LINDGREN & SHARPLES, P.C. Consulting Engineers
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ANNE T. DUNPHY ELEMENTARY SCHOOL
Williamsburg, Massachusetts
July, 2009

INTRODUCTION

In May of 2009, the Town of Williamsburg acting through its' School Committee, placed a priority on upgrading the mechanical and electrical systems in the Anne T. Dunphy elementary School with an emphasis on life safety, energy conservation, and reliability.

In order to understand the challenges posed by this institute, the Town engaged Lindgren & Sharples, P.C. Consulting Engineers, to study the existing conditions of the mechanical and electrical systems and develop a logical course of action to upgrade and improve various systems.

Field surveys of the existing building were conducted in May of 2009, and all existing plans and studies were reviewed. The results of these surveys and reviews is listed in this report which identifies the existing conditions and deficiencies as they relate to age, condition, and code compliance and recommendation for corrective action. Also included is a preliminary cost estimate for each recommendation.

All costs for this study were paid for through a generous donation by the M.J. Moran Corporation, a local business with ties to the community.

FIRE PROTECTION

Existing Conditions:

- The building is not currently served by a sprinkler system.
- The existing kitchen range exhaust system is not fitted with a chemical extinguishing system.
- The existing stage is not equipped with stand pipes.

Recommendations:

The current Massachusetts State Building Code requires all buildings of Use Group E – Educations, to be equipped throughout with an automatic sprinkler system and further require all stage and auditorium spaces to be equipped with a stand pipe system. The National Fire Code requires all commercial cooking hoods to be protected by a chemical extinguishing system. This existing building does not meet current code requirements. Under Chapter 34 of the current Massachusetts State Building Code, existing buildings in Use "E" are not required to be retrofitted unless they are

substantially renovated or undergo a change in use.

Unless the building is substantially renovated, the current codes do not require the building to be retrofitted with automatic sprinklers and/or stand pipes; however, because of the proven life saving benefits of these systems, this office would recommend retrofitting the entire building in the near future regardless of renovation plans.

PLUMBING

Existing Conditions:

The existing plumbing systems are over 50 years old and are at the limit of their useful life. The building is currently served by a 2" water service located in the crawl space below the lunch room. The water service is reportedly equipped with a 2" water meter and a 2" main feed to the building.

The sewage disposal is a gravity type system which is connected to the town sewer system. The majority of the water piping is copper and most sanitary, waste, vent, and drain piping is cast iron and/or copper. The insulation on the water piping appears to be original and may be asbestos containing.

With the exception of few fixtures installed as a unisex handicapped bathroom outside the main office, the remaining fixtures in the building do not meet current ADA or water conservation regulations. The existing fixtures are china and/or enameled cast iron and were installed as part of the original construction.

Urinals are wall hung, flush valve, lavatories are wall hung vitreous china and have been retrofitted with sensor type faucets, and drinking fountains are wall mounted type and do not meet ADA. All toilets are floor mounted flush valve. Janitor sinks are floor mounted. Each classroom is fitted with a single bowl, stainless steel work sink and fitted with a drinking fountain.

The building domestic hot water is Boch oil-fired heater with an input capacity of 175mbh. There is no mixing valve and the building is not fitted with a re-circulating hot water system. In addition to the oil-fired heater, there is an electric water heater serving the janitors sink and an electrical booster heater which serves the kitchen.

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The building is not equipped with natural gas service. A small propane gas storage tank is located outside the boiler room and serving the pilot on the boiler oil-fired burner. The primary fuel for heating and hot water is oil which is stored in three 300 gallon tanks located in the boiler room.

The kitchen is equipped with a slide through dishwasher, a two compartment port sink, and a single compartment pre-sink. The waste from one bay of the two compartment sink and the waste from the dishwasher are each served by separate grease traps located in the crawl space.

Storm drainage is limited to gutters and down spouts which discharge to grade.

Deficiencies:

The existing plumbing fixtures and pipe were installed as part of the original construction, and are over 50 years old. The plumbing fixtures do not meet current ADA regulations or current Massachusetts Building Codes for water conservation. The existing urinals do not have screens as required by current code mandates.

The existing domestic water heating system is not fitted with a mixing valve or return circulation piping system. This system is not capable of maintain proper water temperature in the building and does not meet current plumbing or sanitary codes.

The existing water piping is over 50 years old and there is a high probability that the joints contain lead solder and should be tested. The existing piping systems throughout the building have exceeded their expected useful service life.

The kitchen fixtures and piping do not meet current codes. There is no hand sink in the kitchen or a three bay sink for dishwashing. The grease traps are over 50 years old and do not serve the prep sink or floor drains as required by current codes.

Recommendations:

Due to the age and condition of the existing plumbing systems it is the recommendations of this office that as part of any planned renovation project, all existing plumbing fixtures and piping should be replaced.

For estimating purposes we have assumed as part of a renovation project, all fixtures and above ground piping would be replaced in their entirety with new commercial

grade, water conservation fixtures, with sensor operated controls. A new gas-fired water heater would be installed complete with a central mixing valve and return circulation system. All new water piping would be type L-copper with lead free joints and above ground sanitary and vent piping would be cast iron or copper.

If a limited or phased renovation is planned:

- In terms of the water conservation fixtures, their use is governed by the provisions of the Plumbing and Building Code. Essentially, the code does not require these fixtures be upgraded, but, where new fixtures are installed, as may be required by other codes or concerns, then the new fixtures need to be water conserving types of fixtures.
- The question of accessibility is somewhat more complex. The impact on the Plumbing is fairly simple but can be rather expensive.
- The Mass. Architectural Access Board Regulations are found at 521 CMR and as relates to Plumbing, provide as follows:
- The level of Plumbing Compliance is determined by the value of total work being performed.
- If the total work is less than $100,000.00 and if this work were to include any Plumbing, then the Plumbing Work would need to comply.
- If the total work is less than$100,000 and less than 30% of the full and fair cash value of the building, then an accessible toilet and drinking fountain must be part of the work.
- If the cost of the work exceeds 30%, then all of the existing and new Plumbing Facilities need to be accessible.

This office also reviewed applicable sustainable plumbing systems for this building. Solar hot water is not viable in this building due to the limited use of the building in the summer months. Systems which would be applicable and meet LEED requirements are as follows:

- Dual flush toilets.
- On demand water heaters.
- Waterless urinals

A price to incorporate these systems has been included in the cost estimate section of this report

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HVAC

Existing Conditions:

The HVAC systems currently serving the Anne T. Dunphy Elementary School were installed as part of the original construction and are over 50 years old. The only notable system upgrades are the replacement of the temperature control compressor.

Heat for the building is provided by one (1) low pressure steam boiler. The boiler is Fitzgibbons cast iron sectional boilers with a #2 oil-fired burner. The boiler operates at a steam pressure of 5 psig and has a gross output of approximately 3000 MBH. Oil for the boilers is stored in three 300 gallon above ground storage tanks located in the boiler room.

- Heating Medium: The boiler generates low-pressure steam at approximately 5 psi and distributes to an overhead heater which distributes steam in three individual mains which circulates throughout the buildings in tunnel and crawl space areas. All steam piping is schedule 40 black steel and appears to be entirely covered with asbestos insulation. All condensate piping is also schedule 40 black steel much of which was not insulated, however, what was insulated also appeared to be asbestos. All piping is original to the building and over 50 years old; sections of the condensate have been replaced.

- Condensate Return: Condensate is collected in the boiler room in a floor mounted receiver which is a single wall un-insulated storage tank with two individual feed water pumps. The pumping arrangement is of the primary and standby design, and provides feed water to each boiler through a pipe laid on the floor with branch lines feeding each boiler. Each feed water line is provided with an automatic control valve which is controlled by a low water cut off on the boiler. All piping and controls appear to have recently received modification apparently due to a failure in the system.

- Combustion Air: Combustion air is provided to the boiler room through a single wall mounted louver which for the most part has been completely blanked off. The louver was not provided with any motor operated dampers and the present size and condition would not meet current codes.

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- Breeching: Breeching from each boiler is through a welded black steel ducting system which communicates overhead and terminates in a masonry chimney. We could not verify if a flue liner is installed, however, we did determine that the chimney is of adequate capacity and height for the combustion gases served. The breeching system was installed with a barometric damper and appears to operate satisfactorily. The cleanout doors in the breeching do indicate excessive surface contamination, and considering the age of the entire system, has reached its maximum serviceable life.

- Automatic Temperature Controls: Automatic temperature controls are of the pneumatic design and are supplied by a single air storage tank and a single air compressor and motor. The compressor was noted to be in very good condition and has been installed within the last few years. This tank is undersized for the overall capacity of the automatic temperature control system. The system was not provided with an automatic temperature control board or a refrigerated air dryer. The entire system is extremely antiquated and more than likely is infiltrated with water and oil due to the lack of filtration and the entire system is in need of replacement.

- Crawl Space: All steam and condensate piping travels throughout crawl spaces and tunnels located under the building. All spaces were noted to have a dirt floor with no vapor barrier installed. It does not appear that the areas are ventilated to relieve vapor pressure through the earth.

- Kitchen Heating: Heating of the entire kitchen area is through an individual ceiling suspended horizontal unit heater which ties into the low-pressure steam distribution system. The bottom of the unit heater is hanging into the occupied area and does present a hazard to the occupants. The heaters are in excess of 50 years old, and although it does operate, it has reached its maximum serviceable life and is in need of replacement.

- Kitchen Cooking Exhaust Hood: The kitchen is not served by a kitchen hood or fire protecting system as required by code.

- Cafetorium: The Cafetorium area is served by two vertical unit ventilators located on the exterior wall. Each unit is fitted with a fresh air intake louver, low pressure steam heating coil with valve control, filters and supply fan. We could not determine if the outside ventilation dampers in this unit are

operating correctly, however, considering their age and general state of disrepair, it does not appear that code required ventilation is adequately provided to the space. The entire volume of the air originally designed for the space as well as outside air is not adequate to achieve the space ventilation requirement.

- Stage: The stage area was not provided with any ventilation air nor was it provided with smoke release hatches for use during a fire emergency of which this condition is non code compliant.

- Gymnasium: The gymnasium is served by two central station air handling units. Due to the close proximity of the supply and return registers, a percentage of the total ventilation air provided to the space is ineffective. The unit was noted to be in poor condition and, generally, considering the age, have reached their maximum serviceable life. Each air handling system was provided with a roof mounted exhaust fan which draws exhaust air to the opposite corner of the gymnasium through a roof mounted exhaust fan to maintain minimum code required ventilation air. This exhaust fan does not appear to operate, however, considering their age, have reached its maximum serviceable life.

- Classrooms: Each classroom is similar and is provided with wall mounted vertical discharge classroom unit ventilators and finned tube radiation located along the exterior wall. Each unit ventilator is provided with the intake louver for fresh air, low-pressure steam heating coil with valve control. We could not determine if the outside ventilation dampers in each unit ventilator are operating correctly, however, considering their age and general state of disrepair, it does not appear that code required ventilation is adequately provided to the space. The entire volume of the air originally designed for the space as well as outside air does appear adequate to achieve the space ventilation requirements. Located on the opposite interior walls are exhaust registers which communicate to roof mounted exhaust fans through galvanized sheet metal ductwork. It does appear that for the most part, the exhaust fans are running, however, we could not determine if code required amounts of ventilation air are actually being exhausted. The systems appear adequate in overall design, however, are extremely antiquated and generally in need of replacement.

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- Administration Area: The administration area is heated by a series of fin tube radiation located along the exterior wall which is controlled by individual wall mounted thermostats. All radiation ties into the central steam distribution system and was installed during the original 1950 construction. All radiation was noted to have slight surface soiling and a slight damage, however, does operate and maintain adequate space temperature control. There was no mechanical ventilation systems installed and it appears that all ventilation was intended to be through the use of operable windows. Although this condition does meet minimum code requirements for the exterior spaces, there were internal areas that are not provided with adequate ventilation. This condition is not code compliant and should be improved upon. Throughout the entire administration area window mounted air-conditioning units are installed. These units are sized adequately for the spaces that they serve, however, are noisy when they operate.

- Communicating Corridors: The communicating corridors which circulate throughout the entire building were provided with a limited amount of exhaust air. This entire condition is considered not code compliant and should be improved upon. The corridors were provided with a limited amount of convection heat of which is controlled by wall-mounted pneumatic thermostats. All convectors were noted to have slight surface soiling and slight damage and do appear adequate in maintaining reasonable space temperature control. Based purely on age, the entire system should be upgraded.

- Entrances & Vestibules: The main entrance vestibule located adjacent to the administration area was not provided with any heat. This condition will allow for the infiltration of cold air during frequent use of the area. The entrance lobby was provided with a single cabinet heater of which is undersized for the area served particularly during frequent use of the exterior doors. This condition should be improved upon.

- Public Toilet Areas: The common public toilet areas are provided with a series of wall mounted exhaust registers located generally adjacent to the plumbing fixtures. All wall exhaust registers were noted to be extremely antiquated; many of which were damaged. We did note that there was no makeup air provided for the exhaust systems. The exhaust registers communicate to roof mounted exhaust fans through a galvanized sheet metal

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exhaust system, all of which is original to the building and in excess of 50 years old. Heating of the spaces is through various wall mounted convectors which tie into the low-pressure steam distribution system which are controlled by wall mounted thermostats. All heaters were noted to be antiquated, had slight surface soiling, however, do operate and maintain reasonable space temperature control.

- Computer Room: The computer room is conditioned by a window type A/C unit.

Deficiencies:

In general, the existing HVAC systems currently serving this building are over 50 years old and should be replaced. All of the unit ventilators and air handling units are original equipment and have exceeded their serviceable life expectancy.

Other than the control compressor, all of the remaining boiler room equipment is original and in poor condition. Approximately 60% of the piping insulation within the boiler room is missing or damaged. The combustion air dampers appear to be undersized based on the firing rate of the boilers.

All of the existing steam, condensate and heating hot water systems are original and in poor condition. There are numerous locations throughout the building where the piping insulation is missing or damaged. The entire piping system should be replaced at the time of building renovation.

All of the building's toilet and general exhaust systems are original and in fair condition. It is assumed that the systems are not operating at design capacity.

There are numerous code violations at the kitchen including a lack of the required fire suppression and exhaust system, lack of manual pull stations, hood does not cover all of the grease producing cooking equipment and there is no make-up air.

The window air conditioning units are typical residential type with unit mounted controls. The unit in the computer room was visible for inspection and in good condition.

Temperature control systems are original to the building and have failed with age. The system is not capable of meeting the demands of current energy codes or modern

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HVAC systems and equipment.

Recommendations:

Due to the age and deteriorating condition of the existing HVAC systems this office recommends a complete replacement of all systems and equipment with the exception of the oil tanks. We would recommend a hot water system over the current steam system. A hot water system will operate more efficiently than a steam boiler plant and is better capable of controlling temperature. A new HVAC systems will be controlled by a digital energy management system. Several options for replacing the existing system are as follows:

Option 1 – Replace Existing Boiler

This option would be an interim measure prior to a total renovation of the existing HVAC system to provide a reliable beating plant for the building. The existing oil-fired system boiler and boiler feed pump would be removed and two new dual fuel cast iron boilers installed.

The new boilers would be a sectional cast iron type boiler to facilitate installation into the existing boiler room without having to remove walls or windows. Each new boiler would be fitted with a fully modulating burner, lead lag controls, and would be capable of being converted to a hot water boiler and used once to the entire system was renovated.

Option 2 – New Two-Pipe Hot Water Heating System with Air-to-Air Heat Recovery

This option would consist of a complete replacement of the existing two-pipe steam heating system with a new two-pipe hot water heating system with air-to-air heat recovery units to provide ventilation. The primary heating plant would consist of two or more high efficiency dual fuel boilers with fully modulating burners, hot water reset control, and lead/lag operation.

A two-pipe hot water distribution system would be run in the crawl space to serve all new heater units and would be fitted with new variable speed hot water pumps, designed to regulate the amount of water flow in proportion to the building's demand. Each existing classroom, office, and multi-purpose space would be heated by a vertical fan coil unit and/or panel type radiator with control designed to provide individual room control. Ventilation would be provided by air-to-air heat recovery

ventilators located in the attic and ducted to each room. All new equipment would be controlled by a digital energy management system designed to optimize system efficiency and provide maintenance screening. The office and computer lab area would be fitted with a variable refrigerant air conditioning system capable of providing cooling year round, and the kitchen would be fitted with a variable speed hood exhaust and make-up air system.

Option 3 – Geothermal Heat Pump System

This option would consist of replacing the existing oil-fired steam heating system with a new geothermal heat pump system and air-to-air heat recovery ventilators. The primary heating and cooling plant would consist of approximately 30 closed loop geothermal wells headered together effectively using the ground as a heat source or heat sink for the building's heating and cooling needs. The loop field would be located under the playfield or the parking lot. Each classroom, office, and multi-functional space would be heated and cooled by a heat pump unit connected to the geo-thermal heat pump loop run in the crawl space. As in Option 1, ventilation would be provided by air-to-air heat recovery ventilators also connected to the geothermal loop. All new equipment would be connected to a digital energy management system with a remote energy monitor located in the main entrance to the school which would illustrate the operation of the system to the steamer and public and measure the energy savings. This system is currently eligible for both State and Federal energy savings.

Option 4 – Sustainable Systems

As part of this report, this office also reviewed sustainable (green) energy systems which may be feasible at the Anne T. Dunphy School. The systems reviewed were as follows:

- Solar domestic hot water – This system was not found to be cost effective for this application unless the School was to be used year round.

- Biomass Boilers – This is a boiler system which utilizes processed wood chips as the primary fuel in lieu of gas or oil. Due to the cost of maintenance on the burners and chip feed systems, we would not recommend this system as a primary heating plant for this building. A small system could be installed to augment the oil/gas boilers, and may be cost effective if Federal grants are available, otherwise, the cost of the equipment, maintenance, and the chip feed system make the life cycle cost too high for this application.

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- Photovaltaic Energy – This system would consist of installing a 10kw photovoltaic array on the roof of the school and connecting it to the primary electric service of the building. This system would be capable of generating electrical power to the building year round, and could also be used as an interactive teaching lab for the students. There is currently Federal and State grants available to help fund these systems.

ELECTRICAL AND TECHNOLOGY

Existing Conditions:

Power Distribution:

The existing main service disconnect switch is a 400A circuit breaker with current transformer cabinet for utility metering for a 208/120V, 3 phase, 4 wire service. The main electric service is located in the kitchen which also houses the telephone service demarcation and the fire alarm control panel. The main electric service distribution serves panelboards which are located in the kitchen and in corridors. The main service equipment and feeders appear to be original to the building. Being in operation for fifty years, the panelboards and associated feeders are at the end of their useful and dependable life. The original panelboards and associated circuit breakers are no longer available and are not supported by the manufacturer. The existing service and distribution is still in working order and appears to have sufficient capacity for the existing facility but may be inadequate for moderate expansion or load increase. The location of the existing main service distribution and panelboards are inaccessible due to the storage practices at the facility. The distribution equipment requires a minimum of 3 feet of unobstructed clearance and shall be readily accessible.

Lighting:

The lighting systems throughout the school are primarily T8 fluorescent lamps in either open louver pendant fixtures or surface wraparound lensed fixtures in the corridors, office and classrooms. The gymnasium and cafetorium, being high ceiling rooms, utilize high intensity fluorescent or metal halide light fixtures which appear to be newer and in good condition. The classroom toilet rooms and utility spaces utilize incandescent lamps. The main entrance has exterior incandescent light fixtures. The remaining exits do not have exterior light fixtures. Due to the age of the existing light fixtures, the ballasts should be checked for PCB content which would require hazardous disposal.

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The lighting control in the classrooms and offices have been modified since the original construction to provide occupancy sensor control of the room lights.

The dimmer control of the stage lights in the cafetorium appears to be original to the building and is at the end of its useful life.

Emergency Lighting:
Emergency lighting consists of battery light fixtures. Fixtures are stand alone and are not connected to the existing local lighting circuits. Emergency lighting was observed in the corridors and the large spaces such as the gymnasium and cafetorium. The quantity and locations of emergency lights appear to be inadequate to provide the minimum 1 footcandle light levels required by code. The exterior side of the egress doors do not have emergency lighting as required by current code.

The exit signs do not have battery back-up and do not meet current code for stencils requirements.

Fire Alarm:
The fire alarm system was recently installed. The fire alarm system consists of manual pull stations located at the corridor egress doors and egress doors from the gymnasium and cafetorium, smoke detectors, horn and/or strobe units in most occupiable spaces, heat detectors in high heat spaces such as the boiler room and control panel in the kitchen. The fire alarm system is an addressable system manufactured by Edwards.

Although the fire alarm system is new, the spacing and locations of strobes do not meet current code. The use of ceiling mounted strobes does not meet ADA.

Special Systems:
The clock system is not original to the building. The original clock system failed and stand alone clocks were installed in each classroom.

The sound system is by Bogen. The age of the system is indeterminate based on visual inspection. The speakers are surface mounted at the corner between the wall and ceiling and display the Bogen manufacturer brand label.

Technology:
The telephone system service entrance is located in the computer classroom with 110 punch down blocks.

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Emergency telephones are all mounted in each classroom adjacent to the door.

The data rack is located in the computer room with horizontal distribution to each classroom, office and similar space. Each classroom has a single data back box locations with two data jacks per back box.

Recommendations:

Recommendations for the Electrical systems are based on code compliance and the age and condition of the systems.

Replace main service distribution, panelboards, dimmer panel and associated feeders.

Replace existing fluorescent light fixtures with energy efficient type containing either T8 or T5 lamp technology and electronic ballasts. The proposed light fixtures will result in a reduction of energy consumption by between 12% and 20%.

Replace existing incandescent light fixtures with fluorescent light fixtures. The proposed light fixtures will result in a reduction of energy consumption by approximately 80%.

The exit signs should be replaced with new battery back-up exit signs meeting current code for letter stencil dimensions and direction chevrons. The proposed exit signs should be LED type which would reduce the energy consumption of each exit sign by approximately 90%.

The original emergency light system utilizing battery units in the storage and utility rooms with recessed remote heads should be removed. The self-contained emergency lights should have the batteries replaced if they are more than two years old. Self-contained emergency lights with batteries that are no more than two years old should be tested and failed batteries should be replaced. Additional emergency lights should be added to ensure that any point along each egress path does not have less than 1 footcandle of illumination when normal power is lost.

Normal and emergency lighting should be provided at the exterior side of each required exit as required by current code.
The need for additional receptacles should be reviewed with the school to ensure that current and future needs will be satisfied.

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Add a fire suppression system to the kitchen hood and reconfigure the power to all equipment under the hood with shunt trip function to shut down power upon hood suppression system activation. Monitor the fire suppression system with the fire alarm system.

Relocate and add fire alarm horn/strobe units in the corridors to meet current code.

Add manual pull stations at each fire exit that does not currently have manual pull stations including the fire exits from the classrooms.
Test incoming phone lines and replace lines that do not meet signal test requirements.

Need and function of the clock system, security system, CATV system, and the sound system should be reviewed with the school board for operational requirements and modifications.