HUNTLEY

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January 20, 2009

Deputy Chief Robert Strahan
Greenfield Fire Department
412 Main Street
Greenfield, MA 01301

RE: ***Structural Evaluation of Elevated Apparatus Bay Floor; Greenfield Fire House, Greenfield MA***
SEA Project No. S09-018

Dear Chief:

Per the Fire Department's request, Huntley Associates, P.C. (HAPC) has completed its inspection and evaluation of the existing elevated concrete apparatus bay floor at the Greenfield Fire House located at 412 Main Street. The purpose of our inspection was to review deteriorated and cracked conditions observed within the existing concrete floor, and offer an opinion as to the floor's structural integrity. The following is a summary of HAPC's observations and evaluation of the existing floor system, as well as some observations made about the remainder of the building. Attached hereto also are a number of photographs depicting the general structural conditions observed with the building's elevated floor system and a summary of our structural analysis results.

Existing Elevated Floor System

The Fire House's existing elevated apparatus bay floor is a composite of two structural systems. Its original construction was that of concrete waffle slabs supported by concrete beams and piers reportedly dating back to around 1935. Some design plans of this original floor system were available for review, but contained little information regarding its allowable floor load capacity. Reportedly due to the increase in number, size and weight of more modern fire apparatus needed by the Fire Department, the existing waffle slab system was structurally reinforced around 1962-1963 through the incorporation of a concrete topping applied directly on top of the original floor system, as well as numerous welded steel members placed beneath the original floor system and around its respective piers. Steel beams and girders (comprised of various sized steel wide flange members) were used to help strengthen/support the existing concrete waffle slab system, while the existing concrete piers were reinforced with channels, angles and flat stock steel. Unfortunately, no construction plans of this structural steel reinforcing or concrete topping systems were available forcing HAPC to obtain limited as-build field information and make various assumptions in our evaluation of the same. The reinforced piers supporting the elevated floor system pass through the basement slab-on-grade and reportedly rest on concrete spread footings of sufficient frost depth.

Observations

The existing elevated apparatus bay floor system is in varying degrees of condition, ranging from good to poor, depending on location and which system (original concrete waffle slab or structural steel reinforcement) was observed. The top surface of the original waffle slab was not visible due to the fact that an approximate 2" thick overlay of concrete was supposedly placed on top of the slab sometime during the 1962-1963 reinforcement pursuit. However, the existing 2" concrete overlay itself displayed numerous signs of cracking and wearing due to consistent loading and traffic from the fire trucks and apparatuses parked/staged on this floor. In many places, the slab was actually rutting along the apparatus wheel travel paths. Most of the more severe cracking observed was located parallel to and at the bay entrances (approximately where the elevated slab extended over and past the building's front foundation wall and becoming a slab-on-grade), as well as over the existing interior

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concrete waffle slab beam/new reinforced steel girder locations. Various other smaller cracks, as well as some "spider web" cracking were also noted throughout the elevated slab area.

From the basement level, HAPC was able to observe most areas of the original waffle slab's underside surface (unless hidden by the supporting steel members). Multiple cracks, spall areas and water damage were observed throughout various parts of the slab's underside surface. The spall areas were such that it was possible to confirm the existence of steel reinforcement within the waffle slab system by evidence of this reinforcing being exposed and starting to corrode and deteriorate. HAPC was further able to observe multiple other locations where rust stains were becoming visible within the concrete waffle slab leading to the expectation of further corrosion of the reinforcing steel still buried directly beneath the concrete surface, but had not yet spalled. An examination of those areas within the basement directly around the existing piers that support the elevated slab system found that their respective foundation systems appeared adequate, as there were no obvious signs of foundation settlement. Portions of the existing basement concrete slab-on-grade, however, did appear to have experienced some differential settlement. But it is believed that this settlement is a result of localized subgrade and/or subbase settlement/failure directly below the respective slab area and not a result of more serious elevated slab interior pier support settlement/failure.

HAPC observed and documented the newer structural steel support members within the basement supporting the concrete waffle slab and surrounding piers finding them to be in good condition with only minor issues. Although there were areas of rust observed (likely due to water infiltration/damage from the apparatus bays above), the steel did not appear to be in a severely deteriorated state. Obviously continued exposure to moisture could increase the chances of further and more serious deterioration. Lastly, it appears that steel shims had been installed between the existing concrete waffle slab and newer steel support systems in order to ensure some bearing between the two systems.

Analysis/Evaluation

Using the same dead and live uniform loading (60psf and 250psf) information provided within the November 1988 structural report prepared by Joel Lunger, P.E. of Cleverdon, Varney & Pike, Inc. together with the updated fire apparatus axle loading information provided by the Greenfield Fire Department (copy attached hereto), HAPC was able to conduct a comparative analysis (to that of Mr. Lunger's report) of the existing structural steel system supporting the underside of the concrete waffle slab in order to determine any approximate change in the steel's stress due to the even newer heavier fire apparatus currently being used by the Fire Department. The Lunger report concluded that the existing structural system was more than adequate to support the fire apparatus of that time and that, in fact, the 250psf uniform live loading criteria used within his analysis was the governing criteria; not the localized axle point loading that would have been created by the actual fire apparatus. This report, however, does little to explain how he calculated and applied the truck loading used within his analysis. Based on the level of calculations provided, it is assumed he looked at only one load scenario.

In order to more accurately analyze the existing steel support members, HAPC looked at three different loading scenarios. They are as follow:

- Load Case 1) Single heaviest vehicle with rear axle load located at mid-span of beam (other axle load assumed outside of beam span).
- Load Case 2) Single heaviest vehicle, having shortest wheelbase, with both axle loads acting on beam (located equal distant from opposite girders).
- Load Case 3) Two heaviest vehicles, back to back, whose heaviest rear axles are approximately 9 feet apart from one another, acting on beam (located equal distant from opposite girders).

As previously stated, HAPC's analyses used Mr. Lunger's same applied dead and live uniform loading, but recalculated the new vehicle point loading based on the updated fire apparatus axle load and wheel base information provided by the Fire Department. Our analyses concluded that the load carrying capacity of the existing floor system, with the supporting structural steel members in place, is in fact still adequate in handling each Load Case. For Load Case 3, however, some of the supporting beams were found to be at their maximum allowable stress capacity.

Due to the appearance of the existing supporting steel members beneath the waffle slab not being located evenly over the apparatus bay drive areas, it is possible that some of the beams could experience slightly higher axle wheel loading (depending on the beams exact positioning within a drive bay and how the fire apparatus equipment is ultimately positioned over these beams). To account for this, HAPC reran its calculations to include a 25% load increase on the vehicular point loads. The results of this follow-up analyses concluded that the load carrying capacity of the existing floor system, with the supporting structural steel members in place, was still adequate in handling Load Cases 1 and 2. However, a number of supporting beam members failed under Load Case 3. A summary of our tabulated calculations for the beam members is attached. A review of the steel girders supporting these beams between the existing piers concluded similar results with respect to each Load Case, but with minimal overstress conditions. HAPC did not find any of the beams or girders as exceeding their allowable live and total load deflection limits of L/360 and L/240 respectively.

It is important to note that the above analyses (as did likely the previous reports') assumed that the existing steel and concrete materials in these systems, as well as the connections between them, were in adequate structural condition. Therefore, allowances (e.g., allowable stress reductions) incorporated into the analyses to account for deteriorated conditions would obviously decrease the available remaining floor capacity (or increase the amount of overstress for beams currently overstressed) identified in our calculations; in some cases enough so that the need for "use and or" staging restrictions might need to be considered.

As for the observed cracking and deterioration within the concrete topping and original waffle slab, HAPC offers the following. It is HAPC's professional opinion that the cracking observed at the bay entrances and over the existing interior concrete waffle slab beam/new reinforced steel girder locations are a direct result of reverse bending taking place within the concrete topping and the lack of proper jointing at these locations. As the slab system between these locations would deflect downward under load, the concrete topping at the crack locations (prior to the cracking occurring) would experience reverse bending, thus, introducing tensile stresses into the concrete topping material. Due to the limiting thickness of the concrete topping, these tensile stresses were likely too great, thereby, causing the concrete topping to crack. The other noted slab cracks and "spider web" cracking noted within the concrete topping are believed to also be a result of the slab system's natural downward deflection and the topping's age. The use of the existing apparatus bays for cleaning of the fire trucks (particularly in the winter time) allows water and potentially road salt to enter the cracks (further deteriorating them) and migrate down to the reinforced waffle slab and steel support system below, thereby, causing and breeding more corrosion/deterioration of the steel reinforcing within the concrete (causing additional concrete spalling) and the structural steel support system.

Other Observations

During HAPC's inspection of the elevated apparatus bay area, HAPC also conducted a general walk-through of the building's remaining areas and exterior perimeter. Various areas of step cracking were noted within the exterior bearing (and non-bearing) wall's brick façade along the rear of the building, traveling from the upper window headers down toward the building's nearest corner. This cracking is likely due to some minor differential settlement with the exterior building walls and does not appear to cause any structural threat of failure or collapse. No evidence of bowing, bulging, or lateral movement within any of the walls was noted that would cause imminent structural concerns. None-the-less, these cracks should probably be filled with a flexible joint compound (matching the color of the brick) and monitored over time for any increases in width. Upon pursuing these repairs, a closer examination of the brick mortar should also be pursued at these locations, as well as the upper (5) feet of the perimeter walls to determine whether they have become deteriorated and need to be repointed.

HAPC also conducted a walk-through of the newer single apparatus bay addition (for the Fire Department's ladder truck) located to the east of the original structure containing the elevated concrete waffle slab system. The concrete floor slab within this addition was also elevated, but much newer and of flat construction. Two cracks were noted within this floor slab (parallel to the entrance bay door) approximately 5-feet from each end of the ladder truck's wheel base. Although minor and of no immediate structural concern, their presence and location relative to the ladder truck appears to indicate that they may likely have been caused by the live point load weight of this vehicle. Although no immediate repair is required, these cracks should continue to be monitored for any increases in width, thereby, suggesting that progressive damage could be occurring. Should this become the case, it is recommended that the Fire District have the elevated slab re-inspected/re-evaluated.

Final Recommendations

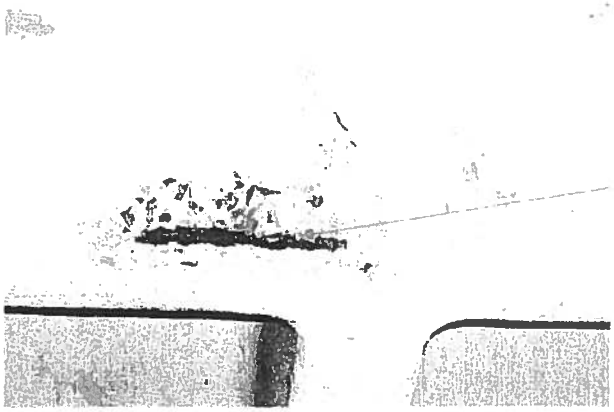
There does not appear to be an immediate need to reinforce the existing concrete waffle slab/steel support systems based on our structural analyses results. However, maintenance repairs to the current concrete topping, in order to make it watertight, and the corroded waffle slab reinforcing and structural steel support members, as well as the spalled concrete areas on the underside surface of the waffle slab, are warranted and should be pursued as soon as possible, if the Fire Department intends on staying at the current facility. Although, at a minimum, the cracks within the concrete topping should be sealed with either a flexible or cementitious (depending on location) joint repair material, it is recommended that serious consideration be given to having the current concrete topping completely removed, such that the existing waffle slab's top surface could be properly inspected/evaluated and a new stronger high-strength concrete and/or epoxy topping installed. These measures will help make the elevated slab watertight to hopefully minimize further corrosion and spalling of the steel and concrete construction below it. The corroded and deteriorated structural steel support members should be thoroughly cleaned and painted with a rust-preventive coating. The spalled areas on the underside surface of the concrete waffle slab should also be cleaned (especially the steel reinforcing) and an epoxy repair mortar applied.

It is HAPC professional opinion and recommendation, based on numerous past firehouse project (new and renovated) experience, that the Fire Department seriously consider planning for either a complete rehabilitation and expansion or replacement of the current firehouse based on future fire apparatus needs and size/weight. HAPC does not recommend the use of the existing apparatus bays with any additional and/or heavier apparatus without an in-depth structural analysis/review and additional structural support. If replacement options are not possible, then one easy was to remedy the current elevated slab deficiencies is to infill the basement area such that the elevated slab now becomes fully supported. We hope that this report presents a clear understanding of the general structural conditions surrounding your existing elevated slab system and its current load carrying capacity. As always, please feel free to contact me should you have any questions.

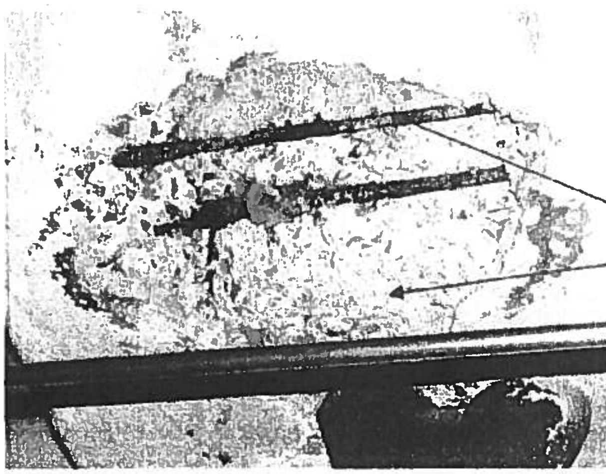
Sincerely,

HUNTLEY ASSOCIATES, P.C.

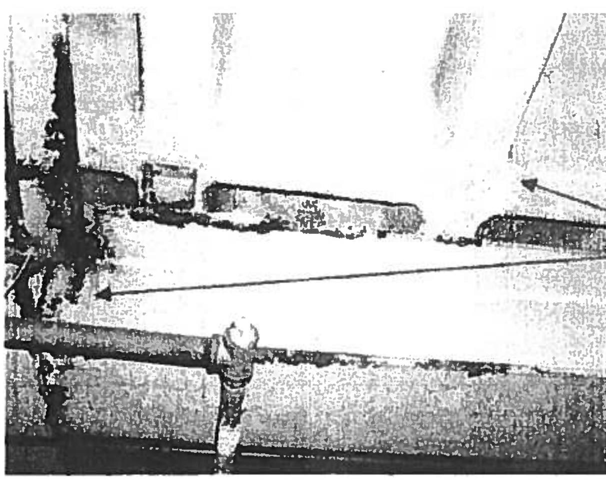
Michael W. Schafer, P.E.
President



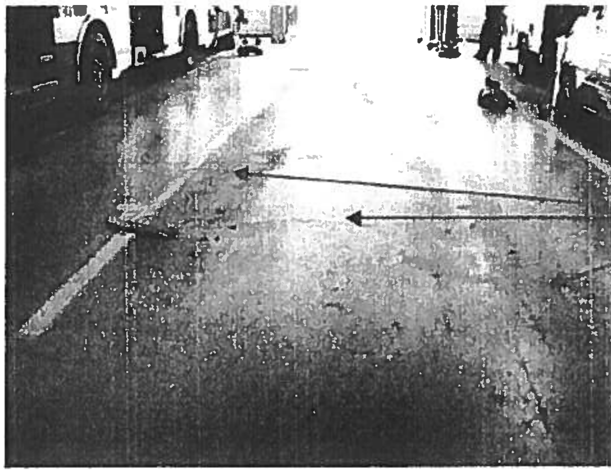
View of the corroded reinforcing steel and concrete spalling within the underside surface of the waffle slab system.



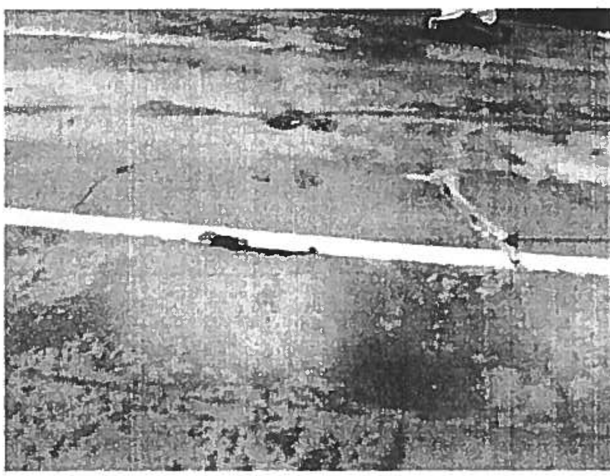
View of the corroded reinforcing steel and concrete spalling within the underside surface of the waffle slab system.



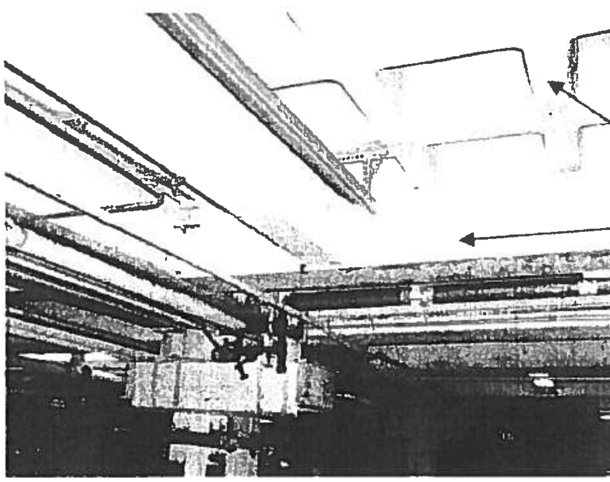
View of the water infiltration and staining on underside of concrete waffle slab causing corrosion within the structural steel support beam members.



View of the elevated apparatus bay floor 2" concrete topping which is cracking and rutting from continually use.



View of the elevated apparatus bay floor 2" concrete topping which was cracked and filled with an epoxy sealant.



Overall underside view of the concrete waffle slab and how it is supported/reinforced by steel beam and girder members.

GREENFIELD FIRE - VEHICLE APPARATUS WEIGHT DATA

TRUCK	GVWR	FAGV	RAGV	FATIRE	FARIM	RATIRE	RARIM	WHEEL BASE
ENG 1	40,000	16,000	24,000	315-80R-22.5 (L)	22.5x9.0	12R-22.5 (H)	24x8.25	189"
ENG 2	40,540	16,540	24,000	315-80R-22.5 (J)	22.5x9.0	12R-22.5 (J)	22.5x8.25	187"
ENG 3	40,200	16,200	24,000	12R-20 (J)	20x8.5	11R-20 (G)	20x8.0	169"
RESCUE	31,000	12,000	19,000	11R-22.5 (G)	22.5x8.25	11R-22.5 (H)	22.5x8.25	196"

GVWR – Gross Vehicle Weight
FAGV - Front Axle Gross Weight
RAGV - Rear Axle Gross Weight
FATIRE- Front Axle Tire
RATIRE- Rear Axle Tire
FARIM - Front Axle Rim
RARIM – Rear Axle Rim

GREENFIELD FIRE HOUSE ELEVATED APPARATUS BAY SLAB STRUCTURAL ANALYSIS RESULTS

Approx. Weight of Concrete	116.56 psf
General Apparatus Bay Live Load	60 psf
Heavy Apparatus Bay Live Load	250 psf

#	Span	M-Max	Trib	WDL	MDL	M250	M60	MDL+250	MDL+60	Avail MPL	MPL Single (1)	MPL Single (2)	MPL Double	TCK CAP Single (1)	TCK CAP Single (2)	TCK CAP Double	Original Report TRUCK CAP	Original Report 250L CAP
1	24	188.60	6.44	0.7506	54.05	115.92	27.82	169.97	81.87	106.93	76.64	62.81		119%	130%		124%	111%
2	24	188.80	6.48	0.7553	54.38	116.64	27.99	171.02	82.38	106.42	76.64	62.81		119%	130%		124%	110%
3	24	221.98	7.50	0.8742	62.94	135.00	32.40	197.94	95.34	126.64	77.36	63.32		129%	140%		147%	112%
4	24	221.98	7.50	0.8742	62.94	135.00	32.40	197.94	95.34	126.64	77.36	63.32		129%	140%		147%	112%
5	24	221.98	8.69	1.0129	72.93	156.42	37.54	229.35	110.47	111.51								
6	13	72.22	7.75	0.9033	19.08	40.93	9.82	60.01	28.91	43.31								
7	21	169.00	5.50	0.6411	35.34	75.80	18.19	111.14	53.53	115.47	66.18	45.63	77.14	141%	170%	129%	159%	162%
8	21	169.00	5.50	0.6411	35.34	75.80	18.19	111.14	53.53	115.47	66.18	45.63	77.14	141%	170%	129%	159%	162%
9	21	169.00	7.50	0.8742	48.19	103.36	24.81	151.55	73.00	96.00	66.18	45.63	77.14	121%	142%	113%	134%	112%
10	21	169.00	7.50	0.8742	48.19	103.36	24.81	151.55	73.00	96.00	66.18	45.63	77.14	121%	142%	113%	134%	112%
11	21	169.00	6.13	0.7145	39.39	84.48	20.27	123.87	59.66	109.34	66.18	45.63	77.14	134%	161%	124%	151%	136%
12	21	169.00	6.13	0.7145	39.39	84.48	20.27	123.87	59.66	109.34	66.18	45.63	77.14	134%	161%	124%	151%	136%
13	23	169.00	5.83	0.6213	41.08	88.11	21.15	129.19	62.23	106.77	73.03	62.67	92.37	125%	135%	109%	130%	131%
14	23	169.00	6.50	0.7576	50.10	107.45	25.79	157.55	75.89	93.11	73.03	62.67	92.37	113%	122%	100%	116%	107%
15	23	205.85	7.50	0.8742	57.81	123.98	29.76	181.79	87.56	118.29	73.89	53.79	88.89	127%	146%	117%	145%	113%
16	23	205.85	7.50	0.8742	57.81	123.98	29.76	181.79	87.56	118.29	73.89	53.79	88.89	127%	146%	117%	145%	113%
17	23	169.00	6.13	0.7145	47.25	101.34	24.32	148.58	71.57	97.43	73.03	62.67	92.37	117%	126%	103%	120%	114%
18	23	169.00	6.13	0.7145	47.25	101.34	24.32	148.58	71.57	97.43	73.03	62.67	92.37	117%	126%	103%	120%	114%

Approx. Weight of Concrete	116.56 psf
General Apparatus Bay Live Load	60 psf
Heavy Apparatus Bay Live Load	250 psf
Tributary Increase Factor	25%

#	Span	M-Max	Trib	WDL	MDL	M250	M60	MDL+250	MDL+60	Avail MPL	MPL Single (1)	MPL Single (2)	MPL Double	TCK CAP Single (1)	TCK CAP Single (2)	TCK CAP Double	Original Report TRUCK CAP	Original Report 250L CAP
1	24	188.60	6.44	0.7506	54.05	115.92	27.82	169.97	81.87	106.93	95.80	78.51		106%	118%		124%	111%
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11	21	169.00	6.13	0.7145	39.39	84.48	20.27	123.87	59.66	109.34	82.73	57.04	96.43	119%	145%	108%	151%	136%
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14	23	169.00	6.50	0.7576	50.10	107.45	25.79	157.55	75.89	93.11	91.29	78.34	115.46	101%	110%	89%	116%	107%
15	23	205.85	7.50	0.8742	57.81	123.98	29.76	181.79	87.56	118.29	92.36	67.24	111.11	114%	133%	104%	145%	113%
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17	23	169.00	6.13	0.7145	47.25	101.34	24.32	148.58	71.57	97.43	91.29	78.34	115.46	104%	113%	[illegible]	120%	114%
18	23	169.00	6.13	0.7145	47.25	101.34	24.32	148.58	71.57	97.43	91.29	78.34	115.46	104%	113%	90%	120%	114%

ECM-12: Fire Station Ceiling Insulation

Description

The Fire Station is brick construction and based on the physical inspection and a review of the drawings, there are varying amounts of insulation. In recent years, insulation above dropped ceilings was added for portions of the second floor. However, there is another area on the second floor that has plaster ceilings. The attic space directly above this area was found to have very minimal insulation (0 - 4 inches). This lack of insulation certainly contributes to the overall heat load of the building. Therefore, it is recommended that 12 inches of blown in cellulose insulation be added to the attic space of the Fire Station. Insulation is considered a preapproved Energy Conservative Measure under the DOER Energy Audit Program. The following table includes the estimated R-value for the existing and proposed ceiling configurations:

Existing Configuration

Material	R-value
Inside air film	0.61
1/2" Plaster or Drywall	0.45
2" blown in insulation (average)	6.80
Top air film	0.61
Total R-value (between framing)	**8.47**

Proposed Configuration

Material	R-value
Inside air film	0.61
1/2" Plaster or Drywall	0.45
12" blown in insulation	40.80
Outside air film	0.61
Total R-value (between framing)	**42.47**

R-value Units: $^{o}F\text{-hr-ft}^2/\text{Btu}$

Operation

- There are no operational changes associated with this Energy Conservation Measure.

Initial Cost Estimate

- The attic area is estimated to be 80 ft x 20 ft = 1,600 ft^2

Using a combined surface area of 1,600 ft^2 and a unit rate of \$1.75/ft^2, the total installed cost[23] is estimated to be \$2,800.

Annual Savings Estimate and Payback

Energy Savings: $(1/R_{exisitng} - 1/R_{new})$ x Degree Days[24] x 24 hrs/day x C_d Adjustment[25] x Ceiling Area

Energy Savings: (1/8.47 – 1/42.47) x (6,321) x (24) x (0.62) x (1,600) = 14.2 MMBtu

Assuming 80% boiler efficiency, the annual cost savings is expected to be:

Cost Savings = (14.2 MMBtu / 0.80) x (\$17.39/MMBtu) = \$308.67

Simple payback is \$2,800 / \$309 = 9.1 years

[23] Unit rate estimates are based on published information from RSMeans
[24] Average Annual Heating Degree Days for Chicopee/Westover ARB, MA (1967 to 1996)
[25] Annual Heating Degree Day Correction Factor, 1989 ASHRAE Fundamentals Handbook

ECM-13: Fire Station Space Heating Improvements

Description

The first floor Apparatus Room and adjoining Tower Bay are areas with high ceilings and high air exchanges, due to the frequent opening of the garage doors when calls are received. These spaces combined account for 30% of the total building square footage. As a result, it is conservatively estimated that these areas account for 50% (288.8 MBH) of the adjusted[26] total building heat load[27]. Although the space is 30% of the total building square footage, it is assumed to account for 50% of the total heat load due to the high ceilings and frequent air changes associated with the space. The oil fired hydronic heating system supplies forced hot water to ceiling mounted unit heaters in these areas. As designed, the heating distribution system is an inefficient use of energy for this high bay application. The heat is distributed to the terminal units and the heat that is emitted from the terminal units tends to be stratified with the warmest areas being nearer the ceiling. Additionally, the frequent air changes, due to the opening of the garages doors, require the continuous heating of large amounts of outdoor air.

A more efficient means of heating the space would be to install an infrared radiant heating system for these areas. Radiant heating is very well suited for large air spaces with high ceilings, because rather than heating the air the heating element transmits heat through electromagnetic radiation to the floor and other objects within the space. This allows the heat to be delivered in a much more targeted manner and thus provides a more efficient mechanism for transferring the heat to where it is needed[28]. An additional benefit is that individual units can be turned off in portions of the space that are not used regularly. While the radiant method of heat transfer does not heat the air directly, the air is heated indirectly by the convective heat transfer between the ambient air and the objects in the room. The end result is that radiant heating will provide a given level of comfort at a reduced ambient air temperature as compared to non-radiant heating systems.

The specific equipment considered for this application is a low intensity, gas-fired, tube style unit, such as the HL2 Series, DET3 Series, or LD Series offered by Detroit Radiant. These units are typically specified by length, BTU rating, single stage or two stage and material of construction. The units can be used with either natural gas or propane and require connections to the outside for venting and combustion air.

With an estimated space design heat load of 288.8 MBH approximately ten (10), two-stage, 30 ft long tube style units, rated for 25,000 – 50,000 Btu/hr each, would be sufficient to heat these areas. Each unit would be controlled by its own thermostat for each bay area.

The balance of the adjusted building heat load, approximately 288.8 MBH, could be met by replacing the existing heating plant with two smaller, energy-efficient, oil-fired boilers, approximately 200 MBH each, with outdoor reset.

The final improvement to the building's space heating needs can be achieved by adding programmable thermostats for each heating zone, as well as new thermostatic radiator valves (TRVs) for individual rooms that are not used frequently. Other zoning options may be possible; however, detailed heating

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26 Space load assumed to be 50% of building load and then increased by 50% to adjust for design conditions
27 Appendix XV: Estimated Heat Load Profile for Fire Station
28 Appendix I: Technical Report on the Advantages of Two-Stage Infrared Heating

drawings were not available. Nevertheless, the programmable thermostats and new TRVs, in combination with boiler outdoor reset, will provide significantly more environmental control of the space. Currently, due to the lack of adequate control instrumentation, space temperature is modulated by opening windows during the heating season.

Ultimately, prior to implementing the recommended heating improvements, a detailed heat load analysis should be performed to allow for precise sizing of the necessary equipment.

Operation

- It is important that the infrared heating system is operated in full compliance with the manufacturer's recommendations, including sufficient clearance from combustible materials. An additional benefit of this technology is that units associated with the unused portions of the building can be turned off. Only using units when and where they are needed could dramatically reduce the level of energy consumption.

Initial Cost Estimate

The total project cost is estimated to be $49,073[29]

Annual Savings Estimate and Payback

Fuel oil costs for last year, which was a mild heating season, was $16,941. Changing to infrared radiant heating can reduce the heat usage by approximately 25% to 50% per year according to manufacturer studies[30]. As previously assumed, the area that would be upgraded to infrared radiant heating currently accounts for approximately 50% of the building heat.

The heating system for the balance of the building would be improved by right-sizing the boiler plant, incorporating outdoor reset and installing programmable thermostats. The combination of these three measures should reduce energy costs by eliminating the need for heat to be regulated by opening windows. Additionally, by installing two smaller boilers in a staged configuration, the overall efficiency of the boiler plant will be improved.

Therefore the estimated savings were calculated as follows:

Infrared Radiant Heating: (Existing Building Costs) x (Percent of Total Heating Load) x (Estimated Savings)

Infrared Radiant Heating: ($16,941) x (50%) x (37.5%) = $3,176

Boiler Plant Efficiency: $1,276 [31]

Outdoor Reset/Programmable Thermostats: (Existing Building Costs) x (Percent of Total Heating Load) x (Estimated Savings)

Outdoor Rest/Programmable Thermostats: ($16,941) x (50%) x (14% [32]*) = $1,186*

Total Savings: $3,176 + $1,276 + $1,186 = $5,638

[29] Appendix XVI: Fire Station Heating Upgrade (Source Data: RSMeans CostWorks – 1st Qtr 2008 Pricing)
[30] Appendix IV: Radiant Heat Savings
[31] Appendix XVII: Fire Station – Boiler Heating Analysis
[32] Appendix XVIII: Tekmar Outdoor Reset

Berkshire Gas provides incentives for installing certain energy-efficient equipment. This includes $500 - $1,000 for eligible forced hot water boilers, $500/unit (maximum 5 units per account) for low intensity infrared heating units and $25 per eligible thermostat (maximum 2 thermostats per account). Based on the recommendation, this ECM would have a maximum incentive of $4,550, assuming all customer qualifications and equipment specifications are met. Incentives are subject to Berkshire Gas approval.

Simple payback is $49,073 / $5,638 = 8.7 years