Pitting Index: 9.6 % - Moderate Pitting Activity
Notes: Pipe exists 50 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.136 in.
Average Pipe Loss: 0.004 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 8.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.123 in.
Maximum Pipe Loss: 0.017 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 37.8 %
Remaining Pipe Life: 107.3 Years
Estimated Retirement **November 2124**

Testing Indicates: Pipe Condition Excellent

Comments: We measure noticeably higher pitting activity at this example of pipe but still produce a very favorable assessment. Corrosion activity is far lower than expected than traditionally found. Very long service life remains.

Location No: 72

Photo File #: wes-2-18.jpg
Detail: Pipe Location
Orientation: Below Side View

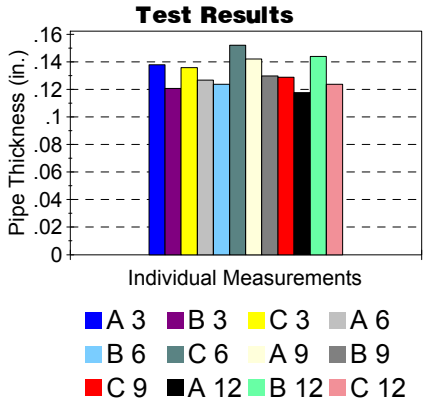
Pipe Identification and Operating Conditions

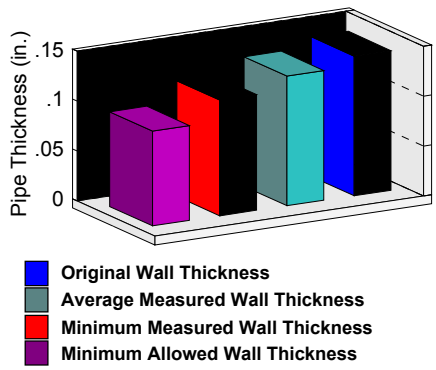
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-27
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate return line to main, near column XO, at South wall. Test points located 1 ft. before elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.010 in. / **High to Low Range:** 0.034 in.
Minimum Theoretical Wall Thickness: 0.099 in.
Pitting Index: 10.8% - Significant Pitting Activity
Notes: Pipe exists 43 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.130 in.
Average Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 22.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

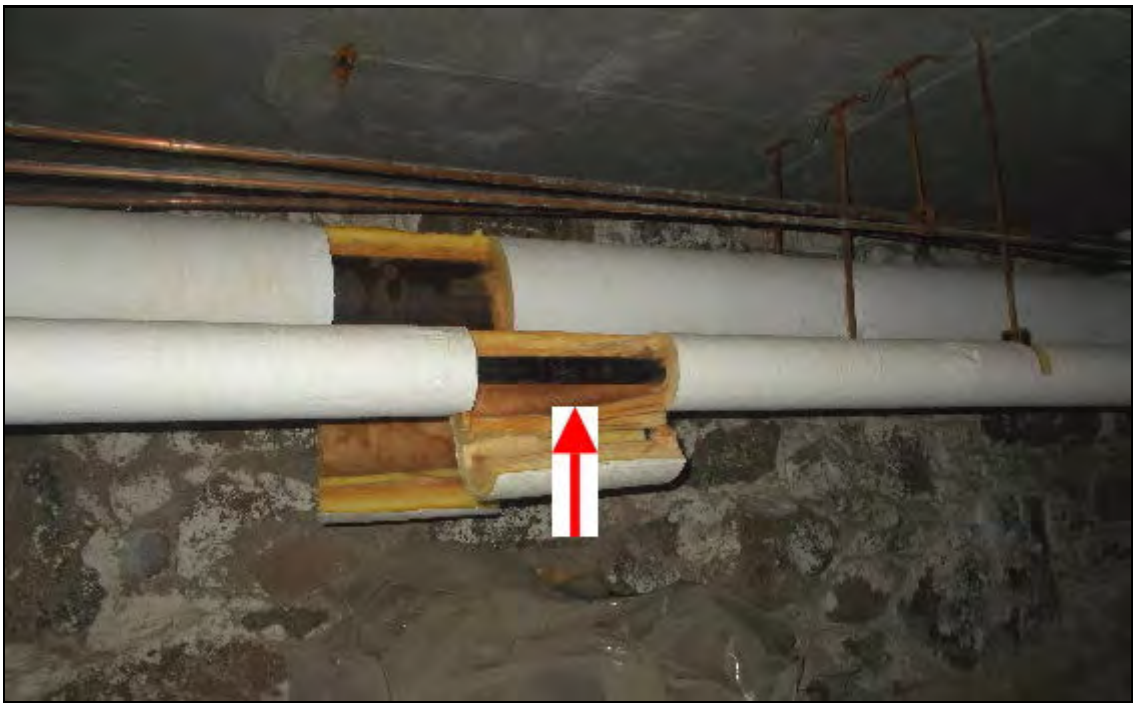
Minimum Thickness: 0.116 in.
Maximum Pipe Loss: 0.024 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 53.3 %
Remaining Pipe Life: 57.0 Years
Estimated Retirement **August 2074**

Testing Indicates: Pipe Condition Very Good

Comments: We measure higher pitting activity at this example of pipe was still produce very favorable results, with high average wall thickness. Very long service life remains.

Location No: 73

Photo File #: wes-2-29.jpg
Detail: Pipe Location
Orientation: Side View



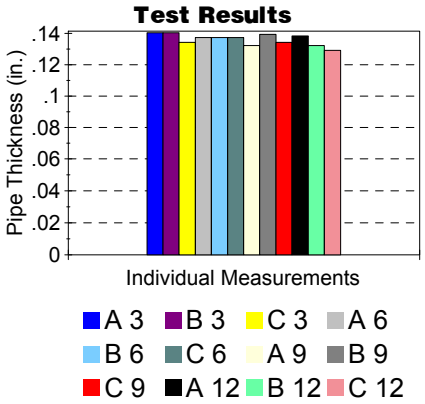
Pipe Identification and Operating Conditions

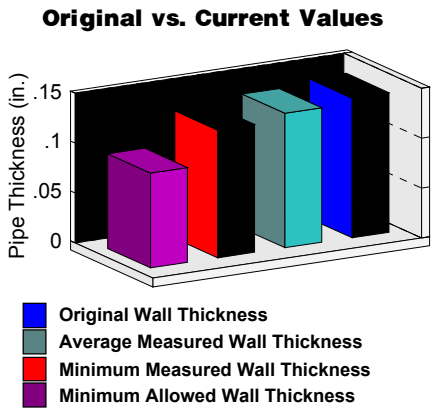
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Welded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-33
Site Drawing Number: n/a
Depth Allowance: 0.000 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate return line to main, in NE corner, near column XAN, in front of stone wall offset. Test points located 8 ft. after elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.000)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.004 in. / **High to Low Range:** 0.011 in.
Minimum Theoretical Wall Thickness: 0.124 in.
Pitting Index: 5.0 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.135 in.
Average Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 11.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

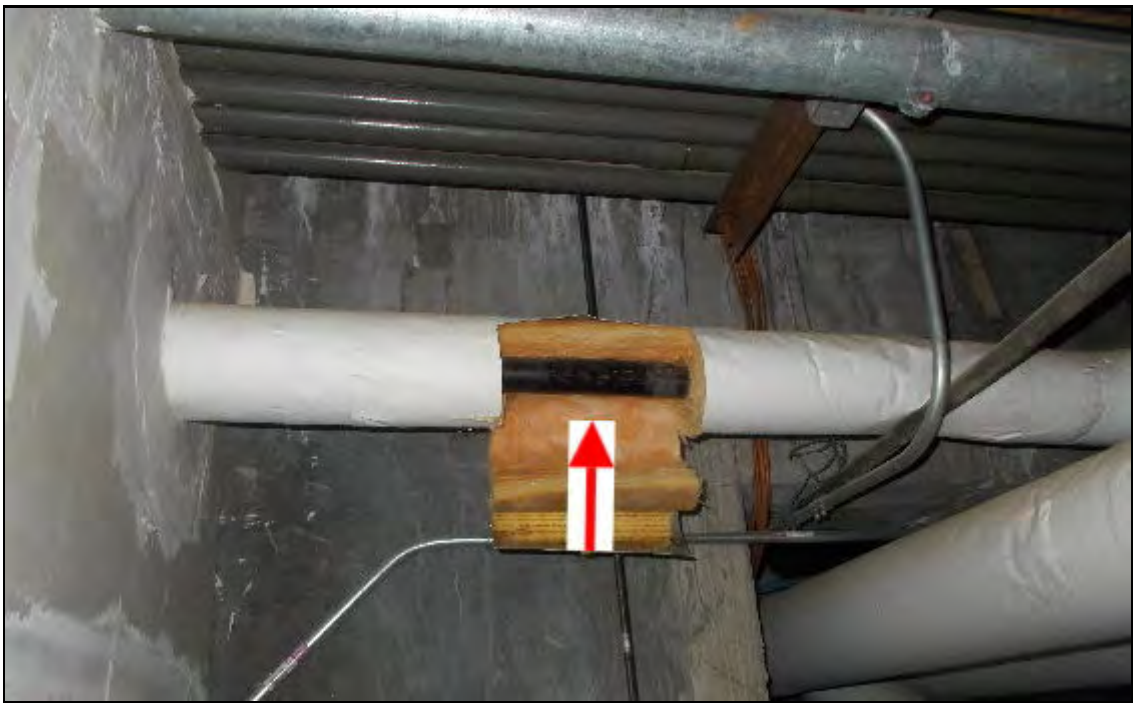
Minimum Thickness: 0.128 in.
Maximum Pipe Loss: 0.012 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 26.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows another example where corrosion activity is almost nonexistent and where current average wall thickness is still at new standard pipe specifications. Virtually unlimited service life remains.

Location No: 74

Photo File #: wes-1-14.jpg
Detail: Pipe Location
Orientation: Below Side View



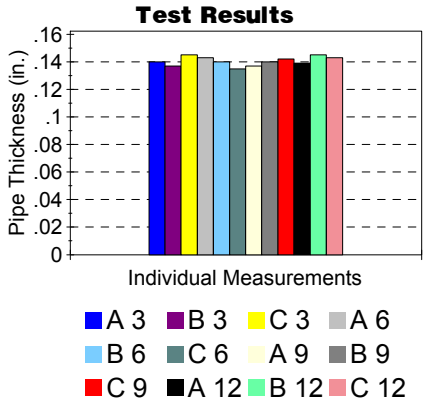
Pipe Identification and Operating Conditions

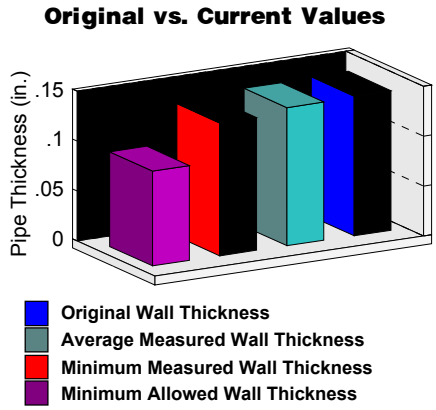
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-81
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Crawlspace: Steam condensate return line to main, near column X53-XAF. Test points located 2-3 ft. before elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.010 in.
Minimum Theoretical Wall Thickness: 0.129 in.
Pitting Index: 4.0 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.139 in.
Average Pipe Loss: 0.002 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 3.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.133 in.
Maximum Pipe Loss: 0.007 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 15.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows another example where corrosion activity is almost nonexistent and where current average wall thickness is still at new standard pipe specifications. Virtually unlimited service life remains.

Location No: 75

Photo File #: wes-1-37.jpg
Detail: Pipe Location
Orientation: Below Side View

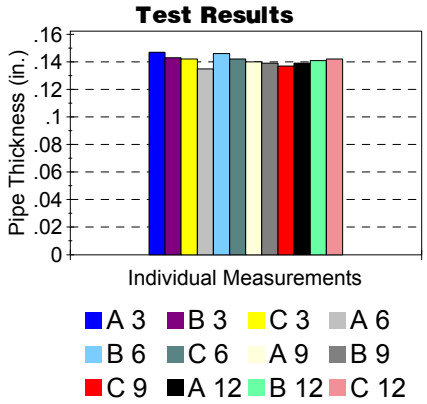
Pipe Identification and Operating Conditions

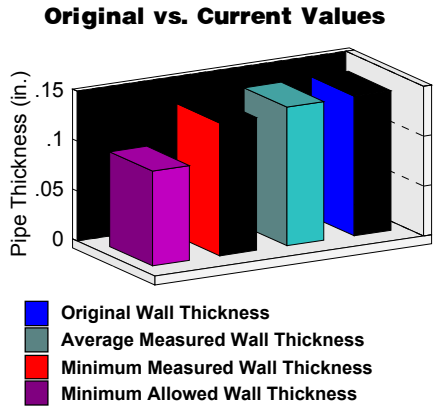
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-93
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate return line to main, near column X24-XAF. Test points located 1-12 in. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.012 in.
Minimum Theoretical Wall Thickness: 0.129 in.
Pitting Index: 4.4 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.139 in.
Average Pipe Loss: 0.001 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 2.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.133 in.
Maximum Pipe Loss: 0.007 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 15.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows another example where corrosion activity is almost nonexistent and where current average wall thickness is still at new standard pipe specifications. Virtually unlimited service life remains.

Location No: 76

Photo File #: wes-1-92.jpg
Detail: Pipe Location
Orientation: Side View

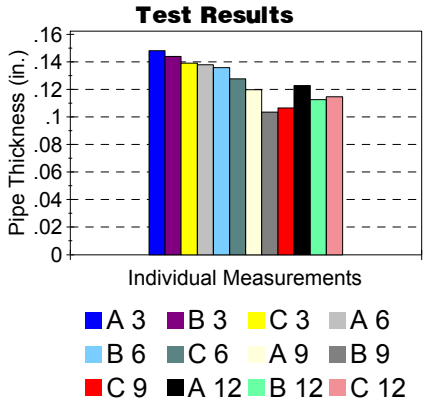
Pipe Identification and Operating Conditions

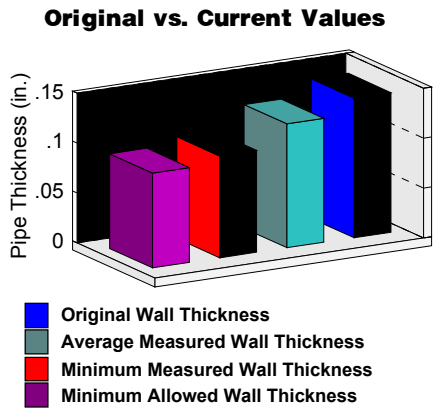
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-97
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Steam condensate return line to main, near column XE, at South wall. Test points located 1-12 in. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.015 in. / **High to Low Range:** 0.044 in.
Minimum Theoretical Wall Thickness: 0.080 in.
Pitting Index: 17.9% - Significant Pitting Activity
Notes: Pipe exists 29 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.124 in.
Average Pipe Loss: 0.016 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 35.0 %
Remaining Pipe Life: 120.9 Years
Estimated Retirement **July 2138**

Worst Case Scenario

Minimum Thickness: 0.102 in.
Maximum Pipe Loss: 0.038 in.
Corrosion Rate: 0.6 Mils Per Year
Percent of Allowable Pipe Loss: 84.4 %
Remaining Pipe Life: 12.0 Years
Estimated Retirement **August 2029**

Testing Indicates: Pipe Condition Satisfactory

Comments: We measure noticeably higher pitting activity at this example of pipe. Testing shows acceptable but potentially limited reliability due to higher pitting activity along its bottom surface.

Location No: 77

Photo File #: wes-2-02.jpg
Detail: Pipe Location
Orientation: Side View

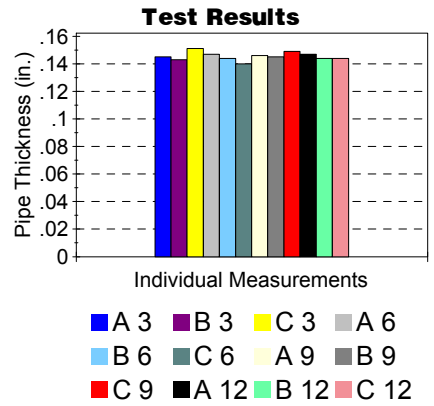
Pipe Identification and Operating Conditions

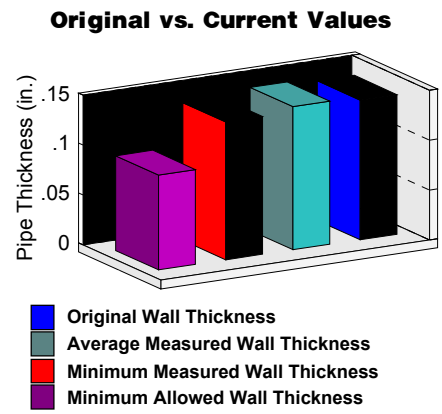
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-100
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Steam condensate return line to main, near column XJ, at North wall. Test points located 1 ft. before elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.011 in.
Minimum Theoretical Wall Thickness: 0.135 in.
Pitting Index: 3.8 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.143 in.
Average Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.138 in.
Maximum Pipe Loss: 0.002 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 4.4 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Pipe In Like New Condition

Comments: We measure very high and uniform wall thickness still at or above. new stated pipe specifications. The obvious high grade at this return line is likely responsible for such favorable results. Virtually unlimited service life remains.

Location No: 78

Photo File #: wes-2-24.jpg
Detail: Pipe Location
Orientation: Side View

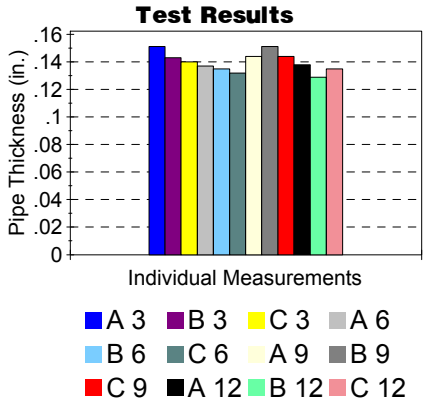
Pipe Identification and Operating Conditions

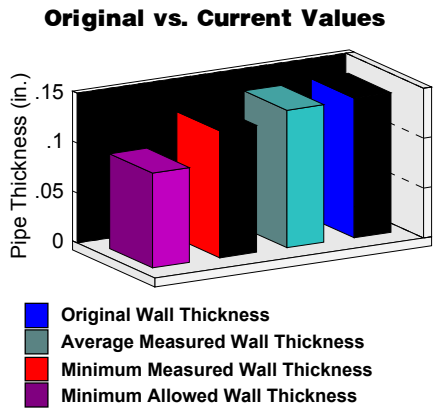
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-107
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate return line to main, in front of stonewall offset, near column XX. Test points located 1-2 ft. before elbow.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.007 in. / **High to Low Range:** 0.022 in.
Minimum Theoretical Wall Thickness: 0.117 in.
Pitting Index: 7.9 % - Moderate Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.138 in.
Average Pipe Loss: 0.002 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 4.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.127 in.
Maximum Pipe Loss: 0.013 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 28.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: Testing shows another example where corrosion activity is almost nonexistent and where current average wall thickness is still near new standard pipe specifications. Virtually unlimited service life remains.

Location No: 79

Photo File #: wes-2-40.jpg
Detail: Pipe Location
Orientation: Side View

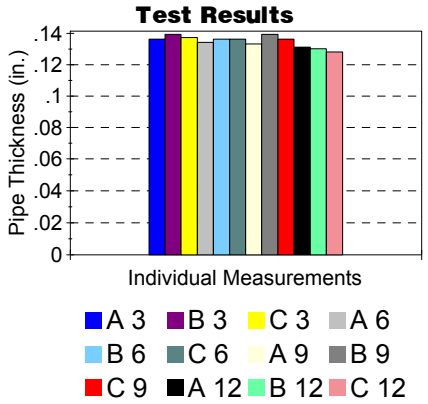
Pipe Identification and Operating Conditions

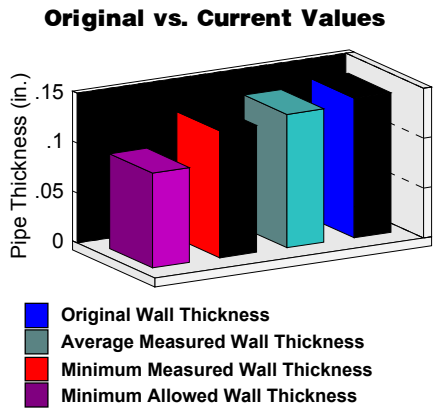
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-1/4-113
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - Lower Level Gym Storage Room 246-1: Steam condensate return line to pump, inside access hatch. Test points located 1-12 in. before elbow to pump.

Placed In Service: August 1, 1958
Date of Test: August 30, 2017
Time In Service: 59.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.011 in.
Minimum Theoretical Wall Thickness: 0.123 in.
Pitting Index: 4.9 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.134 in.
Average Pipe Loss: 0.006 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 14.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.127 in.
Maximum Pipe Loss: 0.013 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 28.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We measure very high average wall thickness which is not far below new standard five specifications. Corrosion and pitting activity are minimal. Virtually unlimited service life remains.

Location No: 80

Photo File #: wes-2-41.jpg
Detail: Pipe Location
Orientation: Side View

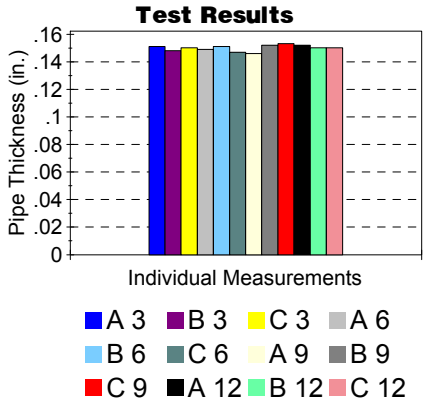
Pipe Identification and Operating Conditions

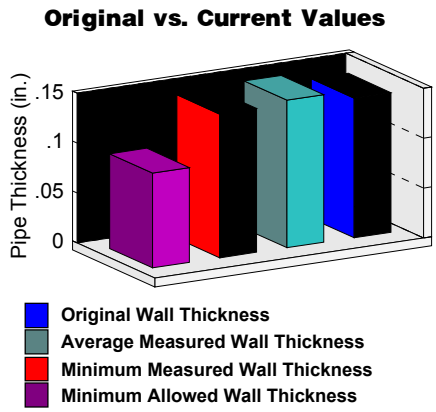
Service: Steam Condensate
Nominal Pipe Size: 1-1/4 in.
Actual Pipe Size: 1.66 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 25 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Vertical
Test Site I.D.: B-SC-1-1/4-114
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - Lower Level Gym Storage Room 246-1: Steam condensate discharge from pump, inside access hatch. Test points located between elbows.

Placed In Service: August 1, 1958
Date of Test: August 30, 2017
Time In Service: 59.1 Years
Original Wall Thickness: 0.140 in.
Minimum Allowable Thickness: 0.095 in. (0.074)
Minimum Thickness Based Upon:
Standard Deviation: 0.002 in. / **High to Low Range:** 0.007 in.
Minimum Theoretical Wall Thickness: 0.142 in.
Pitting Index: 2.6 % - Low Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.148 in.
Average Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.144 in.
Maximum Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Pipe In Like New Condition

Comments: Testing at this vertical pipe section shows very high and uniform average wall thickness still at or above new standard pipe specifications. Clearly, oversized pipe has been installed. Virtually unlimited service life remains.

Location No: 81

Photo File #: wes-2-17.jpg
Detail: Pipe Location
Orientation: Above Side View

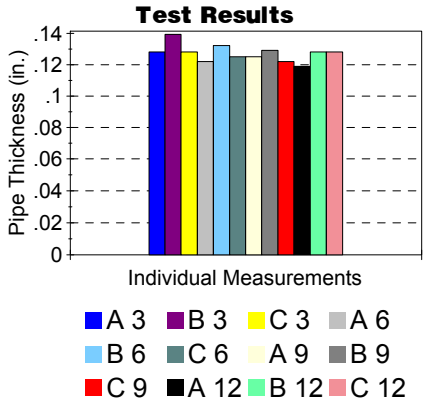
Pipe Identification and Operating Conditions

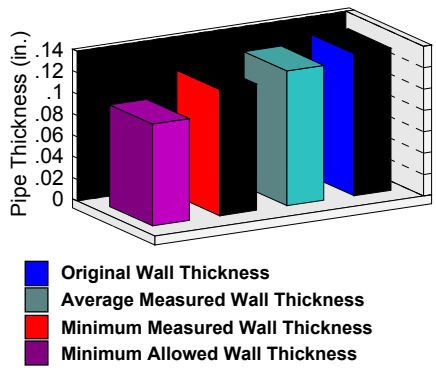
Service: Steam Condensate
Nominal Pipe Size: 1 in.
Actual Pipe Size: 1.32 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-26
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate return line to main, near column XO, at South wall. Test points located 2 ft. before connection to main, in center of expansion loop.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.133 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.005 in. / **High to Low Range:** 0.020 in.
Minimum Theoretical Wall Thickness: 0.110 in.
Pitting Index: 6.4 % - Moderate Pitting Activity
Notes: Pipe exists 45 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.126 in.
Average Pipe Loss: 0.007 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 18.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.118 in.
Maximum Pipe Loss: 0.015 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 39.5 %
Remaining Pipe Life: 99.9 Years
Estimated Retirement **June 2117**

Testing Indicates: Pipe Condition Excellent

Comments: Testing shows excellent results at this smaller diameter steam condensate line. Wall thickness is not far below new standard by specifications due to minimal corrosion activity. Extremely long service life remains.

Location No: 82

Photo File #: wes-2-48.jpg
Detail: Pipe Location
Orientation: Side View

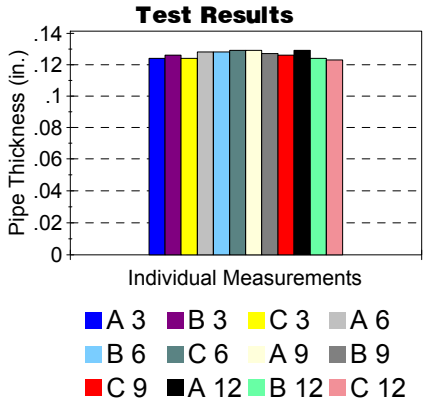
Pipe Identification and Operating Conditions

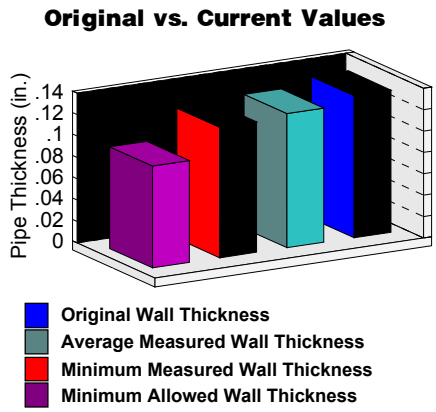
Service: Steam Condensate
Nominal Pipe Size: 1 in.
Actual Pipe Size: 1.32 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Vertical
Test Site I.D.: B-SC-1-38
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - South Wing Basement Corridor: Steam condensate return line to main, in front of exterior door B8. Test points located 4 ft. above floor.

Placed In Service: August 1, 1990
Date of Test: August 30, 2017
Time In Service: 27.1 Years
Original Wall Thickness: 0.133 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.002 in. / **High to Low Range:** 0.006 in.
Minimum Theoretical Wall Thickness: 0.119 in.
Pitting Index: 2.7 % - Low Pitting Activity
Notes: Pipe exists 49 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.125 in.
Average Pipe Loss: 0.008 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 20.0 %
Remaining Pipe Life: 108.7 Years
Estimated Retirement **April 2126**

Worst Case Scenario

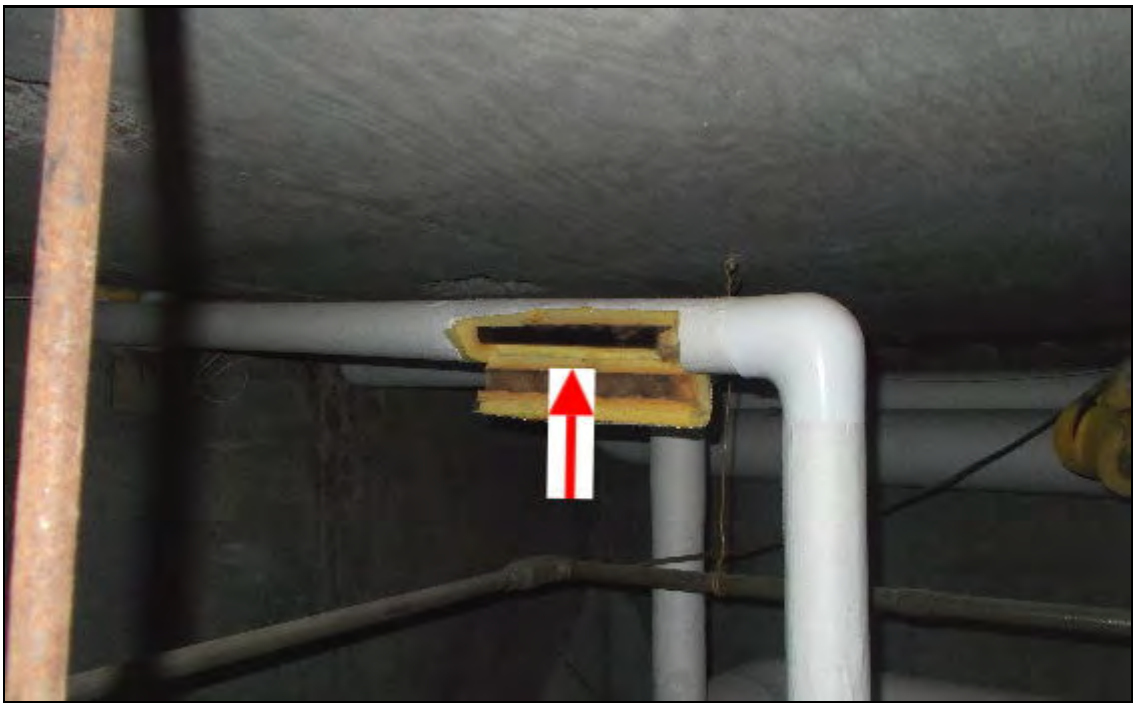
Minimum Thickness: 0.122 in.
Maximum Pipe Loss: 0.011 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 28.9 %
Remaining Pipe Life: 66.5 Years
Estimated Retirement **February 2084**

Testing Indicates: Pipe Condition Very Good

Comments: We produce excellent results at this example of vertical condensate piping, and show current wall thickness not far below new standard pipe specifications. Very long service life remains.

Location No: 83

Photo File #: wes-1-25.jpg
Detail: Pipe Location
Orientation: Side View



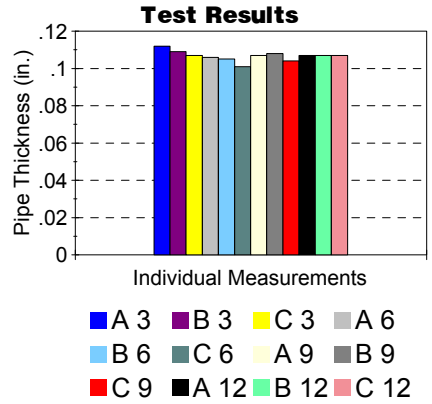
Pipe Identification and Operating Conditions

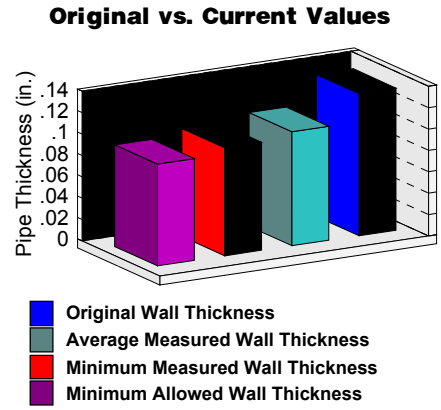
Service: Steam Condensate
Nominal Pipe Size: 1 in.
Actual Pipe Size: 1.32 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-87
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - South Wing Crawlspace: Steam condensate return line to main, at corner of room, near column X49-XZ. Test points located 1 ft. before elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.133 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.003 in. / **High to Low Range:** 0.011 in.
Minimum Theoretical Wall Thickness: 0.099 in.
Pitting Index: 5.3 % - Moderate Pitting Activity
Notes: Pipe exists 28 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.107 in.
Average Pipe Loss: 0.026 in.
Corrosion Rate: 0.4 Mils Per Year
Percent of Allowable Pipe Loss: 69.3 %
Remaining Pipe Life: 28.9 Years
Estimated Retirement **June 2046**

Worst Case Scenario

Minimum Thickness: 0.101 in.
Maximum Pipe Loss: 0.032 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 84.2 %
Remaining Pipe Life: 12.2 Years
Estimated Retirement **November 2029**

Testing Indicates: Pipe Condition Satisfactory

Comments: Although we can estimate far less service life, corrosion activity would actually be considered low for this example of pipe. After 65 years of service, however, such low corrosion has made its impact.

Location No: 84

Photo File #: wes-1-27.jpg
Detail: Pipe Location
Orientation: Below Side View

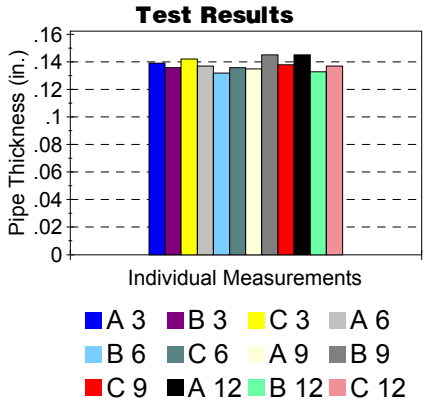
Pipe Identification and Operating Conditions

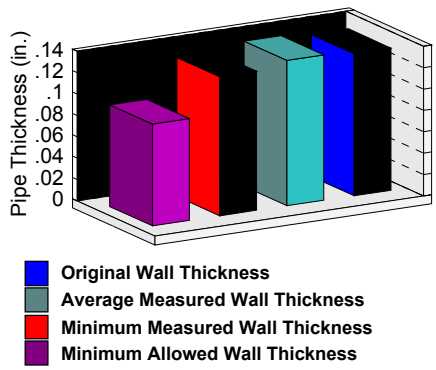
Service: Steam Condensate
Nominal Pipe Size: 1 in.
Actual Pipe Size: 1.32 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-89
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Steam condensate return line to main, after expansion loop, near column X36-XV. Test points located 1 ft. before elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.133 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.004 in. / **High to Low Range:** 0.013 in.
Minimum Theoretical Wall Thickness: 0.123 in.
Pitting Index: 4.4 % - Acceptable Pitting Activity
Notes: None

Graphical Summary





Average Case Scenario

Average Thickness: 0.136 in.
Average Pipe Loss: 0.000 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 0.0 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.130 in.
Maximum Pipe Loss: 0.003 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 7.9 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Pipe In Like New Condition

Comments: Testing shows another example where corrosion activity is almost nonexistent and where current average wall thickness still exceeds new standard pipe specifications. Virtually unlimited service life remains.

Location No: 85

Photo File #: wes-2-03.jpg
Detail: Pipe Location
Orientation: Side View

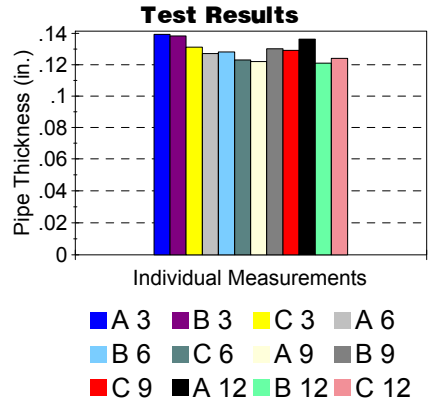
Pipe Identification and Operating Conditions

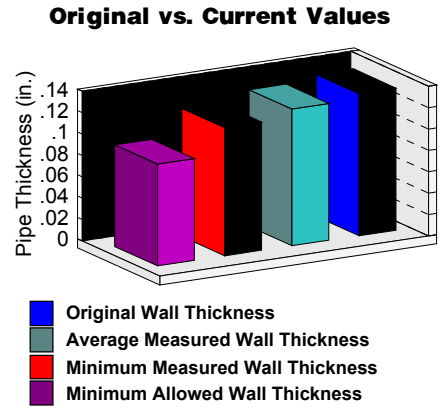
Service: Steam Condensate
Nominal Pipe Size: 1 in.
Actual Pipe Size: 1.32 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-101
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Steam condensate return line to main, near column XJ, at North wall. Test points located 1 ft. before elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.133 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.006 in. / **High to Low Range:** 0.018 in.
Minimum Theoretical Wall Thickness: 0.110 in.
Pitting Index: 6.2 % - Moderate Pitting Activity
Notes: Pipe exists 47 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.128 in.
Average Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 13.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.120 in.
Maximum Pipe Loss: 0.013 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 34.2 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We measure high average wall thickness due to unusually low corrosion and pitting activity. Virtually unlimited service life remains.

Location No: 86

Photo File #: wes-2-11.jpg
Detail: Pipe Location
Orientation: Side View

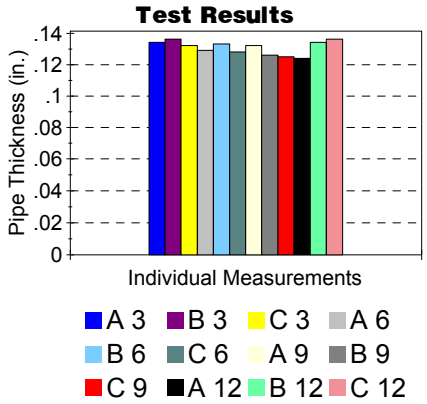
Pipe Identification and Operating Conditions

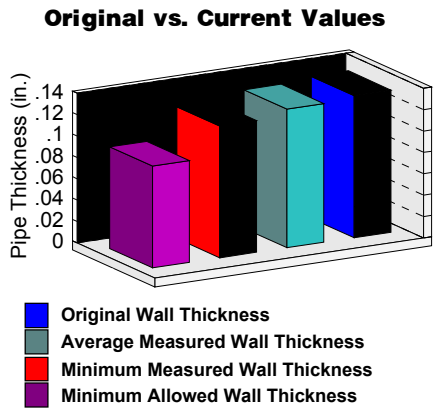
Service: Steam Condensate
Nominal Pipe Size: 1 in.
Actual Pipe Size: 1.32 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1-102
Site Drawing Number: n/a
Depth Allowance: 0.073 in.
Test Pattern: Random Points

Location - North Wing Crawlspace: Steam condensate return line to main, near column XS, at North wall. Test points located 1-12 in. before elbow to main, last branch line from chainlink fence, behind stonewall offset.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.133 in.
Minimum Allowable Thickness: 0.095 in. (0.073)
Minimum Thickness Based Upon:
Standard Deviation: 0.004 in. / **High to Low Range:** 0.012 in.
Minimum Theoretical Wall Thickness: 0.117 in.
Pitting Index: 5.2 % - Moderate Pitting Activity
Notes: Pipe exists 50 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.130 in.
Average Pipe Loss: 0.003 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 8.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

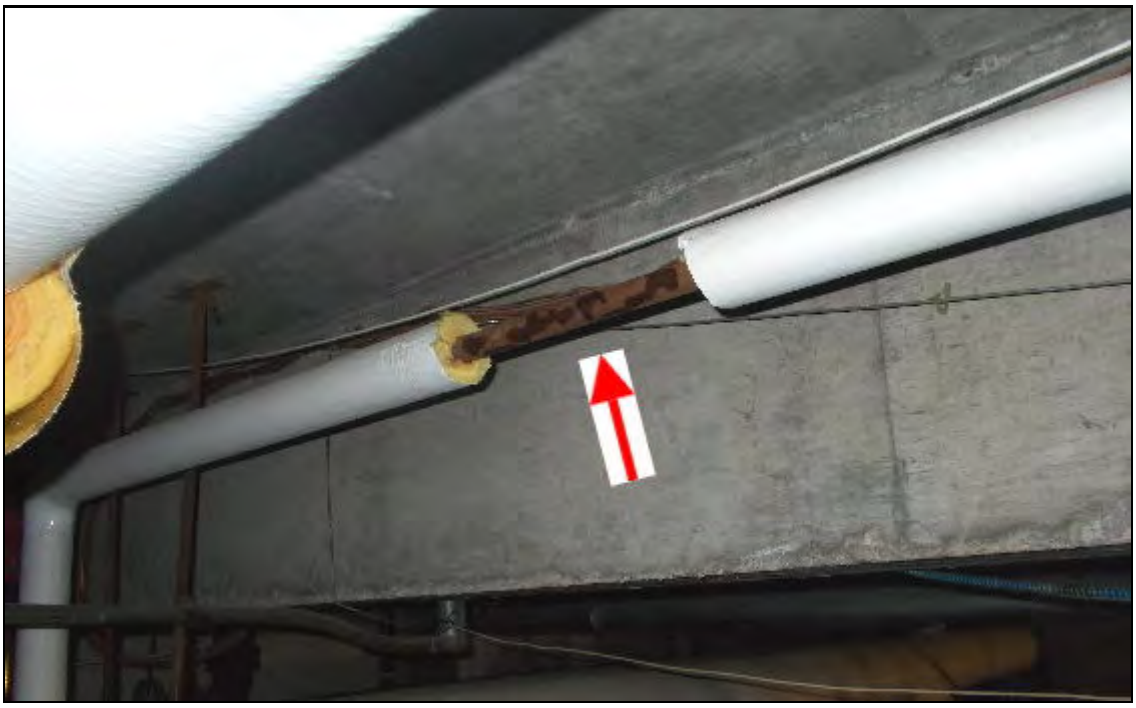
Minimum Thickness: 0.123 in.
Maximum Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 26.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We measure high average wall thickness due to unusually low corrosion and pitting activity. Virtually unlimited service life remains.

Location No: 87

Photo File #: wes-1-17.jpg
Detail: Pipe Location
Orientation: Below Side View



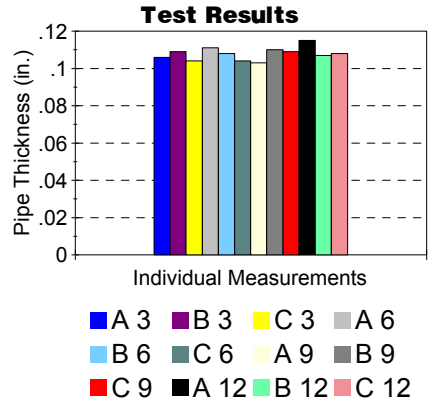
Pipe Identification and Operating Conditions

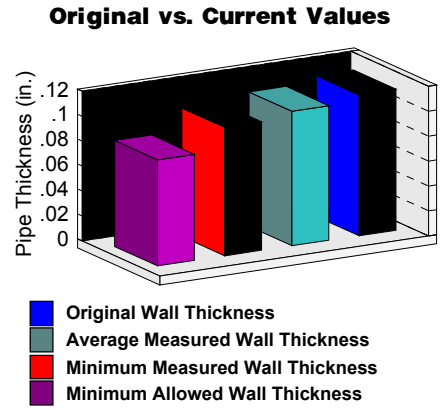
Service: Steam Condensate
Nominal Pipe Size: 3/4 in.
Actual Pipe Size: 1.05 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3/4-06
Site Drawing Number: n/a
Depth Allowance: 0.060 in.
Test Pattern: Random Points

Location - South Wing Crawlspace: Steam condensate return line to main, 1st take-off in room, near column X49-XAD. Test points located 4 ft. from elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.113 in.
Minimum Allowable Thickness: 0.085 in. (0.060)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.003 in. / **High to Low Range:** 0.012 in.
Minimum Theoretical Wall Thickness: 0.098 in.
Pitting Index: 4.5 % - Acceptable Pitting Activity
Notes: Pipe exists 43 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.108 in.
Average Pipe Loss: 0.005 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 18.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.103 in.
Maximum Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 35.7 %
Remaining Pipe Life: 117.2 Years
Estimated Retirement **October 2134**

Testing Indicates: Pipe Condition Excellent

Comments: Testing shows slightly higher wall loss but still excellent results for 3/4 in. steam condensate pipe of this old age. Extremely long service life remains.

Location No: 88

Photo File #: wes-1-88.jpg
Detail: Pipe Location
Orientation: Below Side View

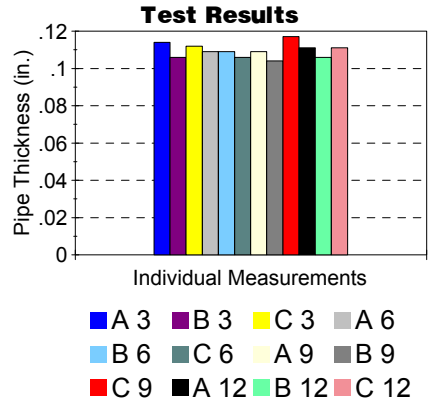
Pipe Identification and Operating Conditions

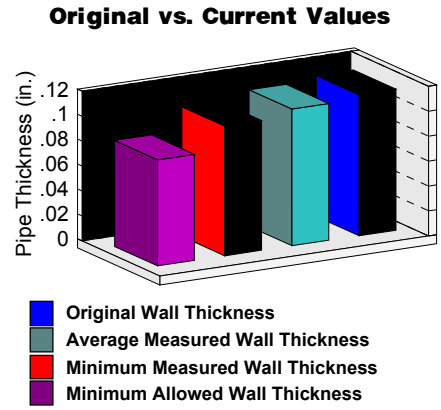
Service: Steam Condensate
Nominal Pipe Size: 3/4 in.
Actual Pipe Size: 1.05 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3/4-17
Site Drawing Number: n/a
Depth Allowance: 0.060 in.
Test Pattern: Bottom & Lower Sides

Location - North Wing Crawlspace: Steam condensate return line to main, near column XJ, at South wall. Test points located 1 ft. from elbow to main.

Placed In Service: August 1, 1952
Date of Test: August 29, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.113 in.
Minimum Allowable Thickness: 0.085 in. (0.060)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.004 in. / **High to Low Range:** 0.013 in.
Minimum Theoretical Wall Thickness: 0.098 in.
Pitting Index: 5.0 % - Moderate Pitting Activity
Notes: Pipe exists 44 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.110 in.
Average Pipe Loss: 0.004 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 12.5 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

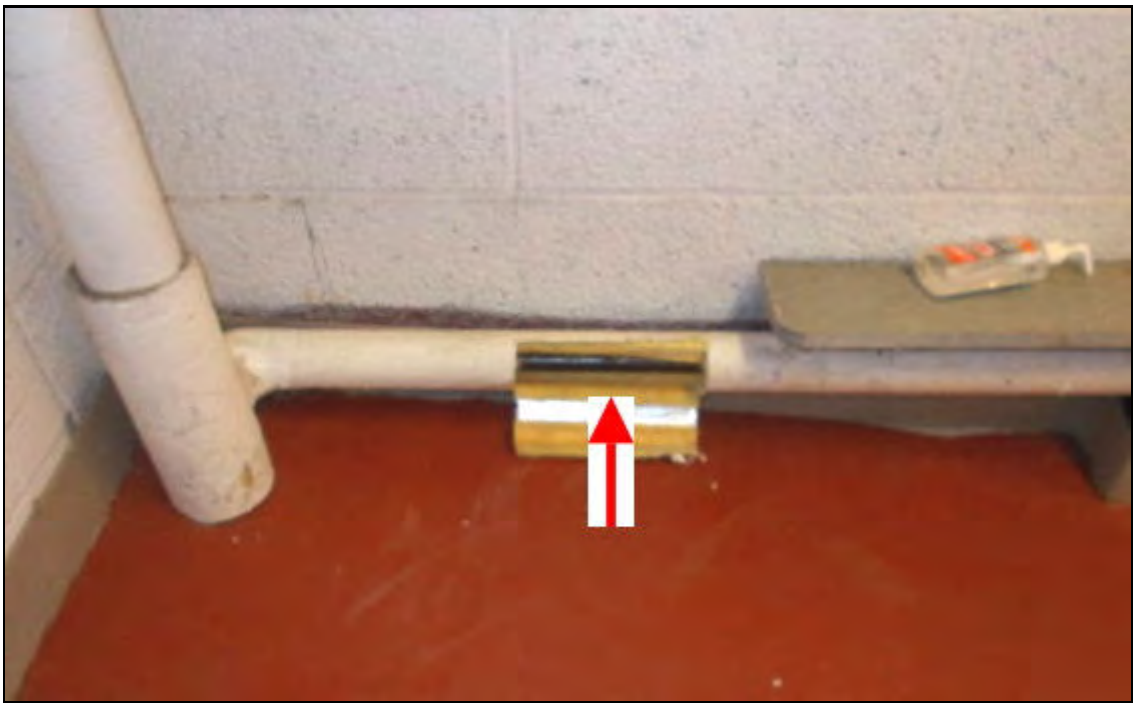
Minimum Thickness: 0.104 in.
Maximum Pipe Loss: 0.009 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 32.1 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: We show another example where corrosion activity is almost nonexistent due to a sharp incline or pitch to the pipe. Virtually unlimited service life remains.

Location No: 89

Photo File #: wes-2-49.jpg
Detail: Pipe Location
Orientation: Above Side View



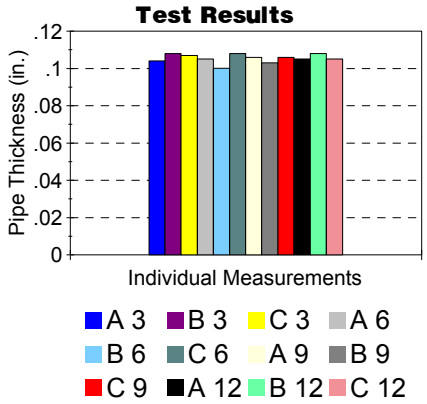
Pipe Identification and Operating Conditions

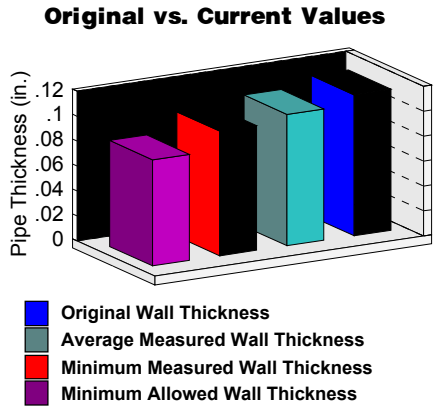
Service: Steam Condensate
Nominal Pipe Size: 3/4 in.
Actual Pipe Size: 1.05 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-3/4-39
Site Drawing Number: n/a
Depth Allowance: 0.060 in.
Test Pattern: Bottom & Lower Sides

Location - South Wing Basement Corridor: Steam condensate return line to main, in front of exterior door B8. Test points located 1 ft. before elbow.

Placed In Service: August 1, 1990
Date of Test: August 30, 2017
Time In Service: 27.1 Years
Original Wall Thickness: 0.113 in.
Minimum Allowable Thickness: 0.085 in. (0.060)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.002 in. / **High to Low Range:** 0.008 in.
Minimum Theoretical Wall Thickness: 0.098 in.
Pitting Index: 5.1 % - Moderate Pitting Activity
Notes: Pipe exists 40 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.105 in.
Average Pipe Loss: 0.008 in.
Corrosion Rate: 0.3 Mils Per Year
Percent of Allowable Pipe Loss: 27.1 %
Remaining Pipe Life: 73.0 Years
Estimated Retirement **July 2090**

Worst Case Scenario

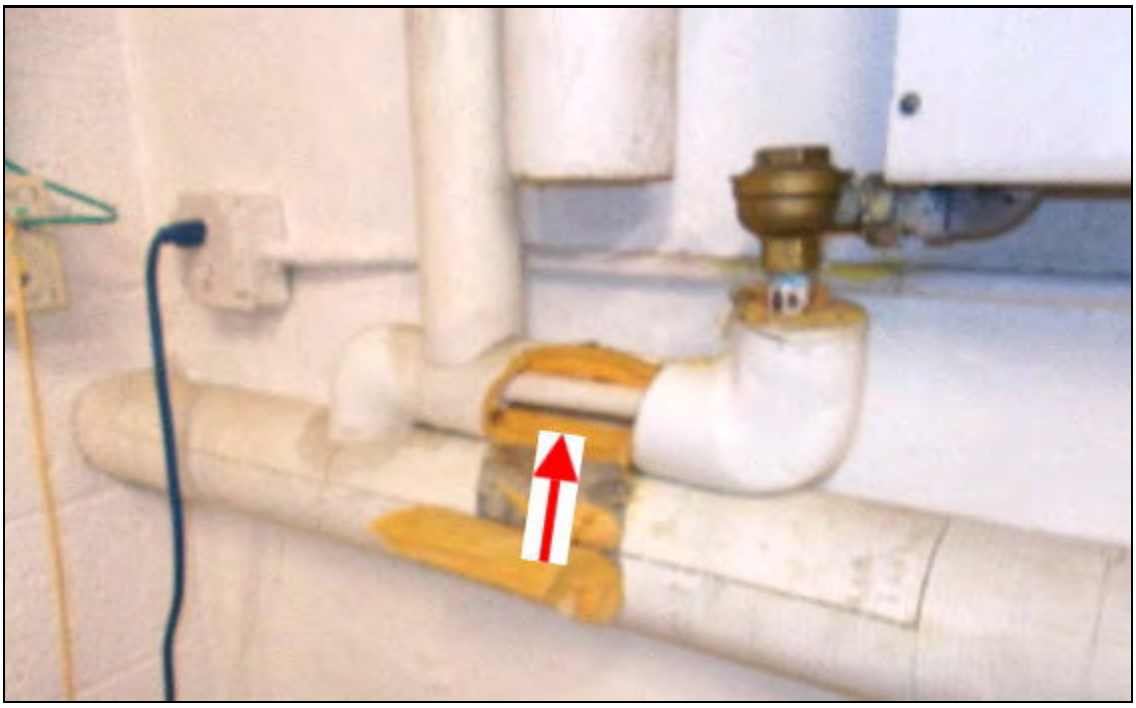
Minimum Thickness: 0.100 in.
Maximum Pipe Loss: 0.013 in.
Corrosion Rate: 0.5 Mils Per Year
Percent of Allowable Pipe Loss: 46.4 %
Remaining Pipe Life: 31.3 Years
Estimated Retirement **November 2048**

Testing Indicates: Pipe Condition Good

Comments: Higher corrosion and pitting activity is identified at this example of more recently installed pipe. Average wall thickness is still high, With long service life remaining.

Location No: 90

Photo File #: wes-2-45.jpg
Detail: Pipe Location
Orientation: Above Side View



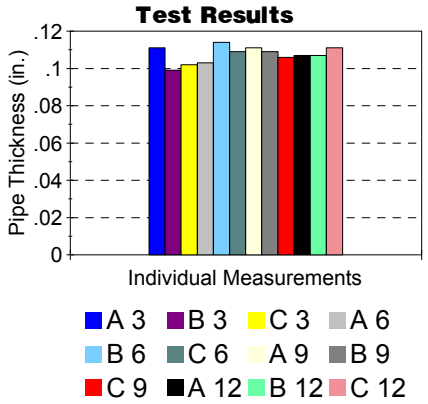
Pipe Identification and Operating Conditions

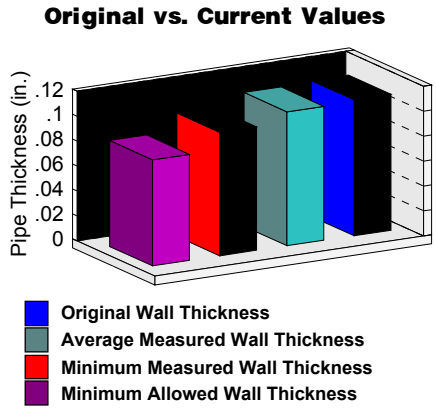
Service: Steam Condensate
Nominal Pipe Size: 1/2 in.
Actual Pipe Size: 0.84 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Horizontal
Test Site I.D.: B-SC-1/2-37
Site Drawing Number: n/a
Depth Allowance: 0.060 in.
Test Pattern: Random Points

Location - South Wing Basement Conference Room 3: Steam condensate return line to main, from radiator. Test points located between elbows.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.109 in.
Minimum Allowable Thickness: 0.085 in. (0.060)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.004 in. / **High to Low Range:** 0.015 in.
Minimum Theoretical Wall Thickness: 0.094 in.
Pitting Index: 7.8 % - Moderate Pitting Activity
Notes: Pipe exists 39 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.107 in.
Average Pipe Loss: 0.002 in.
Corrosion Rate: 0.0 Mils Per Year
Percent of Allowable Pipe Loss: 6.6 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.099 in.
Maximum Pipe Loss: 0.010 in.
Corrosion Rate: 0.2 Mils Per Year
Percent of Allowable Pipe Loss: 41.7 %
Remaining Pipe Life: 91.2 Years
Estimated Retirement **October 2108**

Testing Indicates: Pipe Condition Excellent

Comments: We measure high average wall thickness not far below new standard pipe specifications, which is extraordinary for 1/2 in. pipe of this older age. Extremely long service life remains.

Location No: 91

Photo File #: wes-2-58.jpg
Detail: Pipe Location
Orientation: Side View

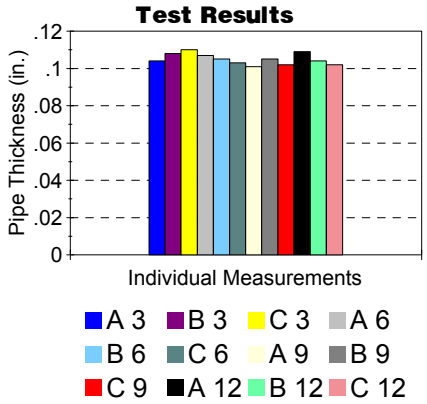
Pipe Identification and Operating Conditions

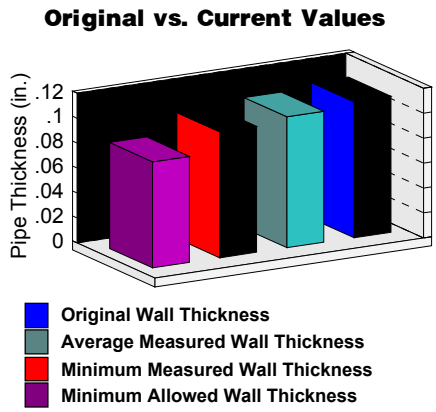
Service: Steam Condensate
Nominal Pipe Size: 1/2 in.
Actual Pipe Size: 0.84 in.
Schedule/Type: Standard
Material: Carbon Steel
Construction: Threaded
Flow: Return To Boiler
Pipe Pressure: 1 PSIG
Temperature: 190 Deg. F.
Pipe Orientation: Vertical
Test Site I.D.: B-SC-1/2-43
Site Drawing Number: n/a
Depth Allowance: 0.060 in.
Test Pattern: Random Points

Location - South Wing Basement Stair 5: Steam condensate return line to main, inside storage hatch. Test points located 1-2 ft. above tee to main.

Placed In Service: August 1, 1952
Date of Test: August 30, 2017
Time In Service: 65.1 Years
Original Wall Thickness: 0.109 in.
Minimum Allowable Thickness: 0.085 in. (0.060)
Minimum Thickness Based Upon: Default Minimum Value
Standard Deviation: 0.003 in. / **High to Low Range:** 0.009 in.
Minimum Theoretical Wall Thickness: 0.096 in.
Pitting Index: 3.8 % - Acceptable Pitting Activity
Notes: Pipe exists 41 mils from the threads, see Addendum.

Graphical Summary





Average Case Scenario

Average Thickness: 0.105 in.
Average Pipe Loss: 0.004 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 16.7 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Worst Case Scenario

Minimum Thickness: 0.101 in.
Maximum Pipe Loss: 0.008 in.
Corrosion Rate: 0.1 Mils Per Year
Percent of Allowable Pipe Loss: 33.3 %
Remaining Pipe Life: 125.0 Years
Estimated Retirement **July 2142**

Testing Indicates: Unlimited Service Life Remains

Comments: The very high and uniform wall thickness of this small diameter return line only confirms the substantially higher quality and greater corrosion resistance of older steel pipe. Virtually unlimited service life remains.

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APPENDIX

6.3 CONSTRUCTION COST ESTIMATE

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W www.rdkengineers.com

CONSTRUCTION COST ESTIMATE

Project phase: Study
Trade Specification Section: **Summary**
By: WWW **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers
RDK Project Number: 20170393 228,000 **SF**

Sheet 1 of 7
Date 10/16/2017

Description		Cost Per SF	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
DIVISION 1	General Requirements				155,530		413,780	569,310
DIVISION 3	Concrete				54,299		69,805	124,104
DIVISION 9	Boiler Room Construction				21,538		21,175	42,713
DIVISION 15400 Plumbing					62,851		56,703	119,554
DIVISION 15500 HVAC					321,073		849,248	1,170,321
DIVISION 15500 HVAC Boilers					251,497		250,923	502,419
DIVISION 16	Electrical				46,416		65,189	111,604
Subtotal Division 1-9	627,132							
Subtotals					$913,203		$1,726,823	$2,640,026
General Contractors 5% Overhead and Bond on Sub Contracts (Division 1-3)								$31,357
Subtotal								2,671,382
General Contractors 10% Profit on Sub Contracts (Division 1-16)								267,138
Subtotal								2,938,520
Design & Bid Assistance 8%								235,082
Subtotal								3,173,602
OPM Costs 5%								158,680
Subtotal								3,332,282
Engineer CA Costs 4%								133,291
Subtotal								3,465,574
Total Cost Per Square Foot	$15.20					**Total**		**$3,465,574**

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CONSTRUCTION COST ESTIMATE

Project phase: Study
Trade Specification Section:
General Conditions
By: WWW **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers
RDK Project Number: 20170393

Sheet 2 of 7
Date 10/16/2017

Description	Qty	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
DIVISION 1 - General Requirements							
A. Job Organization							
Project Manager	60	wks	0	0	1,438	86,280	86,280
Field Superintendent	120	wks	0	0	1,875	225,000	225,000
Field Engineer							
Direct Labor Burden	60	wks	0	0	650	39,000	39,000
B. Field Engineering & other Services							
Survey & Site							
Construction Testing	1	LS	0	0	2,500	2,500	2,500
C. Travel Expenses							
Superintendents							
Freight & Handling							
D. Field Offices & Temp Bldg.							
Mobilization	1	LS	3,750	3,750	16,000	16,000	19,750
Storage Trailer and Sheds	60	wks	625	37,500	0	0	37,500
Phones	60	wks	48	2,880			2,880
Fax Line							
Utilities							
Toilets							
Water							
Office Supplies	1	LS	625	625			625
E. Temp Utilities							0
Heat, Water, Lighting, Ventilation				0			0
F. Winter Protection							
Temp Heating Equipment							
Fuel							
Thawing Material							
Snow Plowing							
G. Construction Equipment				0			0
Small Power Equipment	60		250	15,000			15,000
H. Temp Construction							
Fencing & Barricades	1	LS	20,000	20,000			20,000
Site Signs	1	LS	625	625			625
Stairs & Ramps							
Traffic Control							
Dewatering							
Subtotal				$ 80,380		$ 368,780	$ 449,160

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CONSTRUCTION COST ESTIMATE

Project phase: Study
Trade Specification Section: Division 1

General Conditions

By: WWW **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers

RDK Project Number: 20170393

Sheet 2 of 7
Date 10/16/2017

	Description	Qty	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
I.	Insurance	1	LS	25,000	25,000		0	25,000
	Builders Risk							
	Owners Protective Liability							
	Umbrella Coverage							
	Payment & Performance Bonds	1	LS	9,375	9,375	0	0	9,375
J.	General	1	LS	8,900	8,900	0	0	8,900
	Building Permit							
	Sewer, Water, Street Permits							
	Reproduction	1	LS	1,875	1,875	0	0	1,875
	Cutting/Patching							
	OSHA/Safety Regs.	1	LS	1,875	1,875	0	0	1,875
K.	Close-out & Cleanup	1	LS	0	0	10000	10,000	10,000
	General & Daily	60	wks	0	0	450	27,000	27,000
	Dumpster Rentals	60	wks	250	15,000	0	0	15,000
	Dump Fees							
	Final Cleanup	1	LS	0	0	2000	2,000	2,000
	Punch List	1	LS	6,875	6,875	6000	6,000	12,875
	As Built Drawings	1	LS	6,250	6,250	0	0	6,250
						Subtotal Page 1		$ 449,160
						Subtotal Page 2		$ 120,150
	Subtotal of Page 2				$ 75,150		$ 45,000	
	Subtotal of Pages 1 & 2				$ 155,530		$ 413,780	$ 569,310
						SUB-TOTAL		**$ 569,310**

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CONSTRUCTION COST ESTIMATE

Project phase: Study
Trade Specification Section: **Division 3 Concrete**
By: WWW **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers
RDK Project Number: 20170393

Sheet 3 of 7
Date 10/16/2017

Description	Qty	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
DIVISION 3 - Concrete							
Equipment Pads	100	sf	18.75	1,875	26.90	2,690	4,565
access hatches	6	ea	3,000.00	18,000	5,000.00	30,000	48,000
Concrete repairs/patch	1	ls		25,000		25,000	50,000
Subtotal				$ 44,875		$ 57,690	102,565
10% Overhead				4,488		5,769	10,257
Subtotal				49,363		63,459	112,822
10% Profit				4,936		6,346	11,282
			TOTAL	**54,299**		**69,805**	**124,104**

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CONSTRUCTION COST ESTIMATE

Project phase: Study
Trade Specification Section: **Division 9**
Boiler Room Construction
By: WWW **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers
RDK Project Number: 20170393

Sheet 3 of 7
Date 10/16/2017

Description	Qty	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
DIVISION 9 - Boiler Room Construction							
Doors	2	ea	1,200.00	2,400	900.00	1,800	4,200
Walls/Painting	2	LS	5,000.00	10,000	5,000.00	10,000	20,000
Fire Proofing	2	LS	1,000.00	2,000	1,000.00	2,000	4,000
CO Detection	2	LS	1,200.00	2,400	1,200.00	2,400	4,800
Lighting	2	LS	500.00	1,000	650.00	1,300	2,300
Subtotal				$ 17,800		$ 17,500	35,300
10% Overhead				1,780		1,750	3,530
Subtotal				19,580		19,250	38,830
10% Profit				1,958		1,925	3,883
			TOTAL	**21,538**		**21,175**	**42,713**

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CONSTRUCTION COST ESTIMATE

Project phase: Study
Trade Specification Section: **PLUMBING**
By: _____ **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers
RDK Project Number: 20170393

Sheet 4 of 7
Date 10/16/2017

Description	Qty	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
DIVISION 15400 - Plumbing							
3" Gas Piping - Boilers	400	lf	44	17,600	53	21,200	38,800
3" Fittings - Boilers	44	ea	265	11,660	82	3,608	15,268
3" Hangers - Boilers	44	ea	20	858	42.5	1,870	2,728
3" Valves - Boilers	8	ea	850	6,800	98	784	7,584
Boiler room drains	1	ea	3,000	3,000	5500	5,500	8,500
Make-up water - Boilers	2	lot	2,400	4,800	2000	4,000	8,800
Water Heater - 40 gallon	1	ea	800	800	1000	1,000	1,800
Water Heater - 80 gallon	1	ea	1,500	1,500	1200	1,200	2,700
Water Heaters Piping	2	ls	750	1,500	900	1,800	3,300
Water Heater Flues (CTE)	2	ea	400	800	200	400	1,200
Cleaning/Flushing	1	ls	2,500	2,500	2500	2,500	5,000
Testing	1	ls	125.00	125	3000.00	3,000	3,125
assume gas company provided service							
Subtotal				51,943		46,862	98,805
10% Overhead				5,194		4,686	9,881
Subtotal				57,137		51,548	108,686
10% Profit				5,714		5,155	10,869
TOTAL				62,851		56,703	**119,554**

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CONSTRUCTION COST ESTIMATE

Project phase: Study
Trade Specification Section: **HVAC**
By: WWW **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers
RDK Project Number: 20170393

Sheet 5 of 7
Date 10/16/2017

Description	Qty	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
DIVISION 15500 - HVAC							
Piping							
Steel - Sched 80/40							
3/4"	1,250	LF	8.00	10,000	21	26,250	36,250
1"	625	LF	12.00	7,500	21	13,125	20,625
1-1/4"	510	LF	14.00	7,140	22	11,220	18,360
1-1/2"	550	LF	18.00	9,900	24	13,200	23,100
2"	750	LF	22.00	16,500	30	22,500	39,000
3"	900	LF	27.30	24,570	38	34,200	58,770
4"	150	LF	38.40	5,760	38	5,700	11,460
6"	150	LF	62.00	9,300	52	7,800	17,100
3/4" Insulation	1,250	LF	4.23	5,288	6.50	8,125	13,413
1" Insulation	625	LF	4.53	2,831	6.50	4,063	6,894
1-1/4" Insulation	510	LF	4.93	2,514	6.50	3,315	5,829
1-1/2" Insulation	550	LF	5.16	2,838	6.50	3,575	6,413
2" Insulation	750	LF	5.68	4,260	10.00	7,500	11,760
3" Insulation	900	LF	6.37	5,733	11.00	9,900	15,633
4" Insulation	150	LF	7.28	1,092	24.00	3,600	4,692
6" Insulation	150	LF	20.00	3,000	27.00	4,050	7,050
3/4" Gate Valves	55	ea	50	2,757	100	5,500	8,257
1" Gate Valves	300	ea	61	18,234	100	30,000	48,234
1-1/4" Gate Valves	60	ea	70	4,210	100	6,000	10,210
1-1/2" Gate Valves	32	ea	84	2,694	100	3,200	5,894
2" Gate Valves	20	ea	110	2,201	100	2,000	4,201
3/4" Strainers	10	ea	70	704	100	1,000	1,704
1" Strainers	38	ea	96	3,643	100	3,800	7,443
1" Steam Traps	38	ea	270	10,252	100	3,800	14,052
3/4" Fittings	125	ea	13	1,665	100	12,500	14,165
1" Fittings	63	ea	14	876	100	6,300	7,176
1-1/4" Fittings	51	ea	15	740	120	6,120	6,860
1-1/2" Fittings	55	ea	16	880	125	6,875	7,755
2" Fittings	75	ea	20	1,500	130	9,750	11,250
3" Fittings	90	ea	33	2,970	180	16,200	19,170
4" Fittings	15	ea	55	825	190	2,850	3,675
Hangers	475	ea	44.00	20,900	42.50	20,188	41,088
Hanger Inserts	225	ea	12.00	2,700	45.00	10,125	12,825
Cleaning	1	ls	2,500	2,500	2,500	2,500	5,000
Flushing	1	ls	3,125	3,125	3,125	3,125	6,250
Testing & Balancing	1	ea	125.00	125	5,000	5,000	5,125
Crawl space ventilation (Exhaust fan/louver)	6	ea	2,200.00	13,200	5,000	30,000	43,200
Demolition							
Hangers	475	ea	0.00	0	30.00	14,250	14,250
Piping	4,735	LF	0.00	0	45.00	213,075	213,075
Waste Disposal - Dumpsters	8	ea	1200.00	9,600	200.00	1,600	11,200
Subtotal				224,527		593,880	818,407
30% Overhead and premium time				67,358		178,164	245,522
Subtotal				291,885		772,044	1,063,929
10% Profit				29,188		77,204	106,393
TOTAL				321,073		849,248	**1,170,321**

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CONSTRUCTION COST ESTIMATE

Project phase: Study
Trade Specification Section: **Boilers**
By: WWW **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers
RDK Project Number: 20170393

Sheet 6 of 7
Date 10/16/2017

Description	Qty	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
DIVISION 15500 - HVAC							
3" Piping	220	lf	44.00	9,680	48	10,560	20,240
3" Valves	14	ea	820.00	11,480	98	1,372	12,852
3" Insulation	220	lf	6.37	1,401	9.00	1,980	3,381
3" Strainer	4	ea	186.00	744	98.00	392	1,136
3" Triple Duty Valve	4	ea	290.00	1,160	98.00	392	1,552
3" Flex Connector	8	ea	226.00	1,808	98.00	784	2,592
3" Fittings	24	ea	265	6,360	82	1,968	8,328
3" Hangers	24	ea	19.50	468	42.50	1,020	1,488
Cleaning/Flushing	1	ls	2,500	2,500	2,500	2,500	5,000
Testing & Balancing	1	ea	125.00	125	3,000	3,000	3,125
Boilers (95%, GF, HW, 800mbh)	4	ea	28,000	112,000	23,000	92,000	204,000
Pumps (120 gpm @ 50' HD)	4	ea	4300.00	17,200	5000.00	20,000	37,200
Pump Specialties	10	ea	500.00	5,000	475.00	4,750	9,750
Chemical Treatment	2	ea	1000.00	2,000	800.00	1,600	3,600
Controls (including gateways)	40	pts	600.00	24,000	600.00	24,000	48,000
4" Flues/Breeching	240	lf	38.00	9,120	60.00	14,400	23,520
4" Flues Fittings	28	ea	34.00	952	102.00	2,856	3,808
Rigging	1	ls	250.00	250	6500.00	6,500	6,750
Demolition							
Piping	100	lf	0.00	0	25.00	2,500	2,500
Heat Exchangers	4	ea	0.00	0	1950.00	7,800	7,800
Pumps	8	ea	0.00	0	825.00	6,600	6,600
Waste Disposal - Dumpsters	2	ea	800.00	1,600	200.00	400	2,000
Subtotal				207,848		207,374	415,222
10% Overhead				20,785		20,737	41,522
Subtotal				228,633		228,111	456,745
10% Profit				22,863		22,811	45,674
TOTAL				251,497		250,923	**502,419**

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Andover, MA 01810-1488

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CONSTRUCTION BUDGETARY COST ESTIMATE

Project phase: Study
Trade Specification Section: **ELECTRICAL**
By: WWW **Checked By:** DJW

Project: Wellesley Middle School
Piping Repl, HW Boilers
RDK Project Number: 20170393

Sheet 7 of 7
Date 10/16/2017

Description	Qty	Units	Material Unit Cost	Material Total	Labor Unit Cost	Labor Total	Total
DIVISION 16 - ELECTRICAL							
Branch Circuit Wiring	1,000	clf	5	5,000	6	6,250	11,250
3/4" Conduit	240	lf	23	5,400	48	11,400	16,800
Carbon Monoxide Detector	2	ea	625	1,250	1,200	2,400	3,650
Variable Speed Drives	4	ea	3,031	12,124	2,700	10,800	22,924
30A/3P Circuit Breaker	4	ea	24	96	150	600	696
20A/1P Circuit Breaker	2	ea	19	38	150	300	338
Emergency Shutoff Switch	2	ea	19	38	480	960	998
1x4 Vaportight Fluorescent	4	ea	91	365	91	365	730
Misc/relocate exisitng	1	ls	1,250	1,250	1,900	1,900	3,150
Misc Demolition	1	ls	0	0	2100	2100	2100
Crawl space lights and power	1	ls	8,000	8,000	8,000	8,000	16,000
Power to exhaust fans	4	ea	1,200	4,800	2,200	8,800	13,600
Subtotal				38,360		53,875	92,235
10% Overhead				3,836		5,388	9,224
Subtotal				42,196		59,263	101,459
10% Profit				4,220		5,926	10,146
TOTAL				46,416		65,189	**111,604**

RDK ENGINEERS

APPENDIX

6.4 PHOTOGRAPHS

Photo 1: North Wing Crawl Space – Right Side
Damaged Insulation from Burst Condensate Pipe

Photo 2: North Wing Crawl space – Left Side
Damaged Insulation from Burst Condensate Pipe

Photo 3: Original Building Crawl Space
Insulation Damaged on Condensate Return Piping

Photo 4: Original Building Crawl Space
Damaged Insulation From General Wear and Tear

Photo 5: Original Building Boiler Room
Existing Boilers Currently Serving Wellesley Middle School

Photo 6: Original Building Mechanical Room
Existing Heat Exchangers Side View

Photo 7: Original Building Mechanical Room Existing Heat Exchangers Front View Showing Inlet and Outlet Piping

Photo 8: North Wing Crawl Space Existing Heating Hot Water Pumps with Supply and Return Piping

Photo 9: Original Building Mechanical Rom Existing Heating Hot Water Pumps with Supply Piping from Existing Heat Exchangers

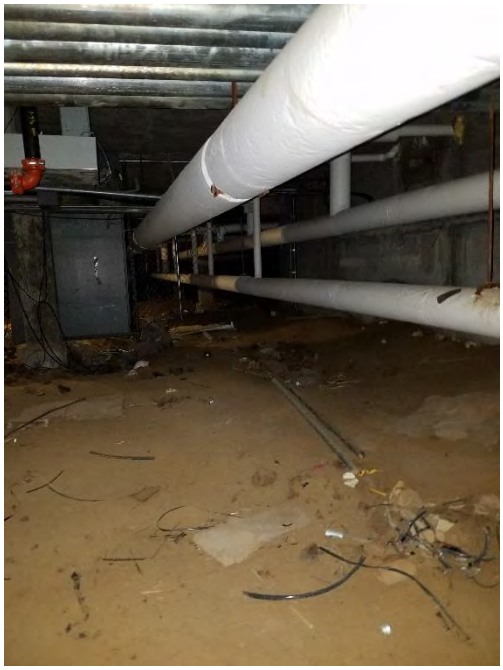


Photo 10: Original Building Crawl Space Steam Supply and Condensate Return Piping Running along North Wall

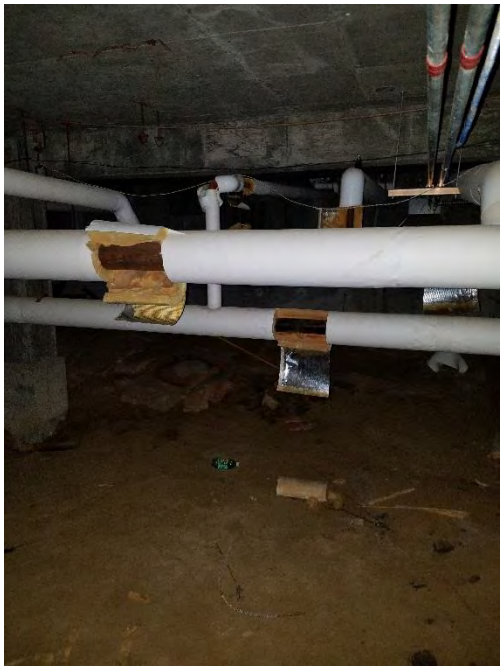


Photo 11: Original Building Crawl Space Insulation Cut Away for Ultrasonic Testing Locations

Photo 12: North Wing Crawl Space – Left Side Water Damaged Insulation w/Pinhole Leak in Flat Condensate Return Piping

RDK ENGINEERS

APPENDIX

6.5 MAINTENANCE DIRECT WORK ORDER SYSTEM (AKA SCHOOL DUDE)

No	WOID	Descriptions	ActionTaken	Request Date	Completion Date	Area Number
1	7296	Boiler #3 not running. Jeff Towne has looked at it.	Replaced water feed pump float switch assembly. ok now.	05/10/17	06/22/17	Boiler room
2	7241	1Chemical Feed Pup mLB02SA, 6 GPD, A Plus		04/25/17		
3	7038	Steam leak in crawl space under north wing. Matt Bovil has already come over and put a temporary patch on the pipe.	Replaced section of leaking steam pipe	03/07/17	03/07/17	crawl space under north wing
4	5848	Boiler number 2 not working	Replaced bad fire eye chassis and programmer. test ok.	03/29/16	04/28/16	boiler room
5	5569	Sight glass on boiler #3 is leaking		01/11/16	01/20/16	Boiler room
6	3189	Repair/Replace cracked boiler section on "Larry"		02/24/14	12/05/14	
7	3088	replace feed line to all 3 boilers	Industrial Burner systems to install new 2-1/2 : welded	01/21/14	03/19/14	Boiler room
8	3062	There is a water leak coming from the valve in the back of boiler #3	Replaced rotted nipple behind boiler 3	01/14/14	01/16/14	boiler room
9	2896	Please repair leaking pipe in the back of boiler #2	Replaced leaking pipe on return line behind boiler	11/20/13	11/25/13	Boiler room
10	1910	Please look at pump #6 it is leaking. Machine room next to boiler room.	Replaced bearing assembly on pump	03/13/13	08/29/13	Machine room
11	1162	Please reinstall the condensate pump in boiler room	Spoke to Mark already done by outside contractor	09/11/12	01/15/13	
12	626	Please repair one of the condensate pumps.(leaking) left hand side.		01/24/12	05/15/12	
13	605	Pump oily water out of interstitial space between steel tank and concrete vault for buried fuel oil tank.		01/15/12	01/21/12	Fuel Oil Tank
14	601	Martin suggested purchasing a conductivity meter to help with boiler blow downs	PO emailed to martin on 1/13/12	01/12/12	01/27/12	
15	294	Number 1 boiler is leaking in back of boiler.It looks like the same leak that boiler 3 had.	IBS looked at waiting for parts	11/08/11	12/10/11	Boiler No. 1
16	198	Due to ongoing high-fire problems (shutdowns) and inefficiencies in operation, Industrial Burner Systems		10/26/11	09/12/12	Boiler Room
17	176	Chemically clean and skim Boiler No. 1, then investigate shut down problems associated with water level fluctuations.	completed by Ind. boiler service on 10/25/11	10/24/11	10/26/11	Boiler Room
18	159	Please replace low water cutoff-MZ switch on boiler #2.	replace LWC switch	10/19/11	10/26/11	Boiler No. 2
19	382	Clean and check burners on all three boilers for ol-to-gas conversion.		08/04/11	11/24/11	Boilers

RDK ENGINEERS

APPENDIX

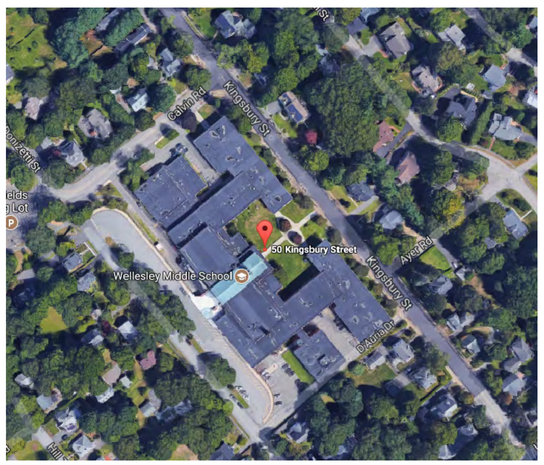
6.6 CONCEPTUAL DESIGN DRAWINGS

WELLESLEY MIDDLE SCHOOL

HEATING SYSTEM REPLACEMENT

50 Kingsbury St. Wellesley, MA 02481

LOCUS PLAN



DRAWING LIST

Sheet Number	Sheet Title
COVER SHEET	
C0.00	COVER SHEET
HVAC	
H0.00	HVAC LEGEND NOTES AND ABBREVIATIONS
H0.01	HVAC OVERALL BUILDING LEGEND
H2.01	HVAC CRAWLSPACE 1952 ORIGINAL BUILDING
H2.02	HVAC CRAWLSPACE 1966-1967 ADDITIONS
H2.03	HVAC CRAWLSPACE 1952 ORIGINAL BUILDING
H2.04	HVAC CRAWLSPACE 1966-1967 ADDITIONS
H2.05	HVAC CRAWLSPACE 1958-1959 NORTH ADDITION
H2.06	HVAC CRAWLSPACE 1958-1959 SOUTH ADDITION
H2.07	HVAC CRAWLSPACE 1966-1967 NORTH WING
H2.08	HVAC CRAWLSPACE 1966-1967 SOUTH WING
H3.03	HVAC GROUND FLOOR 1952 ORIGINAL BUILDING
H3.07	HVAC GROUND FLOOR 1966-1967 NORTH WING
H6.00	HVAC PART PLAN
H7.00	HVAC SCHEDULES

PROGRESS
10-16-17

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RDK Engineers
200 Brickstone Square
Andover, MA 01810-1488

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REVISIONS

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	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

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WW

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N/A

COVER SHEET

C0.00

G:\2017\20170393 - Wellesley Middle School Heating System\CAD\Drawings\C04 HVAC\Dwg Files\20170393 C0.00 COVER SHEET.dwg [Rev-2] October 16, 2017 - 10:00am cclark

RDK

ABBREVIATIONS

GENERAL

A	COMPRESSED AIR
AD	ACCESS DOOR
AF	AIR FOIL
AFF	ABOVE FINISHED FLOOR
AMP	AMPERE
AP	ACCESS PANEL
APD	AIR PRESSURE DROP
ARCH	ARCHITECT
AS	AIR STREAM
ATC	AUTOMATIC TEMPERATURE CONTROL
ATM	ATMOSPHERE
AVE	AVERAGE
BI	BACKWARDS INCLINED
BLDG	BUILDING
BSMT	BASEMENT
BTU	BRITISH THERMAL UNIT
BTUH	BTU PER HOUR
C TO C	CENTER TO CENTER
CENT	CENTRIFUGAL
CF	CUBIC FEET
CFM	CUBIC FEET PER MINUTE
CL	CENTERLINE
CLG	CEILING OR COOLING
CO	CARBON MONOXIDE
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CONTR	CONTRACTOR
D	DRAIN OR DEPTH
DEG	DEGREE
DDC	DIRECT DIGITAL CONTROL
DIA	DIAMETER
DIM	DIMENSION
DN	DOWN
DP	DIFFERENTIAL PRESSURE
EA	EACH OR EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE
EFF	EFFICIENCY
ELEC	ELECTRICAL
ELEV	ELEVATION
EMER	EMERGENCY
EMS	ENERGY MANAGEMENT SYSTEM
ENT	ENTER
ESP	EXTERNAL STATIC PRESSURE
EWT	ENTERING WATER TEMPERATURE
EXH	EXHAUST
EXIST.	EXISTING
EXT	EXTERNAL
EXP	EXPANSION
F	FAHRENHEIT
FA	FREE AREA
FC	FLEXIBLE CONNECTION
FLEX	FLEXIBLE
FLRDR	FLOOR DRAIN
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
FRP	FIBERGLASS REINFORCED PLASTIC
FS	FLOW SWITCH
FT	FEET
G	GAS
GA	GAUGE
GAL	GALLONS
GC	GENERAL CONTRACTOR
GFU	GLYCOL FEED UNIT
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GRD	GRADE
HB	HOSE BIBB CONN.
HD	HEAD
HGT	HEIGHT
HP	HORSEPOWER OR HIGH POINT
HR	HOUR
HTG	HEATING
ID	INSIDE DIAMETER
IN	INCHES
KW	KILOWATT
L	LENGTH
LB	POUND
LF	LINEAR FEET
LP	LOW POINT
LRA	LOCKED ROTOR AMPS
LUVR	LOUVER
LVDR	LOUVERED DOOR
LWT	LEAVING WATER TEMPERATURE
MAX	MAXIMUM
MBH	THOUSAND BTUH
MECH	MECHANICAL
MEZZ	MEZZANINE
MFR	MANUFACTURER
MIN	MINIMUM
MU	MAKE-UP WATER
N/A	NOT APPLICABLE
NIC	NOT IN CONTRACT
No.	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
ODP	OPEN DRIP PROOF
OV	OUTLET VELOCITY
PD	PRESSURE DROP
PH	PHASE
PBG	PLUMBING
POS	PROVIDED BY OTHER SECTION
PPM	PARTS PER MILLION
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSID	POUNDS PER SQUARE INCH DIFFERENTIAL
PSIG	POUNDS PER SQUARE INCH GAUGE
PVC	POLYVINYL CHLORIDE
QTY	QUANTITY
R	RADIUS
RA	RETURN AIR
RET	RETURN
RH	RELATIVE HUMIDITY
RLF	RELIEF
RM	ROOM
RPM	REVOLUTIONS PER MINUTE
SCH	SCHEDULE
SCR	SCREEN
SCT	SATURATED CONDENSING TEMPERATURE
SDET	SMOKE DETECTOR
SEN	SENSIBLE
SHC	SENSIBLE HEAT CAPACITY
SP	STATIC PRESSURE
SPECS	SPECIFICATIONS
SQ	SQUARE
SF	SQUARE FEET
SS	STAINLESS STEEL
STL	STEEL
SUP	SUPPLY
TEMP	TEMPERATURE
T	TEMPERATURE
TSTAT	THERMOSTAT
TON	12,000 BTUH COOLING CAPACITY
TOT	TOTAL
TYP	TYPICAL
	VOLTS (ELECTRICAL)
W	WIDTH OR WATT
W/	WITH
WB	WET BULB TEMPERATURE
WC	WATER COLUMN
WG	WATER GAUGE
W/O	WITHOUT
WPD	WATER PRESSURE DROP
WTD	WATER TEMPERATURE DIFFERENCE
XM	EXISTING EQUIPMENT TO BE REMOVED EXISTING EQUIPMENT TO REMAIN
XN	NEW LOCATION OF RELOCATED EQUIPMENT
XR	EXISTING EQUIPMENT TO BE RELOCATED

BOILER

B	BOILER
BBD	BOILER BLOWDOWN
BDT	BLOWDOWN TANK
BFU	BOILER FEED UNIT
BFP	BOILER FEED PUMP

EQUIPMENT

CDP	CONDENSATE DRAIN PUMP
CSF	CHEMICAL SHOT FEEDER
CUH	CABINET UNIT HEATER
DC	DRY COOLER
DDC	DIRECT DIGITAL CONTROL
DDCFP	DIRECT DIGITAL CONTROL FIELD PANEL
DH	DEHUMIDIFIER
DU	DEAERATOR UNIT
DWDI	DOUBLE WIDTH DOUBLE INLET
DX	DIRECT EXPANSION
ECH	ELECTRIC CABINET HEATER
EHC	ELECTRICAL HEATING COIL
ET	EXPANSION TANK
EUH	ELECTRIC UNIT HEATER
F	FAN
FTR	FINNED TUBE RADIATION
GRV	GRAVITY RELIEF VENT
H	HUMIDIFIER
HC	HEATING COIL
HP	HEAT PUMP
HRU	HEAT RECOVERY UNIT
HWC	HOT WATER HEATING COIL
HV	HEATING & VENTILATING UNIT
HX	HEAT EXCHANGER
P	PUMP
PHC	PREHEAT COIL
PHX	PLATE HEAT EXCHANGER
PRV	PRESSURE REDUCING VALVE
RHC	REHEAT COIL

FUEL OIL

FOG	FUEL OIL GAUGE
FOP	FUEL OIL PUMP
FOR	FUEL OIL RETURN
FOS	FUEL OIL SUPPLY
FOV	FUEL OIL VENT

GLYCOL WATER

GMU	GLYCOL MAKE-UP
GR	GLYCOL RETURN
GS	GLYCOL SUPPLY

HOT WATER

HCR	HOT/CHILLED WATER RETURN
HCS	HOT/CHILLED WATER SUPPLY
HHWR	HIGH TEMPERATURE HOT WATER RETURN
HHWS	HIGH TEMPERATURE HOT WATER SUPPLY
HW	HOT WATER
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
UH	HOT WATER UNIT HEATER

PIPING

AAV	AUTOMATIC AIR VENT
ACV	AUTOMATIC CONTROL VALVE
AS	AIR SEPARATOR
ATV	ATMOSPHERIC VENT
BOP	BOTTOM OF PIPE
CO	CLEAN-OUT
DOV	DRAIN-OFF VALVE
FOB	FLAT ON BOTTOM REDUCER
FOT	FLAT ON TOP REDUCER
FCV	FLOW CONTROL VALVE
MAV	MANUAL AIR VENT
MU	MAKE-UP WATER
TOP	TOP OF PIPE
V	VENT

STEAM

CP	CONDENSATE PUMP
C(X)	STEAM CONDENSATE (X=PSIG)
S(X)	STEAM (X=PSIG)
PC	PUMPED CONDENSATE
ST	STEAM TRAP
STM	STEAM
TAV	THERMOTSTATIC AIR VENT
VB	VACUUM BREAKER

PIPING LEGEND

- GATE VALVE (OUTSIDE SCREW & YOKE UNLESS SPECIFIED OTHERWISE)
- GLOBE VALVE (OUTSIDE SCREW & YOKE UNLESS SPECIFIED OTHERWISE)
- BALL VALVE
- BUTTERFLY VALVE
- HOSE END BALL VALVE WITH CAP AND CHAIN
- PLUG VALVE
- PRESSURE REDUCING VALVE
- ANGLE VALVE (SECTION VIEW)
- ANGLE VALVE (PLAN VIEW)
- GLOBE ANGLE VALVE
- CHECK VALVE (SILENT CHECK TYPE ON PUMP DISCHARGE)
- STRAINER WITH HOSE END BLOWOFF VALVE, CAP AND CHAIN
- SCR — SUCTION DIFFUSER/STRAINER (NON-REDUCING) WITH BLOWOFF
- STRAINER, BASKET TYPE WITH DRAIN VALVE, HOSE BIBB & CAP
- STRAINER, DUPLEX BASKET
- SOLENOID VALVE
- 2-WAY MODULATING PRESSURE INDEPENDENT ACV
- 2-WAY AUTOMATIC CONTROL VALVE (MODULATING)
- 2-WAY AUTOMATIC CONTROL VALVE (TWO POSITION)
- 3-WAY AUTOMATIC CONTROL VALVE (MODULATING)
- 3-WAY AUTOMATIC CONTROL VALVE (TWO POSITION)
- AUTOMATIC FLOW LIMITING VALVE (PRESSURE INDEPENDENT)
- COMBINATION FLOW METER/SHUT-OFF/BALANCING VALVE (CIRCUIT SETTER)
- TRIPLE DUTY PUMP VALVE, CHECK, BALANCING (FLOW METER), SHUT-OFF
- BTU — BTU METER (HOT TAP TYPE WITH VALVE)
- FMT — FLOW METER/TRANSMITTER (HOT TAP TYPE WITH VALVE)
- VENTURI FLOW METER
- ORIFICE FLOW METER
- FS — FLOW SWITCH
- RELIEF/SAFETY VALVE
- THERMOSTATIC RADIATOR VALVE
- UNION
- BLIND FLANGE
- PIPE - CAPPED
- PRESSURE GAUGE (W/ BALL VALVE(S), SNUBBER, AND FOR STEAM, SIPHON)
- PS — PRESSURE SWITCH
- THERMOMETER
- STEAM TRAP (INDICATE TYPE)
- F&T — FLOAT & THERMOSTATIC STEAM TRAP
- IB — INVERTED BUCKET STEAM TRAP
- T — THERMOSTATIC STEAM TRAP
- TD — THERMODYNAMIC STEAM TRAP
- VB — VACUUM BREAKER
- PT — PRESSURE/THERMOMETER WELL
- AV — AIR VENT - AUTOMATIC
- MV — AIR VENT - MANUAL
- TAV — THERMOSTATIC AIR VENT (STEAM ONLY)
- DIRECTION OF FLOW
- EXPANSION LOOP
- EJ — EXPANSION JOINT
- FLEXIBLE CONNECTOR
- PIPE ANCHOR
- PIPE GUIDE
- PIPE CONNECTION - TOP
- PIPE CONNECTION - BOTTOM
- PIPE - DOWN
- PIPE - UP
- R — PITCH OF PIPE - (R) RISE OR (D) DROP
- REDUCER - CONCENTRIC
- REDUCER - ECCENTRIC
- QUICK CLOSING VALVE, FUSIBLE LINK (USED WITH FUELS)
- CO — CLEANOUT FOR CONDENSATE DRAIN
- DIRT LEG
- RISE (DOUBLE LINE - PLAN VIEW)
- DROP (DOUBLE LINE - PLAN VIEW)
- PIPE BREAK (DOUBLE LINE)
- PIPE BREAK (SINGLE LINE)

DIAGRAM EQUIPMENT SYMBOLS

- HUMIDIFIER (H)
- FILTER BANK
- HEATING COIL (H, C)
- HEAT RECOVERY COIL (HR, C)
- PREHEAT COIL (PH, C)
- REHEAT COIL
- CABINET HEATER
- UNIT HEATER
- S/S, ALM, VFD, VFDS, VFDSG — VARIABLE FREQUENCY DRIVE
- AV — AIR SEPARATOR
- BOILER
- BLOW DOWN SEPARATOR
- CONDENSATE PUMP
- EXPANSION TANK
- FLASH TANK
- PUMP
- BACKDRAFT DAMPER
- 2-WAY AUTOMATIC CONTROL VALVE (MODULATING)
- 2-WAY AUTOMATIC CONTROL VALVE (TWO POSITION)
- 3-WAY AUTOMATIC CONTROL VALVE (MODULATING)
- 3-WAY AUTOMATIC CONTROL VALVE (TWO POSITION)
- FINNED TUBE RADIATION
- AIR VALVE
- AIR TERMINAL BOX
- AIR TERMINAL BOX W/ REHEAT COIL
- FAN POWERED AIR TERMINAL BOX
- FAN POWERED AIR TERMINAL BOX W/ REHEAT COIL
- SHELL AND TUBE HEAT EXCHANGER
- PLATE AND FRAME HEAT EXCHANGER
- CHEMICAL FEED SYSTEM

PIPING ABBREVIATIONS

A	COMPRESSED AIR
ATV	ATMOSPHERIC VENT
BBD	BOILER BLOWDOWN
BF	BOILER FEED WATER
CHEM	CHEMICAL FEED
C(X)	STEAM CONDENSATE (X=PSIG)
CWR	CONDENSER WATER RETURN
CWS	CONDENSER WATER SUPPLY
D	DRAIN
FOG	FUEL OIL GAUGE
FOR	FUEL OIL RETURN
FOS	FUEL OIL SUPPLY
FOV	FUEL OIL TANK VENT
GMU	GLYCOL MAKE-UP
GR	GLYCOL RETURN
GS	GLYCOL SUPPLY
HPWR	HEAT PUMP WATER RETURN
HPWS	HEAT PUMP WATER SUPPLY
HTWR	HIGH TEMPERATURE HOT WATER RETURN
HTWS	HIGH TEMPERATURE HOT WATER SUPPLY
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
MU	MAKE-UP WATER
PC	PUMPED CONDENSATE
S(X)	STEAM (X=PSIG)
V	VENT
(NAME)	REMOVE EXISTING PIPING

CONTROL POINT DESCRIPTOR LEGEND

TAG	ATC CONTRACTOR PROVIDED DDC POINT AND HARDWARE
TAG / ELEC PLBG	CONTROL DEVICE FURNISHED BY ELECTRICAL OR PLUMBING CONTRACTOR BUT INTERFACED TO DDC SYSTEM BY ATC CONTRACTOR
TAG	ATC CONTRACTOR INTERFACE TO EQUIPMENT MANUFACTURER'S HARDWARE
TAG	ATC CONTRACTOR PROVIDED LOCAL CONTROL POINT

CONTROL ABBREVIATIONS

ACV	AUTOMATIC CONTROL VALVE
ALM	ALARM
ATC	AUTOMATIC TEMPERATURE CONTROL
BCV	BASEBOARD CONTROL VALVE
BV	BYPASS VALVE
C	CARBON DIOXIDE SENSOR
CAP	CAPACITY CONTROL
%CAP	PERCENT OF FULL LOAD CAPACITY
CO	CARBON MONOXIDE SENSOR
CRT	CONDENSER WATER RETURN TEMPERATURE SENSOR
CST	CONDENSER WATER SUPPLY TEMPERATURE SENSOR
DDC	DIRECT DIGITAL CONTROL
DDCFP	DIRECT DIGITAL CONTROL FIELD PANEL
DL	DEMAND LIMIT
DPS	DIFFERENTIAL PRESSURE SWITCH
DPT	DIFFERENTIAL PRESSURE SENSOR/TRANSMITTER
DPV	DIFFERENTIAL PRESSURE BYPASS VALVE
DSP	DISCHARGE STATIC PRESSURE SENSOR
ES	END SWITCH
FMT	FLOW METER/TRANSMITTER
FS	FLOW SWITCH
H	HUMIDITY SENSOR
HOA	HANDS-OFF AUTOMATIC SWITCH
HRET	HEAT RECOVERY COIL ENTERING AIR TEMPERATURE SENSOR
HRLT	HEAT RECOVERY COIL LEAVING AIR TEMPERATURE SENSOR
HRT	HEAT RECOVERY LOOP TEMPERATURE SENSOR
HRCV	HEAT RECOVERY COIL CONTROL VALVE
HRV	HEAT RECOVERY LOOP CONTROL VALVE
HS	HAND SWITCH
HSPS	HIGH STATIC PRESSURE SWITCH
HSS	HOOD SASH SWITCH
HUV	HUMIDIFIER CONTROL VALVE
HV	HEATING COIL CONTROL VALVE
HWRT	HOT WATER RETURN TEMPERATURE SENSOR
HWST	HOT WATER SUPPLY TEMPERATURE SENSOR
LS	LEVEL SENSOR OR LIGHT SWITCH INTERFACE
LSHA	LEVEL SENSOR HIGH ALARM
LSHS	LEVEL SENSOR HIGH SWITCH
LSLA	LEVEL SENSOR LOW ALARM
LSLS	LEVEL SENSOR LOW SWITCH
MUWV	MAKE-UP WATER VALVE
PR	PRESSURE SENSOR (ROOM)
RV	REHEAT CONTROL VALVE
S	SWITCH
SCLAT	STEAM COIL LEAVING AIR TEMPERATURE SENSOR
SCV	STEAM COIL VALVE
SP	STATIC PRESSURE SENSOR
T	TEMPERATURE SENSOR/THERMOSTAT
TR	TEMPERATURE SENSOR/THERMOSTAT (ROOM)
WC	WATER COLUMN
X	REMOVE EXISTING ITEM

CALLOUT SYMBOLS

- CONNECT NEW TO EXISTING
- LIMIT OF DEMOLITION
- A / H2.0 — SECTION DESIGNATION / SHEET NUMBER
- 1 — REVISION NUMBER
- T — TEMPERATURE SENSOR OR THERMOSTAT
- H — HUMIDITY SENSOR OR HUMIDISTAT
- REMOVE EXISTING ITEM
- SA(100) — S = SUPPLY A = SCHEDULED DIFFUSER. (100) = CFM TO BALANCE TO
- RA(100) — R = RETURN A = SCHEDULED GRILLE. (100) = CFM TO BALANCED TO
- EA(100) — E = EXHAUST A = SCHEDULED REGISTER/GRILLE (100) = CFM TO BALANCED TO
- TA(100) — T = TRANSFER A = SCHEDULED REGISTER/GRILLE (100) = CFM TO BALANCED TO

EQUIPMENT REQUIRING ELECTRICAL SERVICE,
SEE SCHEDULE FOR PERFORMANCE REQUIREMENTS:

TAG 3.1 (XXX, XXX, XXX)

- SCHEDULED EQUIPMENT UNIT NUMBER
- FIRST DIGIT(S) = LEVEL WHERE UNIT IS LOCATED:
  - SB = SUB-BASEMENT
  - B = BASEMENT
  - LL = LOWER LEVEL
  - G = GROUND FLOOR
  - 1 = FIRST FLOOR
  - 2 = SECOND FLOOR
  - 3 = THIRD FLOOR, ETC
  - M = MEZZANINE
  - A = ATTIC
  - PH = PENTHOUSE
  - R = ROOF
  - SECOND DIGIT(S):
    - 1 = FIRST UNIT OF THIS EQUIPMENT TYPE ON THIS LEVEL.
    - 2 = SECOND UNIT OF THIS EQUIPMENT TYPE ON THIS LEVEL.
    - 3 = THIRD UNIT OF THIS EQUIPMENT TYPE ON THIS LEVEL, ETC.
    - (DUE TO EDITING NOT ALL NUMBERS MAY BE USED)
- UNIT CAPACITY INFORMATION (IF APPLICABLE-DATA VARIES DEPENDING ON TYPE OF EQUIPMENT)
  - i.e. FOR FAN POWERED VAV BOXES:
    - FIRST NUMBER = MAX. CFM
    - SECOND NUMBER = MIN. CFM OR PERCENT OF MAX. CFM
    - THIRD NUMBER = COIL GPM OR KW

EQUIPMENT NOT REQUIRING ELECTRICAL SERVICE,
SEE SCHEDULE FOR PERFORMANCE REQUIREMENTS:

TAG 3.1 (XXX, XXX, XXX) — REFER TO EQUIPMENT REQUIRING ELECTRICAL SERVICE SYMBOL ABOVE FOR TAG AND DATA INFORMATION.

PROGRESS
10-16-17

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Durham, NC - Charlotte, NC

RDK Engineers
200 Brickstone Square
Andover, MA 01810-1488

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▲	DATE	CHK	DESCRIPTION
	10/16/2017	DW	REVISION 6

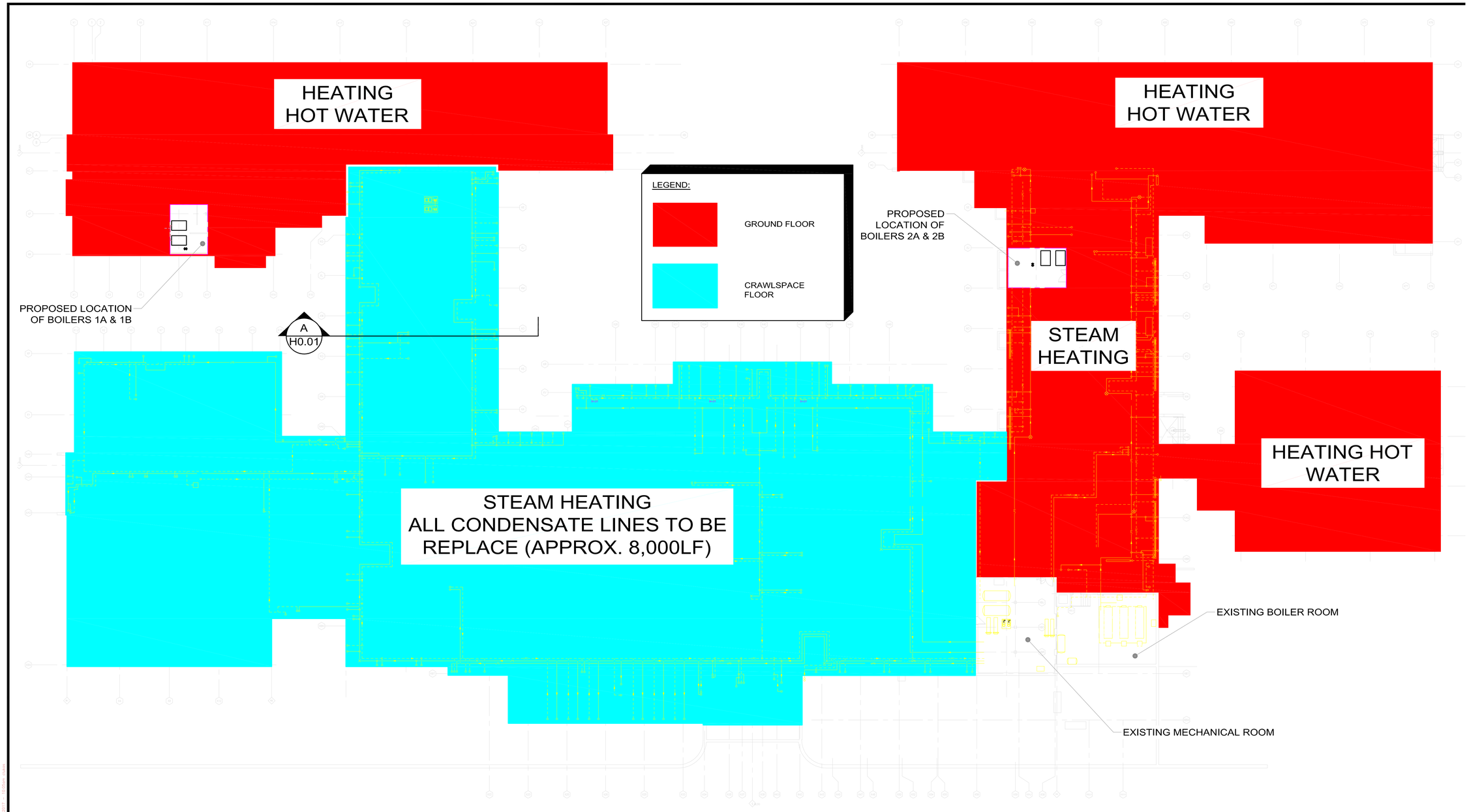
SEAL

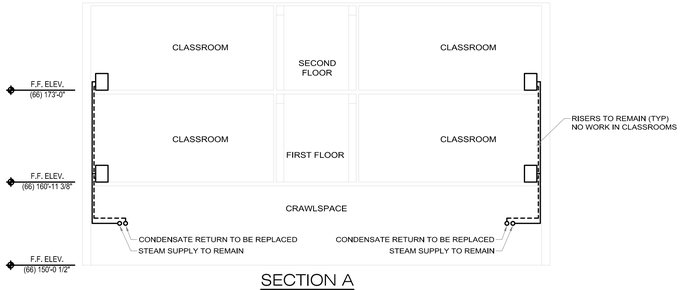
PROJECT
NUMBER 20170393
DATE 10/16/2017

DRAWING
DRAWN BY CSL
CHECKED BY WW
SCALE N/A

HVAC
LEGENDS, NOTES & ABBREVIATIONS

H0.00





SECTION A
SCALE: 1/8"=1'-0"

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Andover, MA - Boston, MA - Amherst, MA
Durham, NC - Charlotte, NC

RDK Engineers
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Andover, MA 01810-1488

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DATE	CHK	DESCRIPTION
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SEAL

PROJECT
NUMBER
20170393
DATE
10/16/2017

DRAWING
DRAWN BY
CSL
CHECKED BY
WW
SCALE
1/16" = 1'-0"

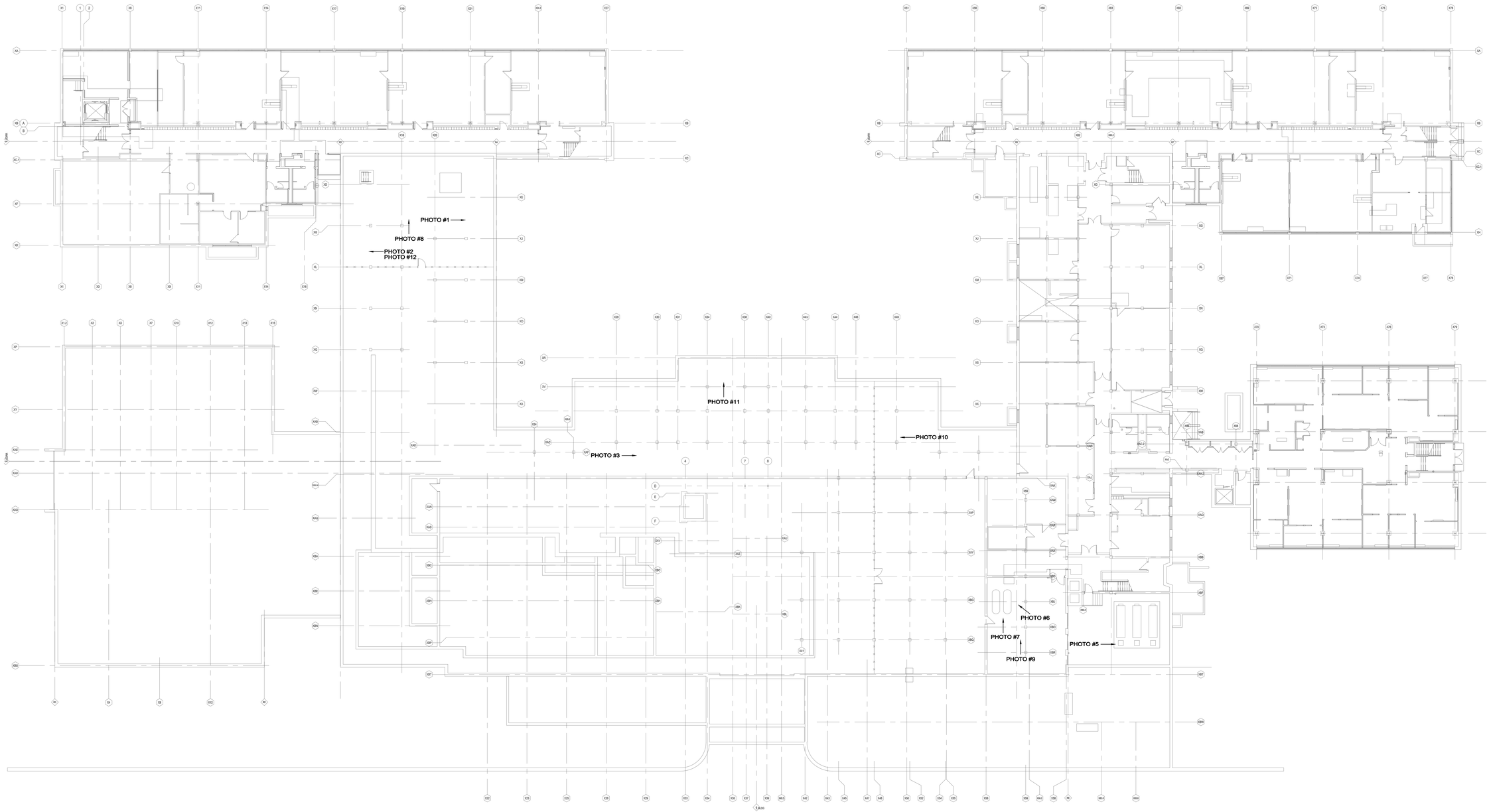
HVAC
OVERALL BUILDING
LEGEND

PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H0.01

RDK



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Andover, MA - Boston, MA - Amherst, MA

Durham, NC - Charlotte, NC

RDK Engineers
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Andover, MA 01810-1488

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WW

SCALE
1/16" = 1'-0"

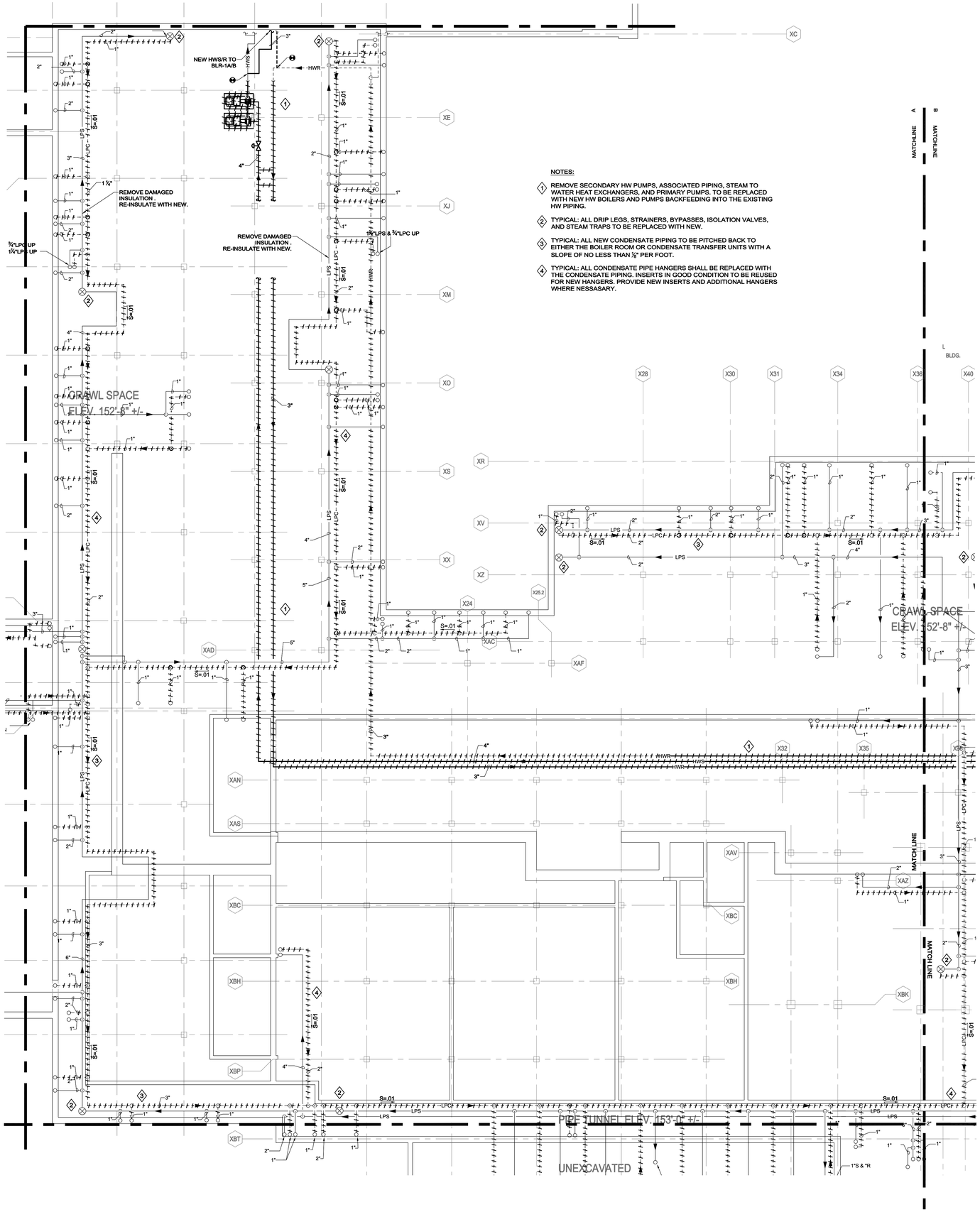
HVAC
PHOTO LEGEND

PROGRESS
10-16-17

1/16" = 1' - 0"
0 16' 32'

H0.02

G:\2017\2017393 - Berkeley Middle School Heating System\CAD Drawings\04 HVAC\Dwl Files\2017393 H0.02 PHOTO LEGEND.dwg [Plan] October 16, 2017 - 10:00am cslack



NOTES:

1. REMOVE SECONDARY HW PUMPS, ASSOCIATED PIPING, STEAM TO WATER HEAT EXCHANGERS, AND PRIMARY PUMPS. TO BE REPLACED WITH NEW HW BOILERS AND PUMPS BACKFEEDING INTO THE EXISTING HW PIPING.
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3. TYPICAL: ALL NEW CONDENSATE PIPING TO BE PITCHED BACK TO EITHER THE BOILER ROOM OR CONDENSATE TRANSFER UNITS WITH A SLOPE OF NO LESS THAN ⅛" PER FOOT.
4. TYPICAL: ALL CONDENSATE PIPE HANGERS SHALL BE REPLACED WITH THE CONDENSATE PIPING. INSERTS IN GOOD CONDITION TO BE REUSED FOR NEW HANGERS. PROVIDE NEW INSERTS AND ADDITIONAL HANGERS WHERE NESSASARY.

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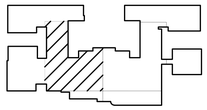

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REVISIONS

▲	DATE	CHK	DESCRIPTION
	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

DRAWN BY
CSL

CHECKED BY
WW

SCALE
1/8" = 1'-0"

HVAC CRAWLSPACE
1952 ORIGINAL
BUILDING

PROGRESS
10-16-17

1/8" = 1' - 0" 0 8" 16"

H2.01

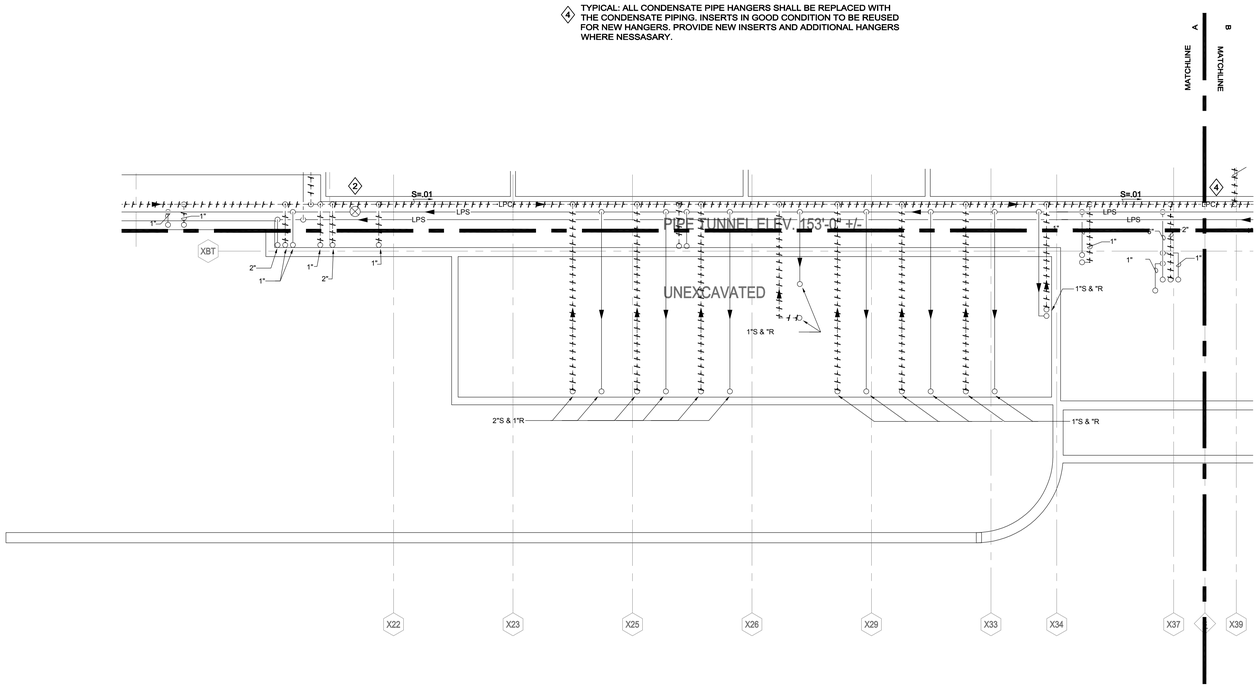
Q:\2017\20170393 - Brentwy Middle School Heating System\H2\H2 HVAC\Dwg Files\20170393 H2.01 HVAC CRAWLSPACE 1952 ORIGINAL BLDG.dwg [Tab=2] October 16, 2017 - 10:07am - csl

RDK

NOTES:

2 TYPICAL: ALL DRIP LEGS, STRAINERS, BYPASSES, ISOLATION VALVES, AND STEAM TRAPS TO BE REPLACED WITH NEW.

4 TYPICAL: ALL CONDENSATE PIPE HANGERS SHALL BE REPLACED WITH THE CONDENSATE PIPING. INSERTS IN GOOD CONDITION TO BE REUSED FOR NEW HANGERS. PROVIDE NEW INSERTS AND ADDITIONAL HANGERS WHERE NESSASARY.



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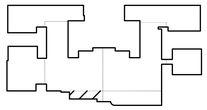

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REVISIONS

▲	DATE	CHK	DESCRIPTION
	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

DRAWN BY
CSL

CHECKED BY
WW

SCALE
1/8" = 1'-0"

HVAC CRAWLSPACE
1966-1967 ADDITIONS

PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H2.02

G:\2017\20170393 - Wellesley Middle School Heating System\500 Drawings\504 HVAC\Rev Dwg\20170393 H2.02 HVAC Crawlspace 1966-1967 ADDITIONS.dwg [Rev 6] October 16, 2017 - 10:00am cclem

RDK

NOTES:

1. REMOVE SECONDARY HW PUMPS, ASSOCIATED PIPING, STEAM TO WATER HEAT EXCHANGERS, AND PRIMARY PUMPS. TO BE REPLACED WITH NEW HW BOILERS AND PUMPS BACKFEEDING INTO THE EXISTING HW PIPING.
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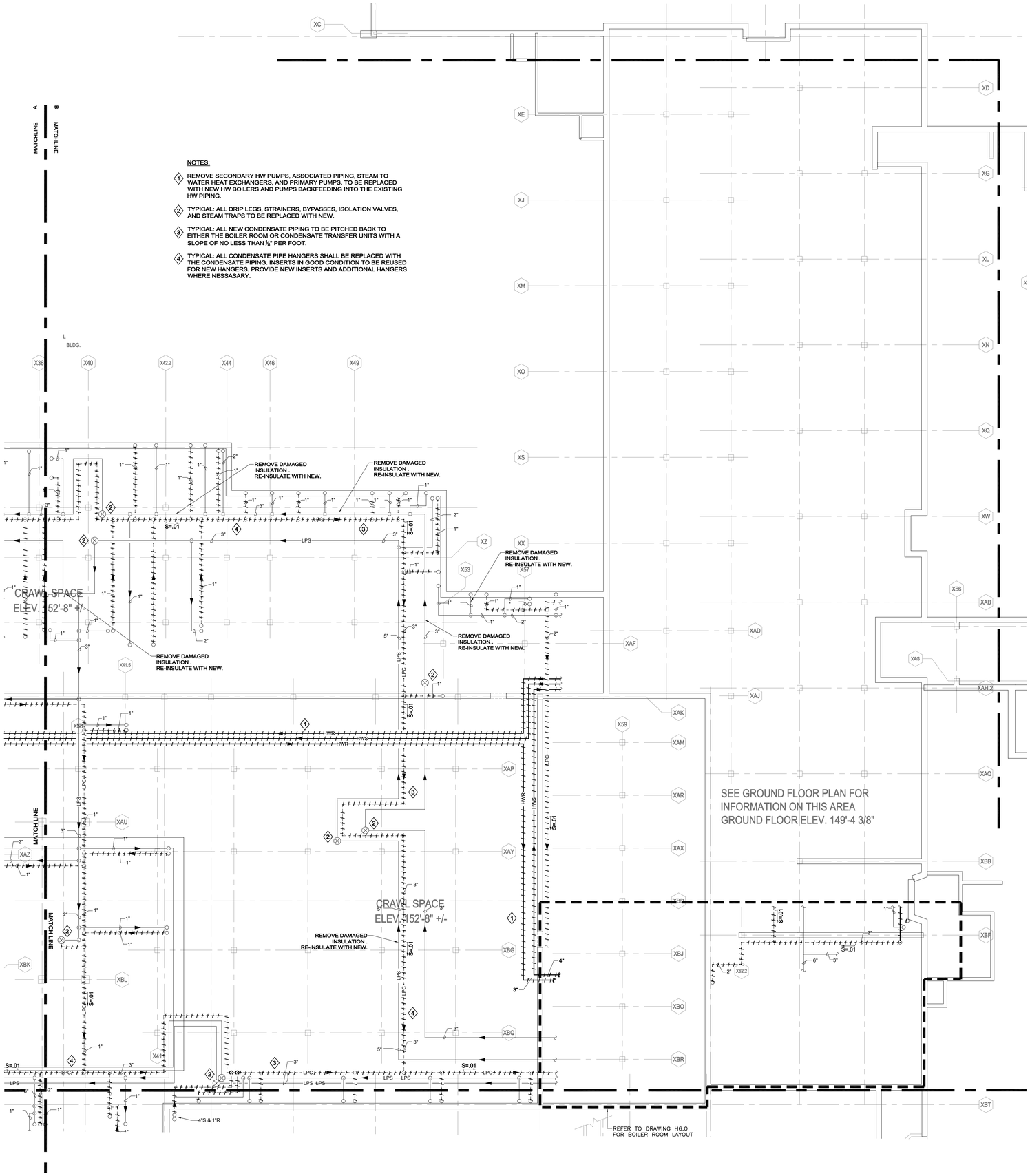

PROGRESS
10-16-17

1/8" = 1' - 0" 0 8' 16'

H2.03

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	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
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DATE
10/16/2017

DRAWING

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CSL

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WW

SCALE
1/8" = 1'-0"

HVAC CRAWLSPACE
1952 ORIGINAL
BUILDING

NOTES:

2. TYPICAL: ALL DRIP LEGS, STRAINERS, BYPASSES, ISOLATION VALVES, AND STEAM TRAPS TO BE REPLACED WITH NEW.

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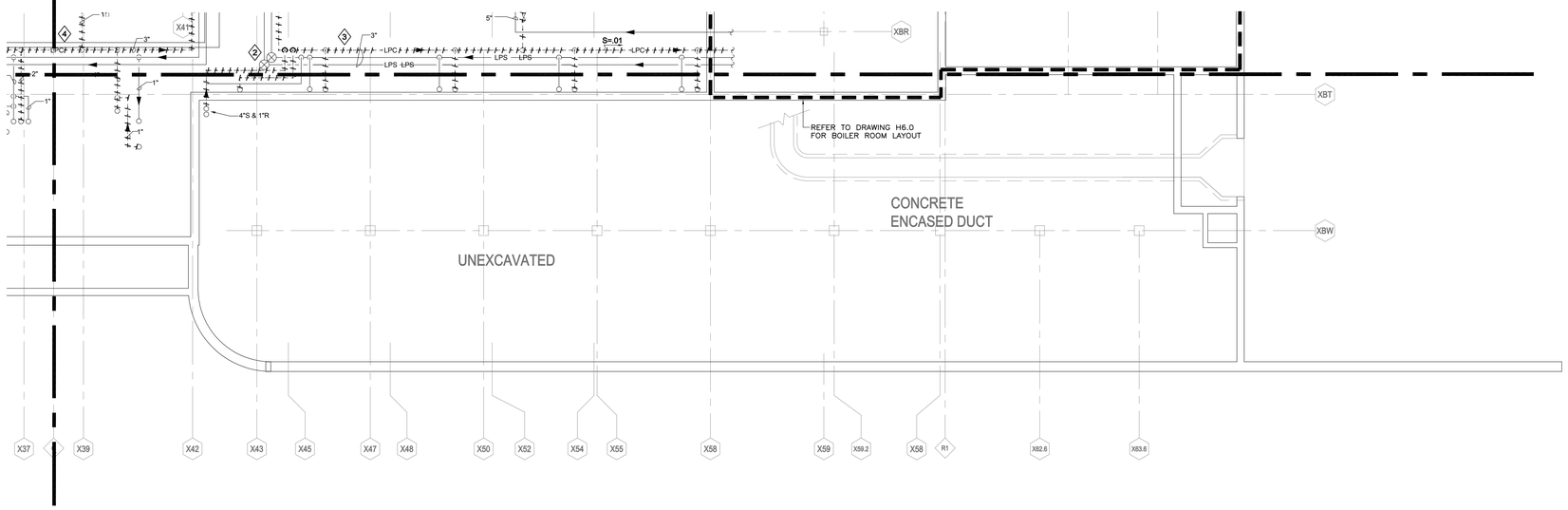

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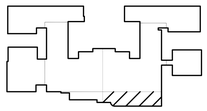

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	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

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WW

SCALE
1/8" = 1'-0"

HVAC CRAWLSPACE
1966-1967 ADDITIONS

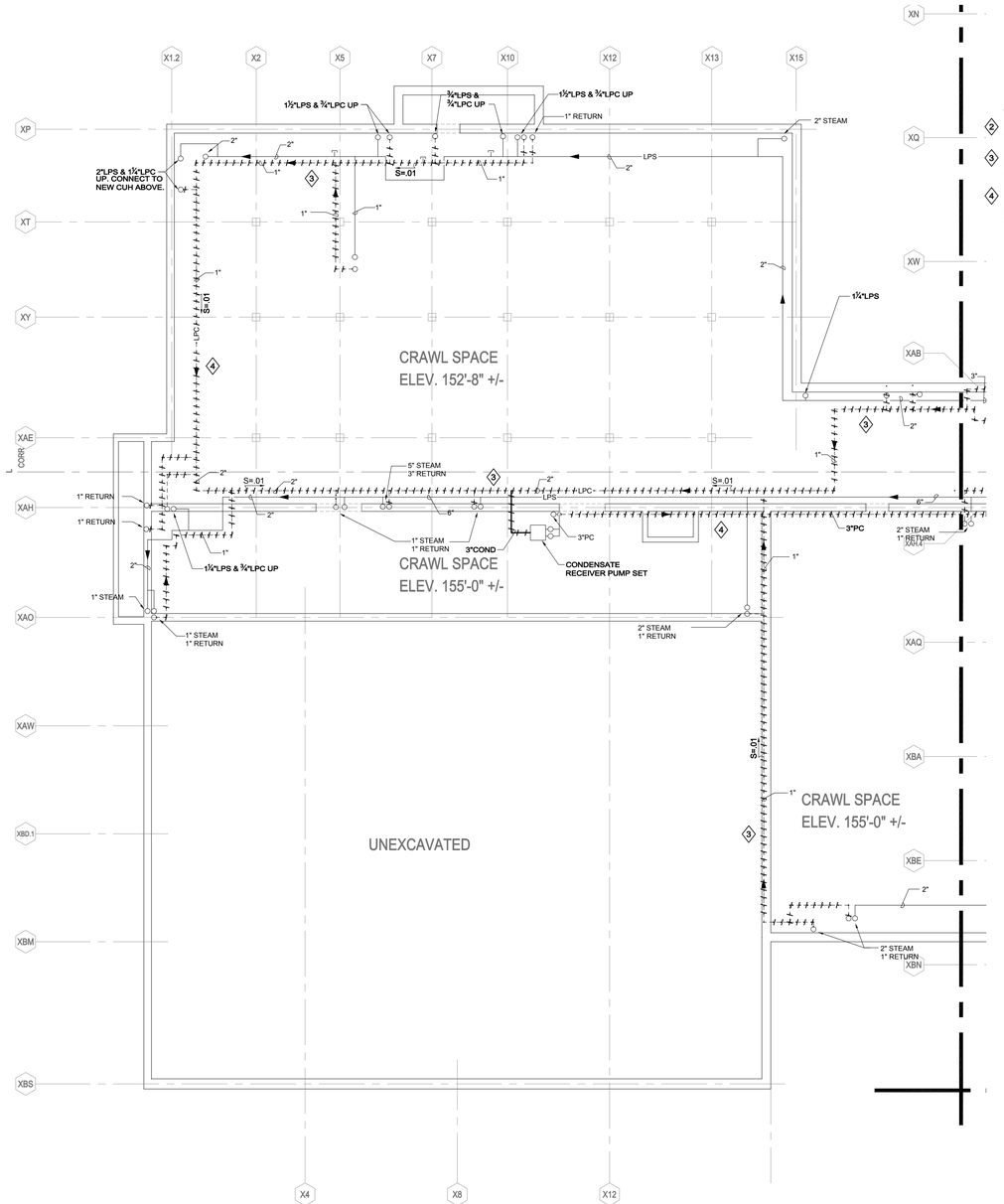
PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H2.04

G:\2017\20170393 - Wellesley Middle School Heating System\500 Drawings\504 HVAC\Dwg Files\20170393-H2.04 HVAC Crawlspace 1966-1967 20170905.dwg [Plan1] October 16, 2017 10:07am cslee

RDK



NOTES:

2. TYPICAL: ALL DRIP LEGS, STRAINERS, BYPASSES, ISOLATION VALVES, AND STEAM TRAPS TO BE REPLACED WITH NEW.
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PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H2.05

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	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

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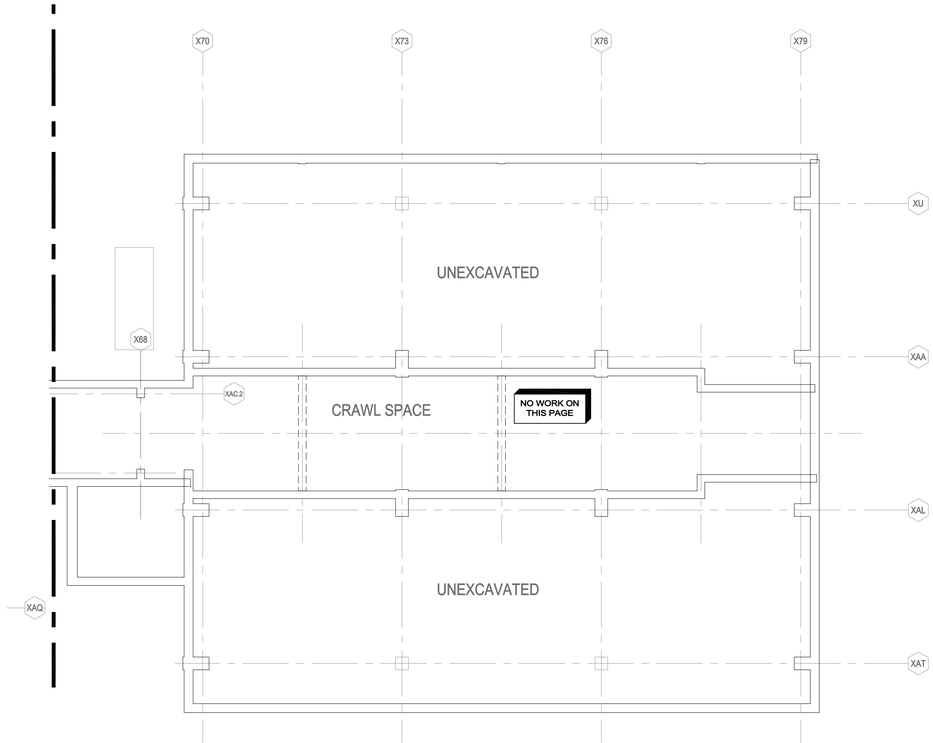
WW

SCALE
1/8" = 1'-0"

HVAC CRAWLSPACE
1958-1959
NORTH ADDITION

J:\2017\20170393 - Bellevue Middle School Heating System\CAD Drawings\H2 HVAC Plan Files\20170393 H2.05 HVAC CRAWLSPACE 1958-1959 NORTH ADDITION.dwg [Rev-1] October 16, 2017 - 10:01am cdale

RDK



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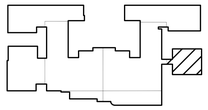

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REVISIONS

▲	DATE	CHK	DESCRIPTION
	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

DRAWN BY
CSL

CHECKED BY
WW

SCALE
1/8" = 1'-0"

HVAC CRAWLSPACE
1959-1958
SOUTH ADDITION

PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H2.06

Q:\2017\20170393 - Bentley Maria School Heating System\050 Design\054 HVAC\Dwg Files\20170393 H2.06 HVAC CRAWLSPACE 1958-1959 SOUTH ADDITION.dwg Thu, October 19, 2017 - 10:01am dallen

RDK

NOTES:

1. REMOVE SECONDARY HW PUMPS, ASSOCIATED PIPING, STEAM TO WATER HEAT EXCHANGERS, AND PRIMARY PUMPS. TO BE REPLACED WITH NEW HW BOILERS AND PUMPS BACKFEEDING INTO THE EXISTING HW PIPING.
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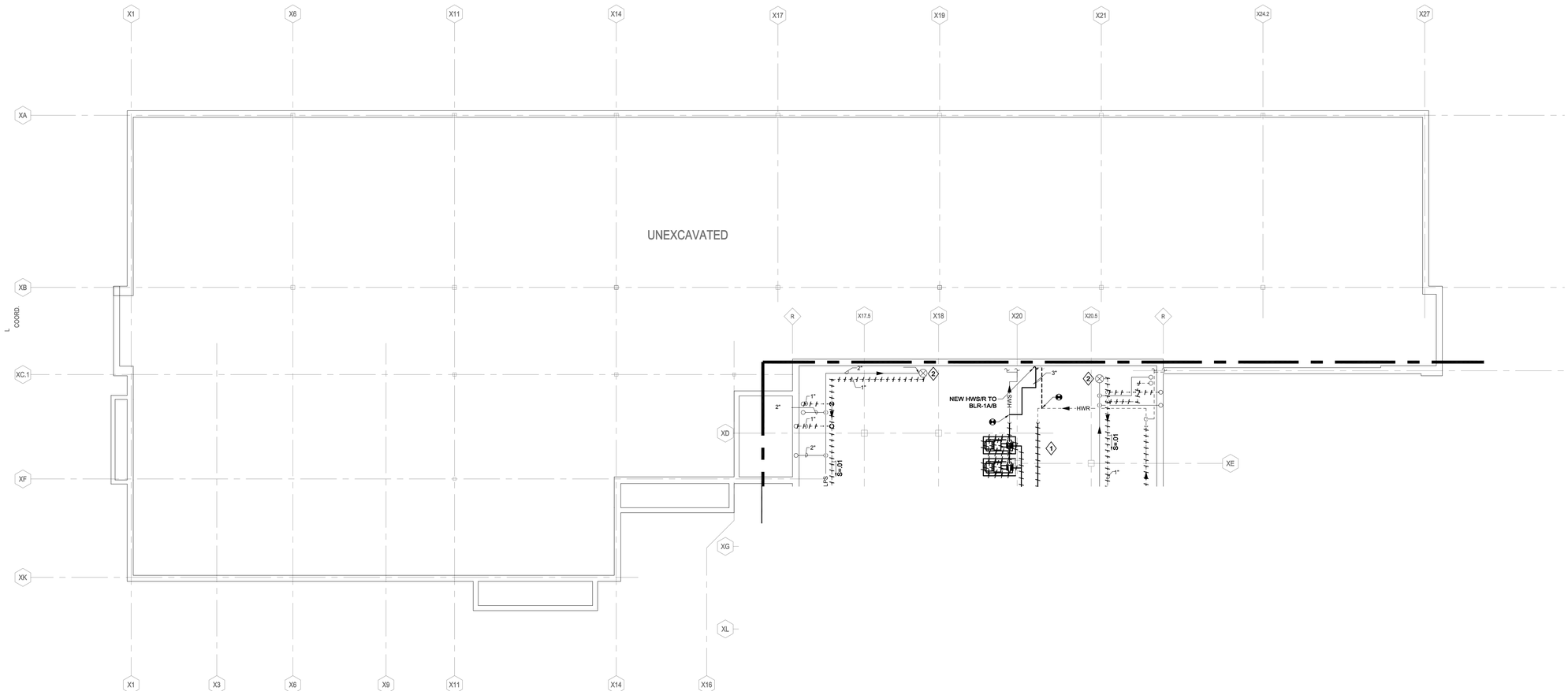

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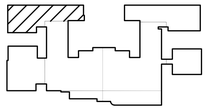

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REVISIONS

▲	DATE	CHK	DESCRIPTION
	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

DRAWN BY
CSL

CHECKED BY
WW

SCALE
1/8" = 1'-0"

HVAC CRAWLSPACE
1966-1967 NORTH WING

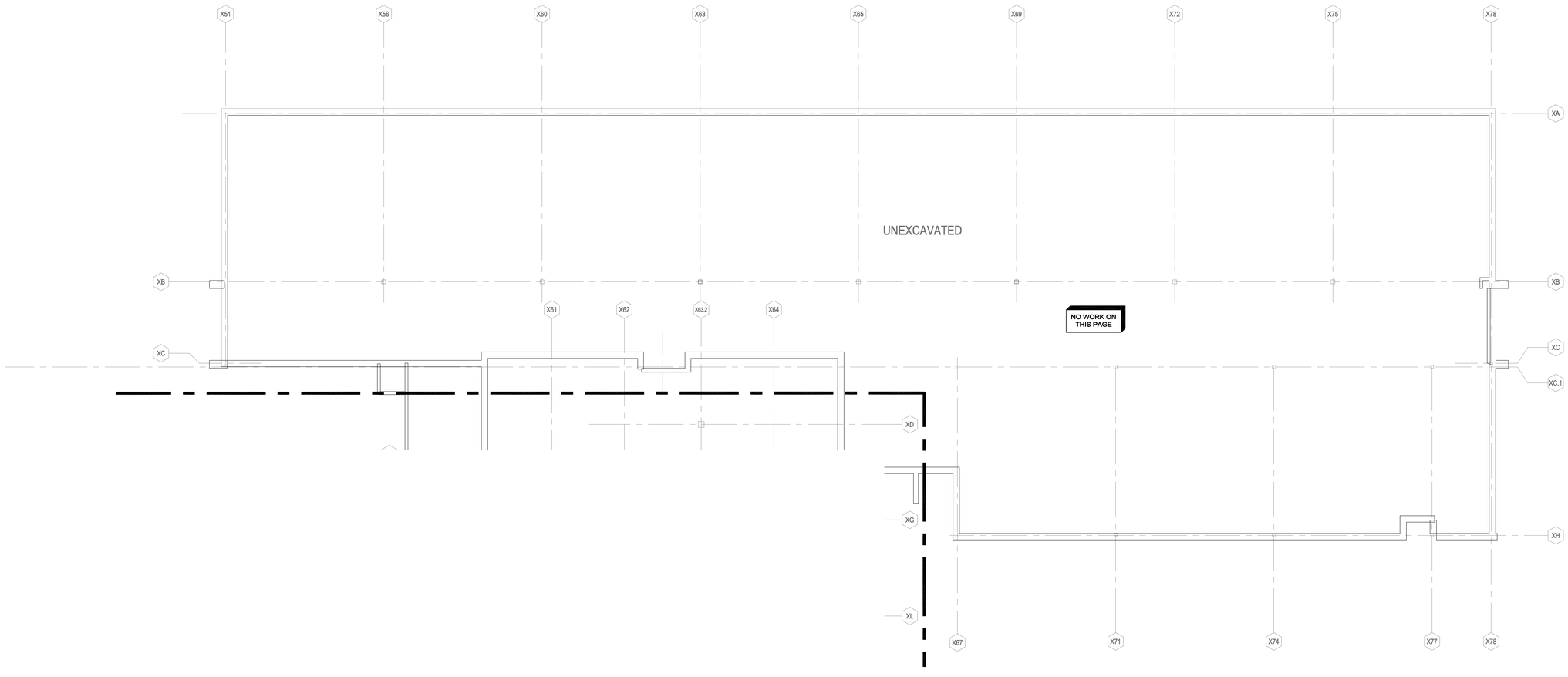
PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H2.07

01/20/2017 20170393 Berkeley Middle School Heating System\500 Drawings\504 HVAC\Dwg Files\20170393 H2.07 HVAC CRAWLSPACE 1966-1967 NORTH WING.dwg [Revit] October 16, 2017 - 10:01am - kdavis

RDK



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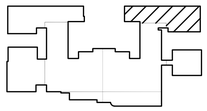

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REVISIONS

▲	DATE	CHK	DESCRIPTION
	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

DRAWN BY
CSL

CHECKED BY
WW

SCALE
1/8" = 1'-0"

HVAC CRWALSPACE
1966-1967
SOUTH WING

PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H2.08

G:\2017\20170393 - Bradley Middle School Heating System\100 Drawings\104 HVAC\Civil Fixs\20170393 H2.08 HVAC CRWALSPACE 1966 - 1967 SOUTH WING.dwg [Tab=A] October 16, 2017 - 10:01am cclem

RDK

NOTES:

1. REMOVE SECONDARY HW PUMPS, ASSOCIATED PIPING, STEAM TO WATER HEAT EXCHANGERS, AND PRIMARY PUMPS. TO BE REPLACED WITH NEW HW BOILERS AND PUMPS BACKFEEDING INTO THE EXISTING HW PIPING.
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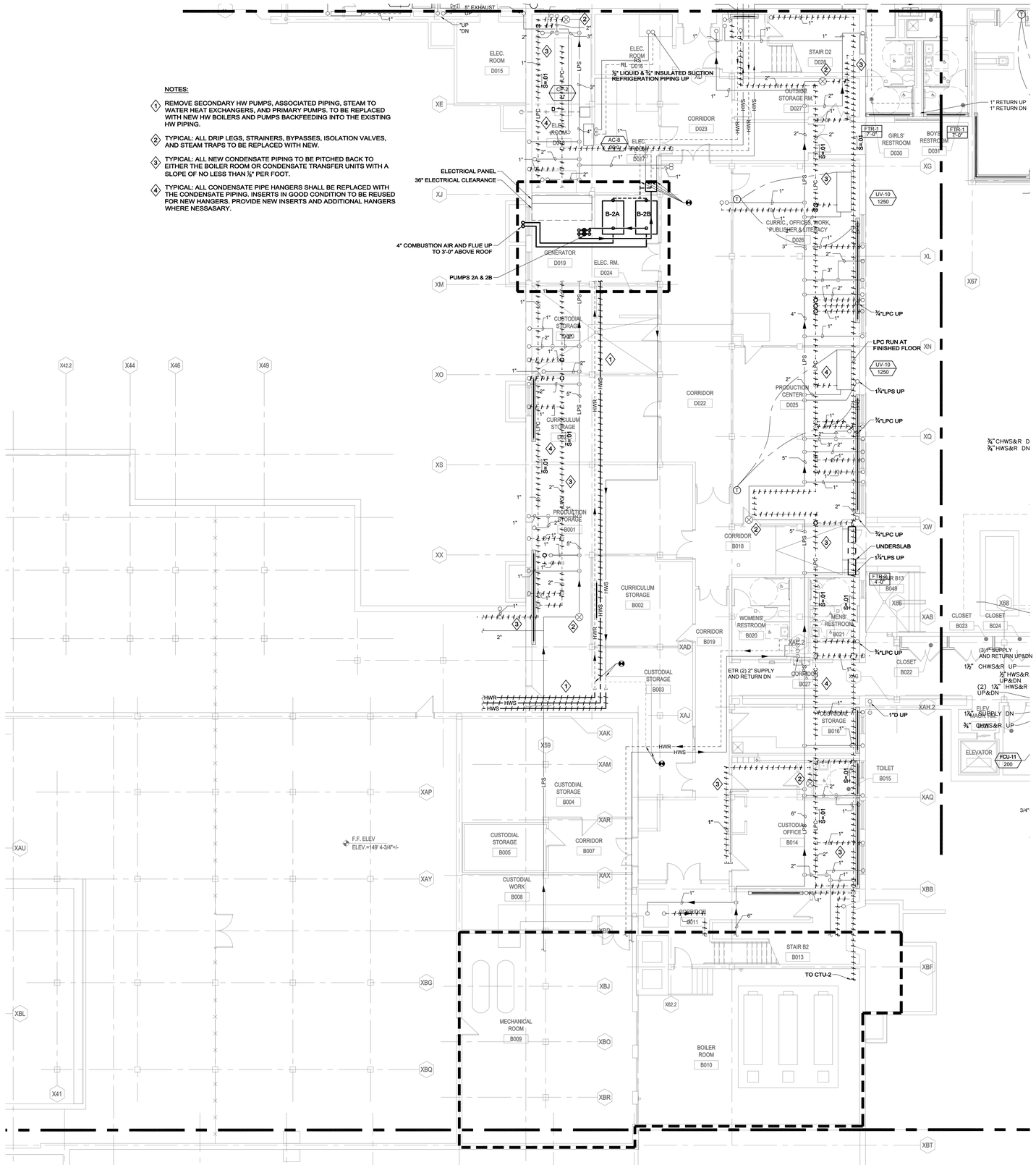

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REVISIONS

▲	DATE	CHK	DESCRIPTION
	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

DRAWN BY
CSL

CHECKED BY
WW

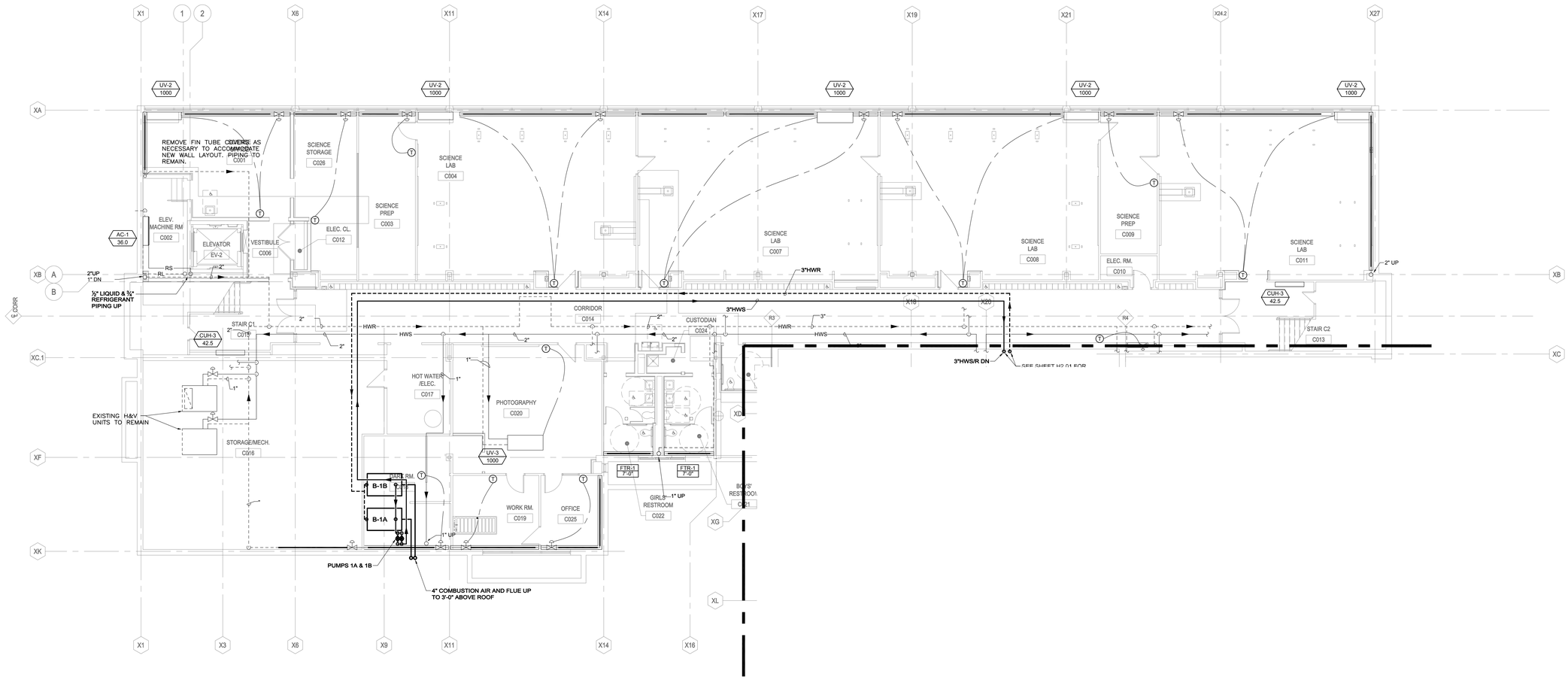
SCALE
1/8" = 1'-0"

HVAC FIRST FLOOR
1952 ORIGINAL
BUILDING (B)

PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H3.03



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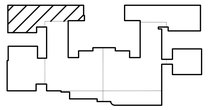

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	10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

DRAWING

DRAWN BY
CSL

CHECKED BY
WW

SCALE
1/8" = 1'-0"

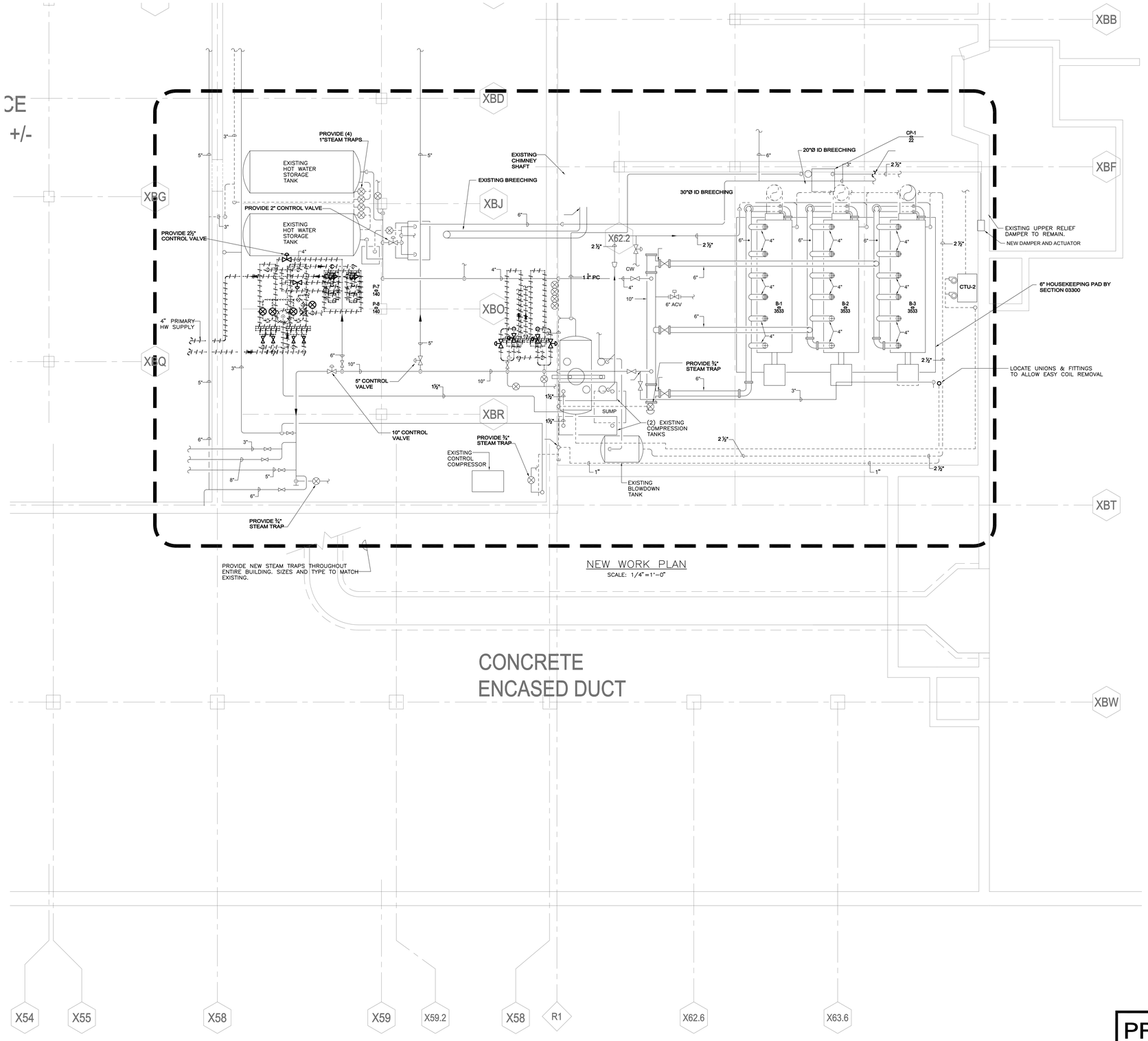
HVAC FIRST FLOOR
1966-1967
NORTH WING

PROGRESS
10-16-17

1/8" = 1' - 0"
0 8' 16'

H3.07

RDK



NEW WORK PLAN
SCALE: 1/4"=1'-0"

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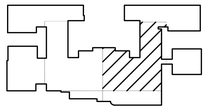

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SEAL

PROJECT

NUMBER
20170393

DATE
10/16/2017

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WW

SCALE
1/4" = 1'

HVAC
PART PLAN

PROGRESS
10-16-17

1/4" = 1' - 0" 0 4' 8'

H6.00

G:\2017\20170393 - Wellesley Middle School Heating System\300 Drawings\CAD\ HVAC\Plan Files\20170393 H6.00 HVAC PART PLAN.dwg [Rev.1] October 16, 2017 - 10:00am dshin

EXISTING PUMP SCHEDULE

TAG	SERVICE	LOCATION	CASING TYPE	FLUID		GPM	NPSHR (FT.)	HEAD (FT.)	SHUT-OFF HEAD (FT.)	IMPELLER SIZE (IN.)	WORKING PRESS. (PSIG)	MOTOR					MANUFACTURER AND MODEL NUMBER (AS STANDARD)	REMARKS
				TYPE	TEMP (°F)							RPM	BHP	HP	V	PH		
P-1	NORTHWING	CRAWLSPACE	-	WATER	190	120	6.3	30	-	6.25	-	1750	1.4	2	480	3	BELL & GOSSETT 1510 1 1/2AC	TO BE REMOVED
P-2	NORTHWING	CRAWLSPACE	-	WATER	190	120	6.3	30	-	6.25	-	1750	1.4	2	480	3	BELL & GOSSETT 1510 1 1/2AC	TO BE REMOVED
P-3	SOUTHWING	OLD GENERATOR ROOM	-	WATER	190	105	5.8	30	-	6.125	-	1750	1.4	2	480	3	BELL & GOSSETT 1510 1 1/2AC	TO BE REMOVED
P-4	SOUTHWING	OLD GENERATOR ROOM	-	WATER	190	105	5.8	30	-	6.125	-	1750	1.4	2	480	3	BELL & GOSSETT 1510 1 1/2AC	TO BE REMOVED
P-7	PRIMARY CIRC	BOILER ROOM	-	WATER	190	140	5.1	65	-	8.25	-	1750	3.37	5	480	3	BELL & GOSSETT 1510 2BC	TO BE REMOVED
P-8	PRIMARY CIRC	BOILER ROOM	-	WATER	190	140	5.1	65	-	8.25	-	1750	3.37	5	480	3	BELL & GOSSETT 1510 2BC	TO BE REMOVED
P-1A	NORTHWING	DARKROOM	-	WATER	180	120	-	50	-	-	-	1750	-	2	208	3	-	-
P-1B	NORTHWING	DARKROOM	-	WATER	180	120	-	50	-	-	-	1750	-	2	208	3	-	-
P-2A	SOUTHWING	OLD GEN ROOM	-	WATER	180	120	-	50	-	-	-	1750	-	2	208	3	-	-
P-2B	SOUTHWING	OLD GEN ROOM	-	WATER	180	120	-	50	-	-	-	1750	-	2	208	3	-	-

NOTES:

1 NOTES 2 AND 3 APPLY TO ALL.
2 REFER TO SPECIFICATIONS, DETAILS, AND CONTROL DRAWINGS FOR ADDITIONAL INFORMATION.
3 PROVIDE ALL FRACTIONAL HP MOTORS WITH INTEGRAL RESETTABLE THERMAL OVERLOAD.
4 MOTORS SHALL BE INVERTER DUTY RATED FOR CONNECTION TO A VFD. PROVIDE BEARING SHAFT RING FOR SHAFT GROUNDING.
5 EQUIPMENT SHALL BE ON GENERATOR STANDBY POWER.

EXISTING CONDENSATE PUMP SCHEDULE

TAG	LOCATION	RECEIVER VOLUME GAL	FLUID		GPM	PSIG	MOTOR					MANUFACTURER AND MODEL NUMBER (AS STANDARD)	REMARKS
			TYPE	TEMP (°F)			RPM	BHP	HP	V	PH		
CP-1	BOILER ROOM	-	COND	180	-	-	-	-	-	-	-	-	-
CP-2	REFER TO DRAWINGS	-	COND	180	-	-	-	-	-	-	-	-	-

BOILER SCHEDULE

TAG	LOCATION	CAPACITY				PRESS. (PSIG)		WATER				BURNER					MANUFACTURER AND MODEL NUMBER (AS STANDARD)	REMARKS
		OUTPUT	NATURAL GAS															
		MBH	INPUT (CFH)	PRESSURE (IN.WG)	EFFICIENCY (%)	MAX DESIGN	RELIEF VALVE	ENT (°F)	LVG (°F)	GPM	%P.G,	TYPE	TURN DOWN	BLOWER				
														A	V	PH		
B-1	DARKROOM	1,200	1,250	4.0	-	47	50	160	180	120	0	MODULATING	25:1	7	120	1	LOCHINVAR FBN1251	1, 2
B-2	GENERATOR ROOM	1,200	1,250	4.0	-	47	50	160	180	120	0	MODULATING	25:1	7	120	1	LOCHINVAR FBN1251	1, 2

NOTES:

1 REFER TO SPECIFICATIONS, DETAILS, AND CONTROL DRAWINGS FOR ADDITIONAL INFORMATION.
2 PROVIDE CONDENSATE NEUTRALIZATION KIT, INTEGRAL VENTLESS GAS REGULATOR, CSD-1 AND MASS CODE SAFETIES, AL29-4C STAINLESS FLUE AND CPVC COMBUSTION AIR.

HVAC DEMOLITION NOTES

1. REFER TO THE ARCHITECTURAL DRAWINGS FOR THE EXTENT OF THE DEMOLITION SCOPE OF WORK AND AREA. THE DEMOLITION PLANS INDICATE THE GENERAL INTENT AND ARE NOT INTENDED TO SHOW ALL ITEMS TO BE REMOVED OR RETAINED.
2. THE LOCATIONS OF EXISTING EQUIPMENT INCLUDING PIPING, DUCTWORK, EQUIPMENT, CONDUITS, ETC ARE SHOWN IN AN APPROXIMATE WAY ONLY. VISIT THE SITE PRIOR TO SUBMISSION OF THE BIDS AND COMMENCEMENT OF WORK TO BECOME FAMILIAR WITH THE ACTUAL CONDITIONS AND EXTENT OF THE WORK.
3. TRACE AND LABEL ALL EXISTING SYSTEMS WITHIN THE DEMOLITION AREA AND BEYOND PRIOR TO DISCONNECTION AND REMOVAL TO ENSURE THAT NO AREA OUTSIDE THE DEMOLITION AREA IS AFFECTED. REVIEW IN DETAIL WITH THE GENERAL CONTRACTOR AND OWNER WHAT IS TO BE REMOVED AND REMAIN PRIOR TO WORK COMMENCING THE DEMOLITION. THERE SHALL BE NO INTERRUPTION OF SERVICES OUTSIDE THE DEMOLITION AREA WITHOUT APPROVAL FROM THE OWNER'S REPRESENTATIVE.
4. COORDINATE EQUIPMENT REMOVAL WITH ALL PARTIES TO PROVIDE DISCONNECTION. REMOVE EQUIPMENT BY UNFASTENING AT THE SUPPORTS OR ATTACHMENTS. ALSO REMOVE THE ATTACHMENTS FROM THE BUILDING, LEAVING NO COMPONENT OF THE ORIGINAL INSTALLATION.
5. EXERCISE CARE WITH EQUIPMENT THAT IS TO BE RELOCATED OR TURNED OVER TO THE OWNER. EXAMINE THE EQUIPMENT BEFORE REMOVAL IN THE PRESENCE OF THE OWNER'S REPRESENTATIVE TO DETERMINE ITS CONDITION. DELIVER OWNER-RETAINED EQUIPMENT TO AN ON-SITE LOCATION DESIGNATED BY THE OWNER AND OBTAIN ACKNOWLEDGMENT OF RECEIPT IN ORIGINAL CONDITION.
6. INSTALL RELOCATED EQUIPMENT IN ORIGINAL CONDITION ENSURING NO DAMAGE.
7. PROMPTLY REPAIR ANY DAMAGE CAUSED DURING/BY THE EXECUTION OF WORK. DAMAGE INCLUDES BUT IS NOT LIMITED TO DESTRUCTION OF ITEMS INTENDED TO REMAIN OR TO BE SALVAGED.
8. NOTIFY THE OWNER'S REPRESENTATIVE IMMEDIATELY OF ANY UNANTICIPATED HIDDEN CONDITIONS ENCOUNTERED DURING THE DEMOLITION.
9. ALL ITEMS REMOVED SHALL BE OFFERED TO THE OWNER FOR SALVAGE. IF THE OWNER DOES NOT TAKE POSSESSION, DISPOSE OF THE ITEMS IN A SAFE AND LEGAL MANNER. ALL ITEMS CLASSIFIED AS HAZARDOUS SHALL BE DISPOSED AS HAZARDOUS WASTES AND A UNIFORM HAZARDOUS WASTE MANIFEST SHALL BE PROVIDED TO THE OWNER.
10. ENSURE THE SAFE PASSAGE OF PERSONS IN AND AROUND THE BUILDING DURING DEMOLITION. PREVENT INJURY TO PERSONS AND DAMAGE TO PROPERTY. PROVIDE ADEQUATE SHORING AND BRACING TO PREVENT COLLAPSE. IMMEDIATELY REPAIR DAMAGED PROPERTY TO THE CONDITION BEFORE BEING DAMAGED. TAKE EFFECTIVE MEASURES TO PREVENT WINDBLOWN DUST.
11. DO NOT USE CUTTING TORCHES UNTIL WORK AREA IS CLEARED OF FLAMMABLE MATERIALS. AT CONCEALED SPACES, SUCH AS PIPE INTERIORS OR SHAFTS. VERIFY CONDITION AND CONTENTS OF HIDDEN SPACE BEFORE STARTING FLAME-CUTTING OPERATIONS. MAINTAIN FIRE WATCH AND PORTABLE FIRE-SUPPRESSION DEVICES DURING FLAME-CUTTING OPERATIONS. MAINTAIN ADEQUATE VENTILATION WHEN USING CUTTING TORCHES.
12. DRAIN, PURGE, OR OTHERWISE REMOVE, COLLECT, AND PROPERLY DISPOSE OF CHEMICALS, LIQUIDS, GASES, EXPLOSIVES, ACIDS, FLAMMABLES, OR OTHER DANGEROUS MATERIALS BEFORE PROCEEDING WITH DEMOLITION OPERATIONS.
13. PROPERLY LABEL ALL UNLABLED PIPES THAT REMAIN WITH COLOR PIPE MARKERS AND VALVE TAGS. MOUNT A VALVE AND SERVICE CHART IN THE AREA OF DEMOLITION THAT IDENTIFIES ALL LABELED SERVICES. TURN ONE COPY OF SAME OVER TO THE OWNER.
14. ALL DEMOLITION SCOPE ASSOCIATED WITH LOW VOLTAGE WIRING FOR CONTROLS AND ASSOCIATED INTERLOCKS SHALL BE INCLUDED IN THIS CONTRACT.

HVAC GENERAL NOTES

1. GENERAL NOTES APPLY TO ALL DRAWINGS.
2. THIS PROJECT INVOLVES CONSTRUCTION INSIDE AN EXISTING STRUCTURE. CONTRACTORS, BY SUBMITTING A BID, ARE DEEMED TO BE COMPLETELY FAMILIAR WITH THE EXISTING CONDITION OF THE BUILDING AS IT INFLUENCES THE WORK DESCRIBED. ABSOLUTELY NO CLAIMS FOR EXTRA COMPENSATION WILL BE CONSIDERED FOR EXISTING CONDITIONS VISIBLE OR REASONABLY INFERABLE FROM A CAREFUL EXAMINATION OF THE EXISTING BUILDING.
3. THIS CONTRACTOR SHALL INSPECT THE EXISTING FIELD CONDITIONS AT THE SITE AND THE "AS-BUILT" BASE BUILDING CONTRACT DOCUMENTS PRIOR TO THE START OF ANY WORK TO DETERMINE WHAT EFFECT THE EXISTING CONDITIONS WILL HAVE ON HIS WORK. POTENTIAL PROBLEM AREAS SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT AND/OR ENGINEER IMMEDIATELY.
4. THIS CONTRACTOR SHALL CONNECT HIS WORK TO VARIOUS EXISTING PIPING, DUCTWORK, AND CONTROL SYSTEMS IN THE BASE BUILDING. THE NEW WORK SHALL BE COMPATIBLE WITH THE EXISTING SYSTEMS. LOCATION OF EQUIPMENT OR THE ROUTING OF THE VARIOUS SYSTEMS AS WELL AS OPENINGS IN FLOOR SLABS OR WALLS SHALL BE GOVERNED BY THE EXISTING CONDITIONS AS THEY APPEAR IN THE FIELD OR ON THE "AS-BUILT" DRAWINGS.
5. CARE SHALL BE TAKEN DURING THE INSTALLATION TO NOT DAMAGE OR INTERRUPT BUILDING SYSTEMS AND SERVICES THAT ARE ALREADY INSTALLED. DAMAGE TO SUCH SYSTEMS OR EQUIPMENT CAUSED BY THIS CONTRACTOR DURING INSTALLATION SHALL BE REPAIRED AND/OR REPLACED AT THIS CONTRACTOR'S EXPENSE TO THE COMPLETE SATISFACTION OF THE BUILDING OWNER.
6. SHUTDOWN OF EXISTING SYSTEMS FOR CONNECTION TO EXISTING SERVICES SHALL BE COORDINATED WITH THE CONSTRUCTION MANAGER OR GENERAL CONTRACTOR AND BUILDING OWNER. THIS CONTRACTOR SHALL SUBMIT REQUESTS, WHERE THEY AFFECT THE OPERATION OF THE BUILDING SYSTEMS, AT LEAST ONE WEEK IN ADVANCE OF ANY REQUIRED SHUTDOWN. THE ACTUAL SHUTDOWN PERIOD SHALL BE AS SHORT AS POSSIBLE AND AT A TIME MUTUALLY AGREEABLE TO THE BUILDING OWNER AND THE CONSTRUCTION MANAGER/GENERAL CONTRACTOR.
7. DRAWINGS ARE DIAGRAMMATIC, THEREFORE DETERMINE EXACT LOCATIONS OF SYSTEMS AND COMPONENTS IN FIELD.
8. ALL WORK SHALL BE COORDINATED WITH ALL TRADES INVOLVED. OFFSETS IN PIPING AND DUCTS (INCLUDING DIVIDED DUCTS) AND TRANSITIONS AROUND OBSTRUCTIONS SHALL BE PROVIDED AT NO ADDITIONAL COST TO THE OWNER.
9. VERIFY ALL EQUIPMENT CONNECTIONS WITH MANUFACTURER'S CERTIFIED DRAWINGS. VERIFY AND PROVIDE DUCT AND/OR PIPE TRANSITIONS TO FURNISHED EQUIPMENT. FIELD VERIFY AND COORDINATE ALL DIMENSIONS BEFORE FABRICATION.
10. REFER TO ARCHITECTURAL REFLECTED CEILING PLANS FOR EXACT LOCATIONS OF AIR TERMINAL DEVICES.
11. ALL MATERIALS AND EQUIPMENT UNLESS SPECIFICALLY INDICATED AS REUSED, SHALL BE NEW.
12. DUCTWORK SHALL NOT RUN ALONG FULL HEIGHT PARTITIONS.
13. ACCESS PANELS SHALL BE PROVIDED TO ALLOW FOR CLEANING OF COILS AND SERVICING OF DAMPERS, HEATERS, VALVES, AND ALL CONCEALED MECHANICAL EQUIPMENT.
14. THE INSIDE OF ALL DUCTWORK VISIBLE THROUGH A GRILLE OR DIFFUSER SHALL BE PAINTED FLAT BLACK.
15. EXISTING ROOM THERMOSTATS AND SENSORS SHALL BE PROTECTED DURING CONSTRUCTION AND RELOCATED AS INDICATED ON THE DRAWINGS. INSTALL NEW AND RELOCATED ROOM THERMOSTATS AND SENSORS 4 FEET AFF OR AS DIRECTED OTHERWISE BY ARCHITECT.
16. WHEN SECTION OF DUCTWORK IS NOT LABELED FOR SIZE, THE LARGER SIZE INDICATED ON THE CONNECTED DUCT SHALL PREVAIL. SIZE OF DUCT RUN-OUTS TO DIFFUSER SHALL EQUAL DIFFUSER NECK SIZE.
17. CONTRACTOR SHALL PROVIDE THE FOLLOWING SERVICES, AS APPLICABLE, ON ALL EXISTING HVAC EQUIPMENT INDICATED TO BE REUSED: 1) FILTER CHANGES, 2) BALANCING, 3) LUBRICATION. CONTRACTOR SHALL REPORT ANY EQUIPMENT DEFICIENCIES FOUND TO THE ARCHITECT AND/OR ENGINEER.
18. THE FIRE PROOFING OF THE BUILDING STRUCTURE IS NOT TO BE REMOVED FOR THE INSTALLATION OF HANGERS, SUPPORTS, DUCTWORK, ETC. IF FIRE PROOFING IS DAMAGED, IT SHALL BE REPAIRED AT THE EXPENSE OF THE TRADE.
19. CONTRACTOR SHALL TEST AND CALIBRATE ALL CONTROLS AND VERIFY ALL ARE FULLY FUNCTIONAL AND SUBMIT DOCUMENTATION. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
20. CONTRACTOR SHALL PROVIDE AND SUBMIT DOCUMENTATION FOR TESTING AND BALANCING OF ALL AIR AND WATER SYSTEMS, DUCT AND PIPING PRESSURE AND LEAKAGE TESTS, OPERATING AND MAINTENANCE MANUALS, AND AS BUILT DRAWINGS. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
21. REFER TO THE PROJECT SPECIFICATIONS FOR FURTHER REQUIREMENTS.
22. MANY EQUIPMENT SCHEDULES DO NOT LIST QUANTITIES. CONTRACTOR SHALL REFER TO ALL DRAWINGS AND PROVIDE THE REQUIRED QUANTITIES FOR ALL COMPONENTS.
23. THESE DRAWINGS ARE NOT COMPLETE AND THERE WILL BE REVISIONS ISSUED.

EXISTING BOILER SCHEDULE (STEAM)

TAG	LOCATION	CAPACITY									STEAM PRESSURE (PSIG)			BREECHING		BURNER					MANUFACTURER AND MODEL NUMBER (AS STANDARD)	REMARKS
		OUTPUT (GROSS I=B=R)			NATURAL GAS			FUEL OIL														
		MBH	BHP	LB/HR	INPUT (CFM)	PRESSURE (IN.WG)	EFFICIENCY (%)	INPUT (GPH)	PRESSURE (PSIG)	MIN. EFFICIENCY (%)	OPER-ATING	MAX DESIGN	RELIEF VALVE	°F	CFM	TYPE	TURN DOWN	BLOWER				
																		HP	V	PH		
B-1	BOILER ROOM	3533	136	3680	5773	7.2	-	-	-	-						GAS/OIL	10:1	5	480	3	BURNHAM V1123	SEE NOTE 1
B-2	BOILER ROOM	3533	136	3680	5773	7.2	-	-	-	-						GAS/OIL	10:1	5	480	3	BURNHAM V1123	SEE NOTE 1
B-3	BOILER ROOM	3533	136	3680	5773	7.2	-	-	-	-						GAS/OIL	10:1	5	480	3	BURNHAM V1123	SEE NOTE 1

NOTES:

1 POWER FLAME BURNER MODEL #CR4-G0-25

RDK ENGINEERS

Andover, MA - Boston, MA - Amherst, MA

Durham, NC - Charlotte, NC

RDK Engineers
200 Brickstone Square
Andover, MA 01810-1488

T.978-296-6200
F.978-296-6201
W. www.rdkengineers.com

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REVISIONS

DATE	CHK	DESCRIPTION
10/16/2017	DW	REVISION 6

SEAL

PROJECT

NUMBER
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DATE
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DRAWING

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CHECKED BY
WW

SCALE
N/A

HVAC
NOTES AND SCHEDULES

PROGRESS
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