Groton Heights School – Mechanical Evaluation

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DATE: February 24, 2016; Revised May 31, 2016

On Monday, December 14th Tighe & Bond conducted a site visit at the Groton Heights School in Groton, Connecticut. The school was originally built in 1912 and has been out of service since 2007. The building has had periodic maintenance during the time the school was out of service. Below are our observations of the building.

1 Existing Conditions

1.1 Water Service Entrance

The water service enters the building within a utility closet near the Southeast basement level entrance. The domestic water service pipe enters the building at a size of approximately 4" diameter, but immediately reduces to approximately 2" diameter before entering the building water meter and backflow preventer. Downstream of the backflow preventer there is a domestic water service booster pump and an approximately 20 gallon pressure tank. The domestic water booster pump was not operating at the time of this site visit.

1.2 Domestic Hot and Cold Water Distribution

Domestic cold water service originates at the location of the water service entrance in the southeast basement utility closet. Domestic hot water service originates at the location of the oil-fired domestic hot water heater in the boiler room. The majority of the domestic hot and cold water piping is concealed in normally occupied spaces. Based on the extent of domestic hot and cold water piping that was visible during the site visit, it is assumed that domestic hot and cold water is distributed throughout the building in primarily copper tubing with solder joints. Due to the age of the building, it is likely that the solder and pipe fittings used in the domestic hot and cold water distribution piping may contain lead.

1.3 Domestic Hot Water Heating

Domestic hot water is produced for the building by an oil-fired, 32 gallon, storage-type water heater located within the basement boiler room. The domestic water heater is located between the two existing oil-fired, steam boilers. The domestic water heater burner is 1/8 horsepower with a firing range of 0.5 to 2.75 gallons per hour. Number 2 fuel oil is supplied to the water heater burner from an underground storage tank located on the east side of the building. The domestic water heater vents into the same brick masonry chimney as the two oil-fired boilers through a breeching approximately 6" in diameter. A domestic hot water recirculation pump is located on the west wall of the boiler room and appeared to be thermostatically controlled. The domestic hot water recirculation pump was not operational during the time of this site visit. A domestic hot water mixing valve was not observed during the time of this site visit.

1.4 Plumbing Fixtures

The Groton Heights School building has three bathrooms on the basement level including one multi-user boys' bathroom, one multi-user girls' bathroom, and one single-user unisex bathroom. The boy's bathroom contains four floor-mounted water closets, three wall-mounted lavatories, one mop sink, and six floor mounted urinals. The girls' bathroom contains ten floor-mounted water closets and three wall-mounted lavatories. The basement level single-user bathroom contains one floor-mounted water closet and one wall-mounted lavatory. The building also has two single-user bathrooms within the gymnasium building addition and two single-user bathrooms on the first floor in the main building. Each single-user bathroom at the gymnasium and on the first floor contains one floor-mounted water closet and one wall-mounted lavatory. The building also contains several additional wall-mounted lavatories, counter-mounted sinks, mop sinks, and water coolers at various locations throughout the building. Plumbing fixtures are typical for a school similar to the age and size of the Groton Heights School.

1.5 Fire Protection Service Entrance

The Groton Heights School is a fully-sprinklered building with a dry pipe system serving the attic area and a wet pipe system serving the remainder of the building. The fire protection service main enters the building within the same utility closet as the domestic water service near the southeast basement level entrance. Once inside the building, the fire protection main runs north into the existing boiler room to a main double check backflow preventer. Also within the boiler room is the existing 60 horsepower fire pump, dry pipe alarm valve serving the attic sprinkler zone, and the existing 3/4 horsepower dry pipe sprinkler system compressor. The wet pipe fire protection system main leaves the boiler room and runs back to the wet pipe alarm valve located in the service entrance utility closet.

1.6 Fire Protection System Distribution

The wet pipe fire protection system originates at the location of the fire protection service entrance in the southeast basement utility closet. The existing 4" diameter wet pipe alarm valve serves all spaces within the building other than the attic. The dry pipe fire protection system serving the attic space originates within the existing boiler room as described above. The existing 4" diameter dry pipe alarm valve serves a 4" diameter dry pipe main which runs up through the building to the attic space. Main fire protection piping from the service entrance up to the dry pipe and wet pipe alarm valves is steel grooved-end pipe with mechanical fittings. At the time of this site visit, the majority of wet sprinkler system piping downstream of the alarm valve observed throughout the building appeared to be steel piping with threaded fittings. Sprinkler piping runs exposed in the majority of building spaces with upright sprinkler heads. It is assumed that the pipe material, joining method, and sprinkler head type used for the dry fire protection system within the attic is the same as observed elsewhere in the building.

1.7 Sanitary Waste and Vent Piping

As described above, the Groton Heights School contains two multi-user bathrooms and one single-user bathroom on the basement level, two single-user bathrooms on the first floor, two single-user bathrooms at the gymnasium, and various other plumbing fixtures throughout the building. A substantial amount of the existing sanitary waste system at the basement level is concealed within the basement floor slab and at the upper floors is concealed within walls and above ceilings. Based on observations of visible portions of the existing sanitary waste system, the majority of the piping appeared to be cast iron with hub and spigot fittings. A main sanitary waste line runs north to south through the boiler room along the west wall approximately 24" above finished floor. The main sanitary waste line running along the west boiler room wall exits the boiler room near the existing air compressors. Based on visible portions of the routing of this main sanitary waste line, it is believed that the sanitary waste exits the building on the west side and discharges to City sewer at Monument Street.

A substantial amount of existing vent piping is concealed within walls and above ceilings. Based on observations of visible portions of the existing vent piping systems, the majority of the piping appeared to be cast iron with hub and spigot fittings, with some smaller piping run in copper with soldered fittings.

Each of the multi-user bathrooms located on the basement level contains a single floor drain. Floor drains were not observed during the site visit at any other locations.

A sump pump with a partial cover is located within the boiler room between the two existing boilers. The sump pump has various boiler and condensate drains piped to it and the pump discharges to the existing sanitary waste main that runs north to south along the west wall of the boiler room.

1.8 Roof Drainage

The original building, built in 1912, has a sloped roof that drains to six existing scuppers and downspouts. There are two scuppers and downspouts located on the east side of the building, two scuppers and downspouts located on the south side of the building, and two scuppers and downspouts located on the west side of the building. Each existing downspout appeared to be of galvanized steel or painted steel construction and was connected to a cast iron standpipe. Each existing cast iron standpipe runs below grade. The gymnasium building addition has an internal roof drainage system consisting of roof drains, rainwater leaders, and a stormwater drainage system. Based on what was visible during the December 14th site visit, the routing of stormwater drainage from the building is unknown.

1.9 HVAC System

1.9.1 Steam Boiler

The Groton Heights School is heated by two existing H.B. Smith 450 Mills, number 2 fuel oil fired, low pressure steam boilers. The existing boilers are water tube design with cast iron heat exchanger construction. The existing boilers were not operating at the time of the site visit.

Given the age of the building, it is assumed that the existing boilers are not original to the building. The gymnasium addition was built in the 1960s, which is when the existing boilers were likely installed in an effort to meet the increased heating loads of the expanded building. Number 2 fuel oil is supplied from an underground storage tank located on the East side of the building. The existing boilers vent into the same brick masonry chimney as the existing oil-fired water heater through a shared breeching approximately 24” in diameter. Ventilation for the existing boiler room is provided by an exhaust fan with associated motorized control damper and dedicated intake louver. Combustion air for the existing boiler room is provided through a second dedicated louver.

1.9.2 Terminal Heating Equipment

The two existing oil-fired steam boilers provide low pressure steam to terminal equipment throughout the existing building for heating. The majority of terminal heating equipment consists of steam heating finned tube radiation with slope topped enclosures located along walls with exterior exposure. The existing terminal heating equipment was operating at the time of the site visit.

Miscellaneous steam convectors, cast iron radiators, and bare steel pipe radiators were also observed in various locations throughout the building. Each typical classroom is served by a continuous length of steam heating finned tube radiation controlled by a pneumatic thermostat and pneumatically operated two-way control valve.

1.9.3 Low Pressure Steam and Condensate Piping

Low pressure steam for heating originates in the basement boiler room where it is generated by the two existing steam boilers. Based on what was observed during the site visit, low pressure steam is distributed throughout the building in Schedule 40 black steel pipe. The majority of low pressure steam piping is either insulated or painted white and is run exposed throughout the building to terminal heating equipment. Low pressure steam condensate is returned from terminal heating equipment to the basement boiler room where it is collected by a condensate receiver with duplex condensate pumps, which feeds each of the existing boilers. Based on what was observed during the site visit, low pressure steam condensate is distributed throughout the building in either Schedule 40 or Schedule 80 black steel pipe. The majority of low pressure steam condensate piping is painted white and is run exposed throughout the building from terminal heating equipment back to the boiler room.

1.9.4 Ventilation

Each of the two existing multi-user bathrooms located on the basement level are served by residential style, through-the-wall exhaust fans. Each fan appeared to be equipped with local ON/OFF control via a toggle switch.

The existing basement level single-user bathroom and the two existing single-user bathrooms at the gymnasium addition are served by dedicated exhaust fans, which vent through a sidewall to the outdoors. Each fan appeared to be equipped with local on/off control via toggle switch or interlocked with the local lighting control.

The gymnasium addition is ventilated by an air handling unit located above the stage area, which supplies fresh outdoor air and space heating with an integral steam heating coil. The gymnasium air handling unit works in tandem with a roof-mounted exhaust fan, which removes excess outdoor air to prevent over-pressurization of the gymnasium space.

The two existing single-user bathrooms located on the first floor of the main building, as well as, all classroom spaces throughout the main building, are not served by any form of mechanical ventilation. It appeared that classroom spaces are naturally ventilated through the use of operable windows.

1.9.5 Air Conditioning

At the time of the site visit, the Groton Heights School was not equipped with an air conditioning system or systems.

1.9.6 Gymnasium Air Handling Unit

The gymnasium and stage areas are heated and ventilated by a single air handling unit located above the stage area. The gymnasium air handling unit is equipped with filters, fan, steam heating coil, and controls. Supply ductwork runs just below the roof joists from the stage area along both the north and south walls for the length of the gymnasium. Return air grilles are located on both sides of the opening for the stage area, which allow recirculated air to return back to the air handling unit. The gymnasium air handling unit was not operating at the time of the site visit.

1.9.7 HVAC Controls

The existing steam boilers, gymnasium air handling unit, and terminal heating equipment control valves all appeared to be controlled by an existing, antiquated pneumatic control system. Bathroom exhaust fans are equipped with local ON/OFF control and appeared to be independent of the existing pneumatic control system. Compressed air for the existing pneumatic control system is provided by an existing 30 gallon, 3 horsepower air compressor located in the boiler room. Typical classroom perimeter heating and the gymnasium air handling unit heating coil are controlled by pneumatic thermostats tied to pneumatically operated two-way control valves on the steam supply to the heating elements. A motor starter located in the gymnasium janitor's closet controls the gymnasium air handling unit supply fan. Motor starters located in the existing boiler room control burners for each of the existing boilers.

2 Assessments

The following is Tighe & Bond's assessment of the mechanical systems and equipment serving the Groton Heights School building.

2.1 Water Service and Distribution

The existing water pressure boosting system was not operating during the time of the site visit. The operational state of the pump and pressure tank is unknown at this time. Pump housing corrosion and signs of previous leak events were observed during the time of the site visit. The base of the pressure tank is also showing signs of rust and corrosion.

The size of the water service main would need to be evaluated further based on the future occupancy or usage group of the building and required quantities of plumbing fixtures in order to determine whether it is appropriately sized.

Domestic hot and cold water piping observed throughout the building appeared to be in good condition with no major signs of corrosion or leaking. The domestic water heater also appeared to be in fair condition with no major signs of corrosion or leaking. It is estimated that the majority of the water distribution piping throughout the building is 50 to 60 years old. The existing oil-fired water heater is estimated to be approximately 10 to 15 years old.

2.2 Plumbing Fixtures

Plumbing fixtures throughout the building are outdated, and may have flow rates exceeding the maximum allowable by code. Additionally, many plumbing fixtures are not in compliance with the requirements of the American with Disabilities Act (ADA).

2.3 Fire Protection

The existing dry and wet pipe alarm valves serving the attic and main building appeared to be in fair condition at the time of the site visit. The dry and wet pipe alarm valves are estimated to be approximately 20 to 30 years old.

Fire protection piping observed throughout the building appeared to be in good condition with no major signs of corrosion or leaking. At the time of the site visit, no obvious defects or deficiencies were noticed with the upright sprinkler heads used throughout the building. It is estimated that the majority of the sprinkler heads in the building are approximately 20 to 30 years old.

At the time of the site visit, the existing fire pump was not operating. The operational state of the existing fire pump is unknown at this time. The fire pump was visually inspected and appeared to be in good condition. The age of the existing fire pump is unknown.

2.4 Sanitary Waste and Vent Systems

Based on the observations made during the site visit, the existing cast iron sanitary waste piping systems appeared to be in good condition with no obvious signs of leaking or corrosion. The existing cast iron and copper vent piping systems also appeared to be in good condition based on visual inspection of exposed piping. It is estimated that the majority of the sanitary waste and vent piping systems throughout the building are 50 to 60 years old.

2.5 Roof Drainage

Given the poor condition of the existing roof, and recommendations for replacement, it is assumed that the existing scupper drains are also in poor condition and in need of replacement. Based on observations made from the ground around the exterior perimeter of the building, the existing downspout system serving the main building roof is generally in poor condition. Downspouts at several locations are no longer connected to their associated standpipe and downspout elbows in several locations are showing signs of deterioration.

2.6 HVAC Systems

In general, the existing Groton Heights School HVAC systems are significantly outdated and have exceeded their useful service life. The existing oil-fired steam boilers, and the majority of the existing steam perimeter heating terminal units, are estimated to be approximately 50 to 60 years old.

The current method of supplying combustion air to the existing boilers may not be appropriately sized and does not comply with the requirements of the Building Code. Outdoor air is currently introduced to the boiler room through a metal wall louver with plywood blank offs and rectangular plywood duct terminating approximately 6′ above the finished floor. Wood is not an acceptable material for use in combustion air duct systems.

The low pressure steam and condensate piping throughout the building appeared to be in good condition. There were no major signs of corrosion or leaking during the site visit. Insulation for low pressure steam piping was largely intact and appeared to be in good condition in locations where visible.

The exhaust fans inspected throughout the building appeared to be in various states of disassembly and/or disrepair. The roof mounted exhaust fan serving the gymnasium area was also in poor condition; the weather hood for the fan had been disconnected and was being stored in the gymnasium addition lobby area.

The gymnasium air handling unit and associated duct work appeared to be in good condition at the time of the site visit, although the unit was not running. The gymnasium air handling unit is estimated to be approximately 50 to 60 years old, which is substantially greater than it's recommended useful service life.

The existing pneumatic temperature control system serving the existing boilers, gymnasium air handling unit, and perimeter heating terminal equipment has also exceeded its useful service life. During the site visit it was also noted that some compressed air lines serving pneumatic thermostats were leaking.

3 Recommendations

The following are Tighe & Bond's recommendations for mechanical systems and equipment serving the Groton Heights School building. The items are listed in order of priority.

3.1 Fire Protection

The existing Groton Heights School fire sprinkler system should be inspected in further detail by a certified fire protection professional. The inspection should include review in further detail to determine that the existing sprinkler head locations and densities meet current code requirements. The existing fire pump should also be tested by a certified professional to determine proper operation.

Visible portions of both the dry and wet pipe sprinkler systems appeared to be constructed of black carbon steel piping with either grooved-end or threaded fittings. Although usage of black carbon steel pipe for wet pipe sprinkler systems is appropriate, best practice for dry pipe sprinkler systems suggests the usage of galvanized, or at a minimum internally galvanized, steel pipe to counteract oxidation and corrosion that can occur in the presence of moisture.

Tighe & Bond recommends that pipe sampling be completed on fire protection piping mains at various locations in order to determine whether appropriate pipe wall thickness is present and/or whether excessive fouling has occurred. The results of pipe testing will provide additional information to make a fully informed decision on whether to replace existing sprinkler piping. Depending on the level of pipe corrosion that is discovered, the recommendation to replace sprinkler heads may also be brought forth as debris and corroded material can easily block the water pathways within sprinkler heads.

3.2 HVAC Systems

Due to the availability of more efficient equipment and the estimated age of the existing boilers, we recommend replacement of the existing oil-fired steam boilers with high-efficiency, gas-fired, condensing hot water boilers. Efficiencies of the existing boilers is estimated at 80% when new, as compared to 95-98% for new condensing type hot water boilers. The typical service life expectancy for a cast iron boiler is approximately 35 years, which means the existing Groton Heights School boilers have exceeded their expected useful life span by 15 to 25 years.

Implementing condensing boilers to produce heating hot water would also require the installation of a circulating hot water piping loop. The existing steam terminal heating equipment would also need to be replaced with new appropriately sized hot water terminal heating equipment for compatibility with the head end heating hot water systems. The existing steam terminal heating equipment has also exceeded its expected useful life span and is due for replacement.

Utilizing natural gas or propane as the primary fuel source would require the addition of an appropriately sized gas service or propane storage tank in order to supply fuel for both new space heating boilers and new domestic water heating equipment if fuel oil is eliminated entirely. Concurrent with the replacement of the existing boilers, the method in which combustion air is supplied to new boilers will need to be upgraded to meet current codes and manufacturer's requirements.

Mechanical ventilation is not currently being provided for the classroom and office spaces at the Groton Heights School. The only spaces that are provided with mechanical ventilation are bathrooms and the gymnasium area. Currently, ventilation for classroom and office spaces is assumed to be provided by means of natural ventilation through operable windows. The use of natural ventilation in buildings such as the Groton Heights School presents operational issues such as the inability to provide any ventilation during more extreme hot or cold weather conditions, as well as, poor temperature controllability and stability. Buildings where natural ventilation is used can have window sash position switches installed to prevent the simultaneous operation of the central heating or cooling system while windows are open for ventilation purposes. Further analysis of window sizes and floor areas would be required to determine whether the existing natural ventilation approach is compliant with current building code.

For the health and comfort of the building occupants, it is strongly recommended that an HVAC system be implemented that is capable of providing mechanical ventilation regardless of the weather or outdoor air temperature. HVAC system types that provide mechanical ventilation and are also compatible with the recommended hot water heating system are individual classroom or office unit ventilators or central station air handling units with associated ductwork and variable air volume (VAV) terminal units. Both unit ventilators and VAV air handling units are used to provide space heating or cooling while simultaneously providing mechanical ventilation. Alternatively, a variable refrigerant flow (VRF) system could be implemented without requiring the installation of a gas-fired boiler and heating hot water loop. When coupled with energy recovery ventilators (ERVs), VRF systems can also provide heating and/or cooling while simultaneously providing mechanical ventilation at a constant rate.

All existing bathroom exhaust fans should be replaced due to their age and apparent state of disrepair. New exhaust fans should be added to the existing first floor bathrooms that do not currently have any exhaust systems. Each new exhaust system must be designed to achieve code required exhaust rates for bathroom spaces based upon flush fixture and shower head quantities.

Due to the availability of more efficient equipment and the estimated age of the existing gymnasium air handling unit, we recommend that it be replaced with a new variable volume heating and ventilating air handling unit or energy recovery ventilator (ERV). The typical service life for an indoor air handling unit is 30 to 50 years depending on the methods and materials of manufacture. Based on the estimated age of the existing gymnasium air handling unit, we believe the unit has likely already exceeded its expected useful life span and is due for replacement.

Due to the availability of more advanced technology and the estimated age of the existing pneumatic temperature control system, we recommend it be replaced with a direct digital control (DDC) building management system (BMS). The typical service life expectancy of a pneumatic control system is approximately 20 years, which means the existing Groton Heights School pneumatic control system has likely already exceeded its expected useful life span. Modern automatic temperature control systems offer building owners and operators significantly increased visibility into the operation of a building and provide opportunities for significant operations cost savings by implementing energy saving controls schemes for HVAC equipment.

3.3 Water Service and Distribution

Due to the availability of more efficient equipment, the existing oil-fired water heater should be replaced with a high-efficiency, gas-fired, condensing water heater. Depending on the future use of the building, fixture quantities, and fixture types, some extent of main domestic hot water and domestic cold water piping could be reused to feed new fixtures in new and/or existing locations.

It is estimated that the majority of the water distribution piping throughout the building is 50 to 60 years old. The typical service life expectancy of steel piping systems is 30 years and the typical service life expectancy of copper piping systems is 40 years. However, domestic water piping systems frequently exceed their typical service life expectancies.

It is suggested that pipe sampling be completed on domestic hot and cold water piping mains to be reused in order to determine whether appropriate pipe wall thickness is present and/or whether excessive fouling has occurred. If significant corrosion is present, the piping should be replaced.

3.4 Plumbing Fixtures

Due to the availability of more efficient plumbing fixtures, the estimated age of existing fixtures, and code requirements, all existing plumbing fixtures at the Groton Heights School should be replaced. New plumbing fixtures should be code compliant with respect to flow rates. The implementation of further reduced, low-flow water saving fixtures should be considered where appropriate. New plumbing fixtures must also be ADA compliant where required.

3.5 Sanitary Waste and Vent Systems

It is estimated that the majority of the sanitary waste and vent piping systems throughout the building are 50 to 60 years old. The typical service life expectancy of cast iron piping systems is 35 years and the typical service life expectancy of copper piping systems is 40 years. However, sanitary and vent piping systems frequently exceed their typical service life expectancies.

Tighe & Bond recommends that pipe sampling and/or pipe scoping be completed on sanitary waste piping mains at various locations in order to determine whether appropriate pipe wall thickness is present and/or whether excessive fouling has occurred. The results of pipe testing will provide additional information to make a fully informed decision on whether to replace existing sanitary piping. Reuse of the existing sanitary waste system piping is also subject to the future use of the building and dependent upon the quantities and types of plumbing fixtures being served.

It was noted that the existing sump pump located in the basement boiler room currently discharges to the sanitary waste main that runs North to South along the West wall. Due to the potential for fuel oil spills within the boiler room, an oil separator should be added to the sump pump discharge line to remove any residual fuel oil prior to discharging to the sanitary waste system. An oil separator at the sump pump discharge would not be necessary if replacement boilers are natural gas fired.

The existing floor drains located in both of the basement level multi-user bathrooms were noted as being in poor condition and should be replaced with new.

3.6 Roof Drainage

The existing roof drainage system will need to be analyzed further to determine whether it meets current building code based on roof areas, quantity of roof drains, and sizing of storm drainage piping systems. If the existing quantity of roof drains and sizing of storm drainage piping is determined to be adequate, at a minimum the existing scupper drains and downspouts should be replaced due to their current poor condition.

4 Conclusions

The existing HVAC systems and pneumatic temperature control systems at the Groton Heights School have greatly exceeded their useful life expectancy and should be replaced. The existing fire protection system should be evaluated further by a certified fire protection professional. All existing plumbing fixtures should be replaced with current technology and ADA compliant fixtures. All existing mechanical piping systems intended to be salvaged for re-use in a future fit-out of the building should be sampled and/or scoped to determine extent of corrosion and presence of adequate wall thickness.

Appendix A – Photos

Cast Iron, Oil-fired, Steam Boilers

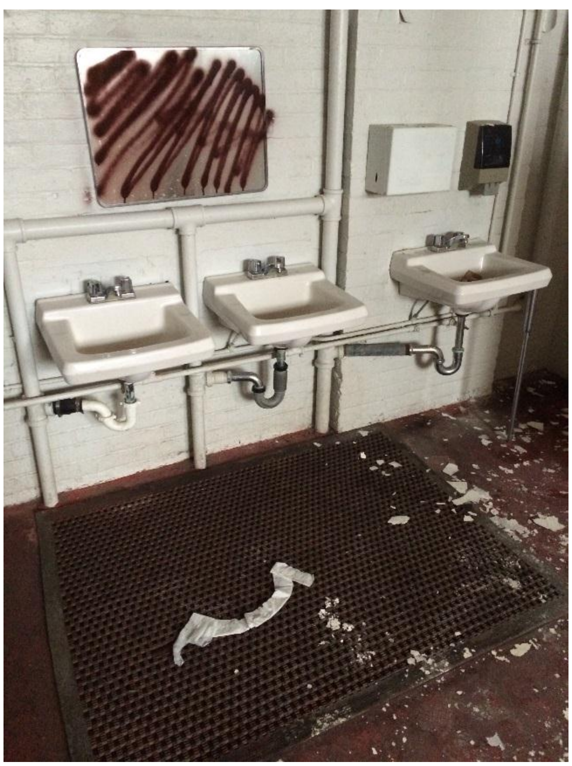
Water and Fire Protection Service Entrance

Dry Pipe Alarm Valve

Oil-fired Domestic Water Heater

Typical Damaged Downspout

Typical Damaged Downspout



Typical Plumbing Fixtures

Typical Plumbing Fixtures

Typical Cast Iron Steam Radiator

Typical Steam Perimeter Finned Tube Radiation