DCAMM

Massachusetts College of Art and Design

Tower Building Analysis

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1 Executive Summary

1.1 Introduction

The Commonwealth of Massachusetts Division of Capital Asset Management and Maintenance (DCAMM) retained Arup USA, Inc. to perform a preliminary building analysis of the Tower Building (Tower) at the Massachusetts College of Art and Design (MCAD).

This report combines three separate interim reports that have been prepared to inform our assessment and analysis of the Tower.

- Existing Building Assessment Narrative issued 22 February 2013
- Mandatory Interim Scope Narrative issued 13 March 2013
- Building Rehabilitation Options issued 12 March 2013

Each report has been included in this report as a respective section and an executive summary has been added to summarize those efforts as well as draw out the salient findings and conclusions.

Multiple building rehabilitation options of renovation and demolition were considered including project phasing. The order of magnitude total ECC ranged from $140,200,000 to $154,350,000 with an estimated project construction duration ranging from 24 to 33 months.

1.2 Building Description

The Tower at the Massachusetts College of Art and Design is located at 621 Huntington Ave in Boston. It is 14 stories tall, 13 of which are occupied plus one mechanical floor, and contains 318,299 gross square feet. Original construction documents are dated May 1972 while the building has been identified as built in 1977. A major renovation and upgrade was completed in 1999.

The Tower is the largest building on the MCAD campus and houses an auditorium, classrooms, offices, lecture halls, galleries and studio spaces for students, faculty and staff. Most significantly, the Tower contains 22 of the College’s 37 classrooms, i.e. 60%.

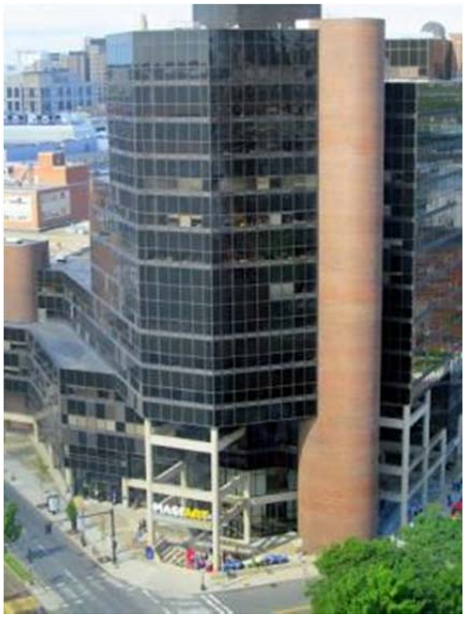


Figure 1 MCAD Tower Building

1.3 Existing Building Assessment

There are numerous concerns raised in this assessment regarding the existing conditions of the Tower. There are numerous systems and equipment that are original to the building, i.e. over 30 years old, and well past their useful life.

The most significant of these building systems is the main switchgear equipment, which currently poses a significant risk of failure. In the event of failure, a considerable amount of downtime (i.e. weeks) of the Tower not in operation would likely result. It is important to note that Collins, East, North and Gym buildings (future Center for Design + Media) on the MCAD campus are also fed from the Tower main electric room. These buildings would also be at risk in the event of failure.

Figure 1.3 MCAD Campus Buildings. The buildings identified in **BLUE** are fed from the Tower electric room.

The following list is a summary of the existing conditions assessment;

Tower Existing Conditions Summary

Façade

Very poor thermal performance

Very poor condition, leaks air and water

Significant repair work to the curtain wall has already been conducted and in places appeared to be deficient

Architectural

Roofs are in very poor condition, except level 13 which was recently replaced.

Interior layout is very inefficient, currently only 52.8% efficient.

Vertical transportation system is inefficient

Fireproofing and firestopping is inconsistent

A waterproofing failure was observed in the basement Electrical Room

The numbers of toilets are inadequate for the occupant loading and staff toilets are not provided as required by current code

Mechanical

Perimeter systems (i.e. unit ventilators and exhaust fans) are not working and difficult to repair since they are integral to the curtain wall system

13 of 15 Air handling units (AHUs) are past useful life

Air distribution system is a constant air volume (CAV) system which is inefficient.

Chillers are approaching end of life

Natural gas chiller is very high maintenance

Building Management System (BMS) has limited capabilities

Electrical Systems

Main switchgear is past its useful life and is in danger of failure

Secondary distribution system is in poor condition. The equipment is Federal Pacific. Replacement parts are no longer manufactured or available.

Emergency system doesn’t have emergency/standby/optional capabilities

Lighting system and fixtures are original to the building and inefficient

No lighting control systems are installed

Plumbing systems

Domestic hot water temperatures are higher than allowable code limits and pose a safety risk

Pipework is original to the building and is in very poor condition

Fire Protection

No stair or elevator pressurization systems are installed in this high rise building (life safety)

No smoke control systems are installed (life safety)

Fire pump is leaking from its casing and its foundation is corroding

Fire alarm devices are not connected to sprinklers

Hose valve connections are located outside rated stair enclosures (code requirement)

Sprinkler coverage is inadequate or non-existent, i.e. Auditorium

Fire alarm system is antiquated and doesn’t provide voice evacuation

No Fire Command Center is provided

Fire alarm panel is at/exceeded capacity. The fire alarm panel very recently had a faulty test

Accessibility *per the Institute for Human Centered Design Report, March 2011.*

The report identified deficiencies (non-compliances) with ADA and MAAB compliance.

Entry, accessible routes and paths of travel, including ramp slopes

Bathrooms and drinking fountains
Signage and wayfinding
Stairs and handrails
Seating areas
Door clearances, hardware and opening forces
Assistive listening devices

Hazardous Materials *per Axiom Partners 2007 report, refer to Appendix C.*

Asbestos is present and pervasive in the building.

Code

Handrails are not compliant
Path of egress issues are present

To address the deficiencies identified above, replacement of each of these systems is recommended. The structural system in the building is sound and in good condition.

It is important to note that piecemeal replacement of systems is not viable as most of the systems noted above are integral to one another and therefore cannot be addressed independently.

For instance, if the façade were to be replaced, the mechanical systems would also require a complete overhaul and redesign since the perimeter systems are integrated in the curtain wall system.

1.4 Mandatory Interim Scope of Work

As a result of the existing conditions assessment, a mandatory interim scope of work was developed.

It is necessary that the Tower continues to operate and be occupied, in the short and medium term. As such, money will need to be spent, separate from typical deferred maintenance, to keep the building running while a long term solution is developed.

As such, the items comprising this scope of work are recommended to be implemented in the immediate future and are different than items typically categorized as deferred maintenance. The scope has been categorized into three (3) classifications of work;

- The ***required scope*** addresses risks to life safety, and/or immediate building and/or MCAD campus operational issues.

Required Scope[1] **-** 11 scope items in total Priority: Immediate Operations and/or Life Safety
Order of Magnitude TOTAL ECC $3,673,015.00[2]

[1] Refer to Section 3 and Appendix A.1 for more details.

[2] During the course of this analysis, we understand that the fire alarm system in the Tower had a faulty test (9/2013) and the fire alarm panel has failed. The entire fire alarm system in addition to the panel has been priced for replacement by DCAMM separate from this study. The quotation provide for full replacement is $980,000.00 and has been added to the order of magnitude costs in this analysis. Refer to Section 3 for full details.

- The ***recommended scope*** includes upgrades which focus on energy efficiency. They can that can be implemented without extensive work and typically have short payback periods, i.e. 5 years or less.

Recommended Scope[1] - 2 items in total Priority: Energy Performance
Order of Magnitude TOTAL ECC $312,650.00

[1] Refer to Section 3 and Appendix A.1 for more details.

- The ***triggered upgrades*** scope addresses code issues, such as accessibility and path of egress issues that may potentially be required depending on the actual scope and schedule of work undertaken.

With the exception of the main switchgear replacement, the items identified would not be able to be maintained as part of the building rehabilitation options. However, the costs associated with the proposed switchgear scope of work are independent of the building and any potential building rehabilitation option so that the money spent is not a sunk cost but is rather an investment to the larger MCAD campus electrical infrastructure.

1.5 Building Rehabilitation Options

Given the lengthy list of deficiencies identified in the Tower and charge to rectify these, while also improving the building's layout efficiency, energy performance and system reliability, our conclusion is that a significant intervention is required.

The building rehabilitation options identified in this report are as follows;

Option 1: Retain Primary Structure and Complete Renovation

This option would strip the building back to its primary structure and completely rebuild the building. The benefit to this option is savings in terms of demolition costs for structure and associated construction time and cost to rebuild the structure. Additionally, a preliminary assessment of space planning indicated with the given floor plates, a slight increase of 6,370 net assignable square footage (i.e. usable square footage) could be achieved.

Three options for the phasing and construction approach have also been suggested,

(1) Unoccupied renovation. This would completely vacate the building and require all staff, faculty and students to relocate.

(2) Horizontal phasing. This option allows the building to remain partially operational with three floors offline at a time. Construction would move progressively up or down the building.

Vertical phasing. This option also allows the building to remain partially operational and be “split” in half vertically with one half under construction at a time. These options were developed with the assistance of Gilbane construction. Refer to section 4.3.1 for more details and Appendix D for Gilbane’s full report.

Option 2: Demolish and Rebuild

1. Rebuild 318,299 GSF

This option has been evaluated assuming the new building would have the same gross square footage as the existing Tower building. The benefit to this option is an increase of 16,521 square feet in net assignable square footage, or usable square footage for MCAD as a result of increasing the efficiency of the space planning from 54.8% in option 1 to 60.0% in a rebuilt scenario.

2. Rebuild 290,763 GSF

This option has been evaluated assuming the new building would have the same net square footage as option 1, i.e. 174,458 square feet. The benefit to this option is a decrease of 27,536 in the gross square footage to be re-built and associated cost savings. Again, this would be as a result of an increase in space planning efficiency from 54.8% in option 1 to 60.0% in a rebuilt scenario.

Refer to section 4.3.2 for more details and Appendix D for Gilbane’s full report.

1.5.1 Energy Use and Leading By Example

MCAD is not currently meeting the energy targets defined in Executive Order 484, Leading By Example (LBE). The Tower is the primary energy consumer at MCAD and its current poor condition is hindering the ability for compliance.

Any of the building rehabilitation options, would result in a significant improvement in energy performance. Preliminary energy modeling based on building rehabilitation option 1: retain primary structure and complete renovation indicates a reduction of 40% in energy use could be achieved. This represents a savings of $315,000 to $500,000 per year in energy costs, refer to Section 4.3.11 for full details. Such a significant reduction in energy use is also important as it would greatly contribute to MCAD meeting the LBE goals established in EO 484.

1.5.2 Findings and Conclusions

The condition of the Tower is beyond normal repair and deferred maintenance, and requires a very significant intervention. The building rehabilitation options presented, while substantial, are the only options that allow for addressing the current deficiencies, system reliability, building layout inefficiency, and energy performance.

The order of magnitude costs are likewise significant for all options. However, it is important to note that they also indicate that numerous options are viable, i.e. one is not immediately apparent as a preferable option based on the initial cost exercise conducted.

For context, the current 2013 CAMIS value of the Tower is $98,127,074.00 The Massachusetts Architectural Access Board (MAAB) 30% trigger for full accessibility compliance within the Tower is a three year rolling value of $29,438,122.00.

Building Rehabilitation Options: Summary Table

	Net Area (NSF)	Gross Area (GSF)	Efficiency[3] (%)	$/GSF	ECC[2]
Option 1: Retain Primary Structure and Complete Renovation					
Unoccupied renovation	174,458	318,299[1]	54.8	$461.80	$146,991,007
Horizontal phasing	174,458	318,299[1]	54.8	$494.37	$154,358,842
Vertical phasing	174,458	318,299[1]	54.8	$482.27	$153,506,294
Option 2: Demolish and Rebuild					
Rebuild 318,299 GSF	190,979	318,299[1]	60.0	$479.90	$152,750,287
Rebuild 290,763 GSF	174,458	290,763	60.0	$482.21	$140,210,393

[1] Areas noted have been provided by MCAD, and represent adjusted gross square footage (AGSF).

[2] The costs noted are 2013 dollars.

[3] Efficiency is the % of net square footage to total gross square footage

2 Existing Building Assessment

2.1 Summary

Arup USA Inc undertook an assessment of the Tower building (Tower) at the Massachusetts College of Art and Design (MCAD) addressing code, architectural, engineering and sustainability issues. This narrative is based on information provided by DCAMM and MCAD as well as a site observation tour of the building on January 17, 2013.

The Tower at MCAD is located at 621 Huntington Ave in Boston. It is 14 stories tall, 13 of which are occupied plus one mechanical floor, and contains 318,299 gross square feet. Original construction documents are dated May 1972 while the building has been identified as built in 1977. A major renovation and upgrade was completed in 1999.

The Tower is connected to but separated by a fire wall from an adjacent gymnasium building. It houses classrooms, offices, lecture halls, galleries and studio spaces for classes and students. 22 of 37 campus classrooms are located in the Tower.

The following assessment narratives have been prepared based on four primary sources of information. Please refer to Appendix G for a fill list of documents;

1. Information provided on CD by DCAMM on December 17, 2012.
2. Information provided by MCAD on December 18, 2012.
3. Site Observation Tour on January 17, 2013 led by Howie LaRosee and Cameron Roberts and attended by Schuyler Larrabee.
4. Follow up information provided by Howie LaRosee of MCAD.

It is important to note detailed field testing or comprehensive surveys were not carried out as part of this assessment and the subsequent discussion is based only on the information and site tour noted above.

There are numerous concerns raised in this assessment and as such needs to be read in its entirety to fully understand the Tower's condition. We have highlighted some of the key issues identified in the assessment below;

Façade (Section 2.5)	The building façade is in very poor condition and has very poor thermal performance. Air and water infiltration and lack of fire stopping between floors are significant issues. Previous repair work to re-anchor the curtain wall appeared to be deficient. This was identified in the *Site Observation Report – Façade Assessment* report issued by Arup April 18, 2012. The full report is provided in Appendix B.

Mechanical (Section 2.7.5)	Mechanical systems are integral to the curtain wall system and one cannot be addressed independent of the other. Wall exhaust fans are not operational and unit ventilators that provide heating and cooling at the building perimeter are not able to be replaced without demolishing the unit.
Electrical (Section 2.8.1)	The existing secondary electrical distribution equipment is old and has exceeded its useful life. The original equipment is also manufactured by Federal Pacific Electric (FPE) and is currently obsolete. Components of the main switchgear and secondary distribution equipment have already failed and emergency repairs were provided. As new FPE replacement parts are not available; another main distribution component failure could result in a significant and extended outage.
Domestic Hot Water (Section 2.9.2)	Water entering the gas water heater was indicated at 140°F and leaving water at 180°F. These are extremely high temperatures and 180°F is dangerous for a domestic hot water system.
Fire Protection Systems (Section 2.7.6) Fire Protection Systems (Section 2.10.1)	The Tower is a high rise building but has no smoke evacuation systems, which is required by current code for high rise buildings but was not applicable at the time of original construction. Of particular concern is the lack of a stair pressurization system for the three (3) egress stairs as it protects stairs from smoke and provides a viable evacuation path for occupants of high rise buildings. The fire pump is leaking from the casing. This leak appears to be extensive and is starting to corrode the fire pump casing and its supports.
Accessibility (Section 2.4.5)	The *IHCD report* dated March 2011 stated that, “none of the existing toilet rooms within the Tower are fully accessible”. This is a non-compliance issue with Federal ADA requirements.
Hazardous Materials	Materials provided to the Team document that asbestos is present in the Tower in many applications and areas. This identification was also confirmed by MCAD staff. Abatement work, in varying extents, will likely be required with any alteration and/or improvement works.
Executive Order 484 Energy Targets (Section 2.11)	MCAD is not meeting the energy targets set forth in EO 484. The Tower is the primary energy consumer for MCAD and is hindering the ability for compliance.

2.2 Code

2.2.1 Background

The Tower was originally subject to the state building regulations enforced by the state Department of Public Safety. This code compliance review is based on 780 CMR 8th Edition, which came into effect on February 5, 2011.

This report is based on the existing conditions of the building and will review the implications of application of 780 CMR 8th Edition to repairs and alterations. This report is based on the following assumptions:

1. There are no proposed additions.
2. There is no change in Use or Occupancy.
3. The building is not qualified as an historic structure and is not qualified for listing as an historic structure.
4. The general triggers for compliance for accessibility in accordance with 780 CMR, 521 CMR and ADA as a result of potential alterations and repairs are discussed below in Section 2.2.1.1.
5. Some of the information in this draft report was based on the report produced by Hughes Associates in 2010 that was based on 780 CMR 7th Edition. This report will be based on 780 CMR 8th Edition.
6. This code review identifies the potential controlling provisions for existing buildings that are contained in the 2009 IEBC Code as amended and could be applied to alterations and repairs to the existing building.
7. Structural Requirements: Structural requirements will be identified in association with the code provisions that are applicable to the proposed work.
8. Energy Conservation Requirements: The requirements related to Energy Conservation will be based on compliance with the “Stretch Code”, 780 CMR Appendix AA and the Executive Order 484 relative to energy standards for state owned buildings.
9. 2009 IEBC as amended Existing Building Definition: “A building erected prior to the date of adoption of the appropriate code, or one for which a legal permit has been issued.”
10. Alterations Definition: “Any construction or renovation to an existing structure other than a repair or addition. Alterations are defined as Level 1, Level 2 or Level 3.”
11. Repair Definition: “The restoration to good or sound condition of any part of an existing building for the purpose of its maintenance.”
12. Owner Definition:

    OWNER: Any agent, person, firm or corporation having a legal or equitable interest in the property.

2.2.1.1 Accessibility

In applying the provisions of the ADA Design Standards and the 2006 521 CMR Massachusetts Architectural Access Board Regulations, the most restrictive should be applied providing that the work carried out complies with both, where both facilities or areas within facilities are subject to both sets of requirements.

ADA

The 2010 ADA Design Standards and the 2006 521 CMR Regulations base the application of their requirements on the total value of qualifying construction costs within a 36 month period.

2010 ADA Design Standards: Up to 20% of the cost of alterations to areas of primary function, the facilities that involve the primary purpose of the facility, is required to be expended on improving the path of access to the altered facilities. In addition, there is an ongoing responsibility to improve access where it is readily achievable and not expensive. Work that involves mechanical, electrical and fire protection systems are generally exempt unless they affect the usability of an accessible space.

521 CMR, The Massachusetts Architectural Access Board Regulations

521 CMR does not apply to employee only facilities. 521 CMR applies to areas open to and used by the public and would include all spaces that are normally accessed by students and other members of the public.

a. If the value of the work that is carried out under a building permit exceeds 30% of the assessed [or CAMIS] value of the building the entire building is subject to compliance with the provisions of 521 CMR

b. If the value of the work that is carried out under a building permit is less than 30% of the assessed [CAMIS] value but more than $100,000 the following are required:

    1. The work carried out must comply
    2. An accessible entrance to the building
    3. An accessible restroom
    4. An accessible drinking fountain [where drinking fountains are provided]
    5. An accessible public telephone [where public telephones are provided]

c. If the value of the work carried out under a building permit is less than $100,000 the work done must comply with 521 CMR.

d. There exists in accordance with 521 CMR 3.3.1 b an exemption of the value of certain work involving electrical, mechanical, sprinkler, plumbing, roofing and hazardous material abatement work, which does not involve the alteration of any spaces required to be accessible, and also of roof repair or replacement, window repair or replacement and masonry repair and replacement if the total value of the work under the building permit does not exceed $500,000. Otherwise the exempted work is included in the total value of work as listed on the building permit.

2.2.1.2 References

780 CMR 8TH Edition, as amended

- 2009 International Building Code [IBC] as amended
- 2009 International Existing Building Code [IEBC] as amended
- 2009 International Energy Conservation Code [IECC] as amended
    - 780 CMR Appendix AA “Stretch Energy Code”
- 2009 International Mechanical Code [IMC]
- 2011 NFPA 70, National Fire Protection Association National Electrical Code as amended
- 527 CMR Fire Prevention Code
- 524 CMR Elevator Code/2004 ASME A17.1
- 521 CMR 2006 Massachusetts Architectural Board Regulations [Review by Others]
- ADA Design Standards 2010 [Review by Others]
- 248 CMR Plumbing Code
- MGL Chapter 148 s. 26G
- Executive Order 484 re: Sustainable Design

2.2.2 Application of 780 CMR 8th Edition/2009 IEBC as amended

There are two basic paths reviewed in this report using the provisions for existing buildings as provided in the amended version of the 2009 IEBC. Chapter 3, Prescriptive Compliance Method, includes all the provisions applicable to work on existing buildings within one chapter and has listings within the chapter for Additions, Alterations, Repairs, Fire Escapes, Glass Replacement, Change of Occupancy Historic Buildings, Moved Structures and Accessibility.

The other approach involves using the individual chapters for the different types of work, repairs, extent of alterations, change of occupancy, additions, historic buildings, moved buildings. The two approaches are described below:

2.2.2.1 Chapter 3, Prescriptive Compliance Method

This chapter encompasses all of the provisions that would govern any type of construction work proposed in an existing building. The provisions of Chapter 3 include the following:

a. Section 301: General provisions applicable to the entire Chapter 3.

b. Section 302: Additions: This section governs proposed additions to existing buildings.

c. Section 303: Alterations: This section governs the work associated with changes to the systems, equipment and arrangement of spaces. In Chapter 3, Prescriptive Compliance Method, there are no classifications of work levels. The work is required to meet the standards as described in the provisions without regard to the extent of the work.

d. Section 304: Repairs: This section governs work that is associated with work associated with upgrading, replacing or renewing systems for the purpose of their maintenance to ensure they operate as intended and are in a safe and sound condition.

2.2.2.2 Individual Chapter Method

The other method of compliance is to use the individual Chapters that address the individual classifications of work and depend on the extent of the work:

a. Chapter 6: Level 1: This chapter deals with basic work involving replacement of materials, elements, equipment or fixtures and is similar to Repairs.

b. Chapter 7: Level 2: This chapter deals with changes to the building spaces and fire protection and life safety systems generally where the total area of the work does not exceed 50% of the aggregate floor area of the building.

c. Chapter 8: Level 3: This chapter deals with work similar to Level 2 except that involves an area of more than 50% of the aggregate area of the building.

d. Chapter 5: Repairs: This chapter deals with requirements that are related to maintenance of the building and the associated building systems.

e. Chapter 9: This chapter deals with change of occupancy. No change of occupancy is assumed.

f. Chapter 10: Additions: This chapter deals with additions to the building height or area. No additions to the building are assumed.

g. Chapter 11: Historic Buildings: This chapter deals with special provisions and allowances for historic buildings. The Tower is not classified as a historic building.

h. Chapter 12: This chapter deals with relocated or moved buildings. The Tower will not be relocated or moved.

Provisions governing accessibility and structural requirements are incorporated in each of the above separate chapters as applicable.

2.2.3 Existing Conditions

Some of the existing conditions described below are based on the report prepared by Hughes Associates in 2010 and the recent inspection of the building on January 17, 2013. The building is more than 70 feet in height and qualifies in Massachusetts as an existing high-rise building.

1. **Height:** 14 stories, 13 occupied stories
2. **Area:**

   Area varies per floor. For occupant load associated with means of egress requirements the various spaces will require evaluation for occupant loads and a review of the egress capacity and path of egress at each level and acceptance by the building official of the arrangements.

   a) Means of Egress

   The means of egress appear to be adequate for the occupant load. Three enclosed, but not pressurized, exits that have a capacity of approximately 360 persons each are provided for floors 1 to 6 and two enclosed exits per floor for floors 7 through 13.

   The occupant load that can be served at each floor where three exits are provided is approximately 1000 persons [limited by the number of separate exits].

   The occupant load that can be served at each floor where 2 exits are provided is approximately 500 persons [limited by the number of separate exits].

   Fire rated doors to the stairs and any that serve corridors require an S – smoke and draft label rating. None of the doors subject to the requirement currently have that rating.

   There are currently some door swings which are in the path of egress travel.

   Luminous Egress Path Markings: §1024: Egress path markings are required by the current code along the required means of egress in exit stairway and passageway enclosures, on steps, landings, handrails, perimeters of landings, walls, and obstacles along egress route. The current provision is inadequate.

Low Level Exit Signs are required at the bottom of exit doors.

Luminous markings are required at door hardware.

Luminous markings are required on the door frame.

b) All door hardware should comply with the requirements for accessible hardware.

3. **Use:** B, Business; A, Assembly including A-3 and A-1 occupancies and various Incidental Accessory Occupancies in accordance with 2009 IBC Table 508.2.5.

   The occupancies in the MA plumbing code, 248 CMR, do not directly align with those of the building code, noted above. The plumbing code has a post-secondary educational occupancy which is applicable to the Tower. Separate staff toilets are required for all educational occupancies under the code.

4. **Type of Construction:** The Type of Construction has not been verified in detail. The basic elements and materials used are as follows;

   Materials: The building construction is noncombustible.

   a. Steel structural frame. The structural frame is protected by spray on fireproofing although coverage in all areas has not been verified.
   b. Floor construction: Steel beams and purlins supporting a metal deck with concrete floor. Some floor/ceiling assemblies appear to rely on approved systems that do not require the spray on protection of the metal deck itself.
   c. Masonry: Masonry walls and partitions in some locations including stairway enclosures and fire walls.
   d. Stair Enclosures: Masonry and concrete.
   e. Roof/Ceiling: Same as floors but where the height is 15 feet or more above the ceilings the structural supports such as purlins may not be protected.

5. Classification of Construction

The construction classification is required to be at least Type 1B. Floor assembly ratings require a 2-hour fire rating. Some structural members that require fire ratings were observed that were not protected with any required protection. The structural fire protection should be verified throughout the building and protected where necessary. Refer also to section 4.6.

6. Fire Protection Systems

a. Sprinkler Systems

The building is protected throughout with a retrofitted NFPA 13 sprinkler system.

b. Standpipes

There are three standpipe risers that are embedded within masonry stairway enclosure walls with hose valves that are accessed on the corridor side of the enclosure wall. The current code would require a hose valve inside every exit stairway at each floor. Three (3) standpipe hose valves would be required on the floors with three required exit stairways on two floors with two required exit stairways.

c. Smoke Control Systems

There are no smoke control systems provided in the building.

Smokeproof Stairway Enclosures:

§403.5.4: Each stairway that serves an occupied floor 75 feet or more above the lowest level of fire department vehicle access requires smoke control by using pressurization of the stairwell.

No pressurization is currently provided.

Atria:

There are two atria in the Tower building. A connection between two or more floors that is not separated in accordance with shaft enclosure provisions per 780 CMR Section 708, is required to be classified as an atrium per 780 CMR Section 404.

Section 404 introduces requirements that limit the occupancy of the atrium floor to low-hazard uses, requires that the building be protected with sprinklers throughout, requires a fire alarm system, limits the interior finishes and travel distances within the atrium space, and requires the atrium to be fire separated from adjacent areas (with some exceptions). Adjacent spaces on up to three stories can be un-separated from the atrium space as long as they are considered in the design of the smoke control system, if such a system is required.

The code differentiates between two-story and three or more story atria in terms of requirements. If the atrium connects three or more stories, a smoke control system is required, and it must be provided with stand-by power. Two-story atrium spaces do not require smoke control or rated separations from adjacent spaces.

The two atria in the Tower building connect two floors and are protected by the building fire suppression system. These are located at Level 10 to Level 11 and Level 12 to Level 13. A smoke control system is not required.

The lower levels that connect Level 2, [TR-2], TR-b, TR-1a and Level 1 [TR-1] operate as an enclosed stairway connecting 2 levels with a mezzanine, and with exit discharge access at two levels. This arrangement does not require a smoke control system, as it is not an atrium, but could require upgrades to one hour rated fire doors serving as part of the stair enclosure system.

High rise structures require a system capable of removing post-fire smoke. Fixed glazing that can be cleared [removed] by fire personnel can satisfy this requirement. [This involves firefighters simply breaking glazing panels to allow smoke out of the building].

d. Fire Command Center

The current system is becoming obsolete and is not efficient for firefighting operations. At the same time, adequate emergency responder communications facilities should be evaluated and upgraded if necessary.

The fire alarm and the fire protection control panels, alarm systems and fire protection monitoring and control systems are located at the building entrance along the wall behind the lobby desk.

Required: 1 hr rated 200SF enclosure for the fire command center.

Fire Alarm Panel: Existing is Analog, which is acceptable as existing condition but current compliance is for a fully addressable system. The current system cannot reasonably be upgraded to achieve this.

The voice evacuation notification should be able to provide selective floor evacuation messages, which the current system does not incorporate.

Emergency responder radio communication system: An antenna or other reliable radio communication system is required.

e. Fire Pump

A fire pump is provided and powered by an emergency generator.

Secondary Water Supply: Required for Seismic Design Category C, D, E, F. The building is applicable to Category B so no secondary water supply is required.

f. Emergency/Standby Generator

Located on the roof are the following;

- Emergency Egress Lighting: Provides power to selected fixtures.

  Adequacy of locations and level of lighting needs verification and improvement if not compliant.

- Signs: Provided throughout. Unknown whether served by battery or generator.
- Elevator Operation

  The generator serves the elevators but it is not known whether more than one elevator can be powered at the same time or whether there is provision for switching standby power to different elevators.

- **Fire Pump**

  A fire pump is provided and is connected to the generator. The Hughes Associates report states that the emergency/standby power distribution does not have two hour rated protection as required by the current codes. This would be in the form of a two hour fire rated enclosure or other similar protection. For additional commentary, on system separation, refer also to section 8.4 Emergency Power.

- Emergency Responder Radio Coverage does not currently exist but is required by the use of biaxial antenna system or other means.

2.3 Architecture

The Tower building anchors the corner of Huntington Avenue and Evans Way, figure 4.2. This triangular shaped site has frontage on both Huntington Avenue, commonly referred to as the Avenue of the Arts, and on Evans Way which is located along the Colleges of the Fenway Spine, figures 4.4 and 4.5.

The Tower building is anchored by three brick stair towers and is clad with a dark curtain wall system, figures 4.3 and 4.6, which steps away at the street level to expose a concrete frame, figure 4.1. The existing structure is steel columns, beams and girders with a composite concrete and metal deck floor assembly.

Figure 2.4.1 Concrete frame at street

Figure 2.4.2 Anchoring corner

Figure 2.4.3 Curtain wall

Figure 2.4.4 Frontage on Huntington Avenue

Figure 2.4.5 Frontage on Evans Way

Figure 2.4.6 Curtainwall

2.3.1 Exterior Envelope

The existing exterior envelope system consists of non-insulated glass (both vision and back painted, spandrel glazing), louvers and painted metal panels in an aluminum curtain wall frame. In concept, the louvers are active when associated with a perimeter mechanical system and blanked off with panels when inactive.

The exterior envelope has been documented in prior studies. The most recent was a Site Observation Report – Façade Assessment prepared by Arup dated April 18, 2012. This report documented the existing conditions, outlined two options for repair/upgrade and one option for replacement. It was noted in the report that the options for repair/upgrade /replacement were contingent upon further examination of the existing conditions and further probes were needed to determine the existing anchoring conditions at the slab edge.

It is the project teams understanding that superficial repairs, to mitigate water infiltration, may have been completed recently. Tasks such as face sealing of the system, due to weephole failure, may have been undertaken with the last round of curtain wall repairs. Any failures identified in the Arup report as a potential risk to the public, are assumed to have been completed as none were observed at the time of the site visit on January 17, 2013.

2.3.2 Roofs

The existing roof assembly appeared to be an EPDM membrane assembly. There are four roof levels:

Level 5 – Visual observation was gained from the adjacent corridor. Areas of ponding water/ice were observed. Sandbags were being used to weigh down areas of loose roof membrane, figures 2.4.7 – 2.4.10.

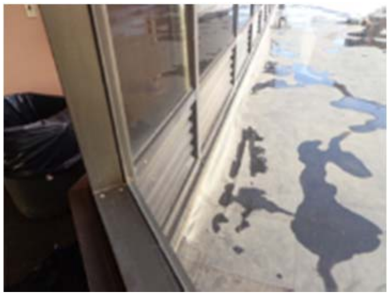


Figure 2.4.7 Water ponding

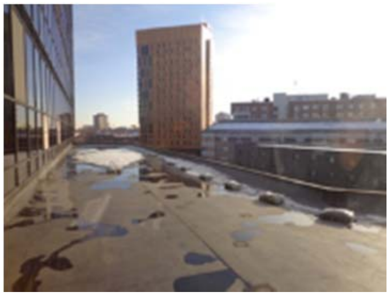


Figure 2.4.8 Water ponding and ice

Figure 2.4.9 Sandbags on membrane

Figure 2.4.10 Sandbags on membrane

Level 7 – Access to this roof level was gained from Stair 3. Coping laps appeared to be in varying states of deterioration, figures 2.4.13 – 2.4.16. Sealant between the laps did not appear to be properly installed and were observed to be failing at some locations, figure 2.4.11. In addition, exposed fasteners thru the top of the coping were observed, figure 2.4.12.

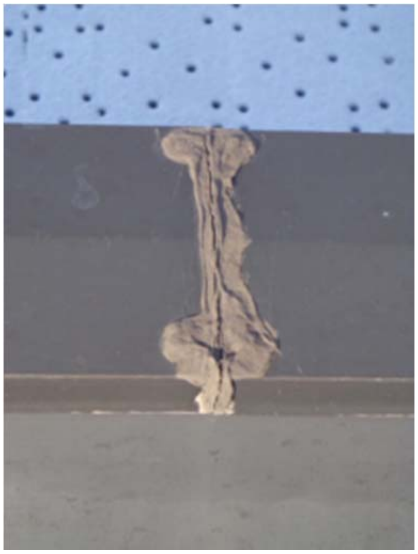


Figure 2.4.11 Poor sealant installation

Figure 2.4.12 Exposed fasteners

Figure 2.4.13 Coping laps

Figure 2.4.14 Coping laps

Figure 2.4.15 Coping at facade

Figure 2.4.16 Coping

Level 11 – This area was not observed during the site visit on January 17, 2013. This area was observed at the site kick-off meeting on December 17, 2012. This roof area contains the Mass Art green roof pilot project.

Level 14 – This area was not observed.

Note that a Roof Assessment Report, dated May 20, 2010, prepared by Austin Architects was made available to the project team. This report outlines their findings and recommendations for roof system replacement at the upper roofs, including Stair roofs. According to this report, the construction phase of this project was undertaken in FY12.

2.3.3 Plans

The current use is as follows:

Level 14 Mechanical/Roof
This level was not observed.

Level 13 Library
The floorplate consists of an open library stack area, offices and conference rooms. A cluster of offices have glass viewing windows overlooking a two story high space down to L12. The two story high space is physically separated from this level. There is a communicating stair.
This is the highest stop for all elevators.

Level 12 Library
The floorplate consists of open library stack areas and a special collections room, figure 4.17. There is a communicating stair up to Level 13.

Figure 2.4.17 Library

Level 11 Administration /Gallery / Trustees / Roof
The floorplate consists of open gallery areas, offices and a Trustees Room. This floor overlooks an open roof area. Refer to Section 4.2 for observations at the roof.

Level 10 Industrial Design
The floorplate consists of open studio areas and classrooms. There is an open studio area that overlooks a two story high space to the level below, figures 4.18 and 4.19. This two story high space is not physically separated and therefore connects levels 10 & 11.

Figure 2.4.18 Two story high studio

Figure 2.4.19 Two story high studio

Level 09	Graphic Design / Illustration The floorplate consists of open studio areas, offices and classrooms.
Level 08	Administration/Service The floorplate consists of offices, service spaces and the upper level of the two story high film studio below. The two story high studio space is physically separated from this level.
Level 07	Animation / Film / Studio / Roof The floorplate consists of offices, classrooms, video studio and support spaces. This floor overlooks an open roof area. Refer to Section 4.2 for observations at the roof.
Level 06	Graphic Design / Fashion The floorplate consists of classrooms and offices.
Level 05	Critical Studies The floorplate consists of classrooms and offices. This floor overlooks an open roof area. Refer to Section 4.2 for observations at the roof.
Level 04	Architecture The floorplate consists of classrooms, offices and an open studio area.
Level 03	Computer Arts / Graduate The floorplate consists of classrooms, offices and support spaces. This level has connectivity to the North building. This level also contains an open stair (adjacent to the central elevator core) to the level below.
Level 02	Administration / Public Safety Suite / Mechanical /Gallery The floorplate consists of classrooms, offices, open gallery spaces, the upper level of the Auditorium and support spaces. This level has connectivity to the North building and a future connection to the new Design Center. This is the top level of the three story high Atrium space that fronts the corner of Huntington Avenue and Evans Way. There is an open stair from this level down to Level 1b and offsets to another stair that continues down to Level 1a.
Level 1b	Level 1 Upper level mezzanine/Loading Dock The floorplate consists of Restrooms, Security Desk area and support spaces.
Level 1a	Auditorium/Entry Huntington Ave & Evans Park Way/ADA Entry The floorplate consists of street entries and the Auditorium
Level 01	Auditorium Stage/Projection/Ticket Office/Green Room The floorplate consists of the Auditorium stage and support spaces. This is the lowest stop for the central elevator core and lowest level of the Atrium.
Level 00	Mechanical/Electrical The floorplate consists of mechanical and electrical rooms. This is the lowest stop for the Freight Elevator.

2.3.4 Elevators and Circulation

The tower contains a central core consisting of eight (8) elevators. These elevators have stops from L1 thru L13. The tower also contains a freight elevator. This elevator has stops from L0 thru L13.

Elevator traffic appeared to be inefficient. Elevator cabs were slow and cab arrivals were uncoordinated.

Note that a Review of Elevator Conditions and Requirements, dated December 1, 2012, prepared by Syska Hennesy was made available to the project team. This document outlines existing conditions and provides a timeline on elevator equipment which should be considered for upgrade.

The tower contains three (3) egress stairs:

- Stair 1: Runs from L0 thru L14. Egress is at L1b, exiting directly to the exterior.
- Stair 2: Runs from L1 thru L14. Egress is at L1, exiting directly to the exterior
- Stair 3: Runs from L0 thru L7 roof. Egress is at L1A, exiting directly to the Lobby on Huntington Avenue.

Corridors connect the stairs to create the egress routes for the floorplate. This results in inefficient circulation around the central elevator core.

2.3.5 Restrooms

Restrooms are symmetrical around the central core from Level 3 thru Level 8.

Level 9 & 10 - The restrooms only occur only on the North side of the core. These appear to be single sex type restrooms.

Level 11 - The restrooms shift outside the core. These allocated sizes appear to be considerably smaller than the other floors. It appears that both genders are provided restrooms at this level.

Level 12 & 13 - The restrooms return to the North side of the core only and appear to be single sex type restrooms. Based on the plans, there are no separate staff toilets. The code allows occupants to move up or down a floor for restroom access. When the building was constructed, there were no requirements for staff toilets.

Note that an ADA Compliance Plan, dated March 2011, prepared by Institute for Human Centered Design, was made available to the project team. This document outlines an assessment of the facility, identifies non-compliant areas and outlines a compliance approach.

It states that none of the existing toilet rooms within the Tower are fully accessible. Their interim recommendation, until modifications are taken, is to provide ADA compliant signage to direct users to the nearest accessible toilet, even if it is in another building.

2.3.6 General Observations

Clarity of construction type was difficult to discern. Examples include inconsistencies in fire-proofing of the structural members, inconsistent or missing fire-stopping along the slab edge and occupancy separation, figures 2.4.20 – 2.4.23. These items were observed in varying stages of questionable compliance throughout the building.

Figure 2.4.20 Inconsistent fireproofing

Figure 2.4.21 Inconsistent fireproofing

Figure 2.4.23 Inconsistent fireproofing

Figure 2.4.22 Inconsistent fireproofing

There appear to be inefficiencies from a planning perspective. For example, overly generous and inefficient circulation and deep floorplan dimensions limit the amount of natural daylight that can be delivered deep into the floorplate.

There may be inefficiency with regards to the elevators. Eight elevators are excessive for the size of the floorplate. The system appeared to lack a central controller which resulted in multiple cars opening onto a floor after depressing the single call button.

The freight elevator doors open directly into the exit access corridor, figures 2.4.24 and 2.4.25. This corridor provides the path of egress travel to the exits. Any event in the freight elevator/shaft may compromise access to the exit. This is not compliant based on the current code.

Figure 2.4.24 Freight Elevator

Figure 2.4.25 Freight Elevator

In the existing electrical transformer room, areas of spalled concrete were observed at one 0beam location. This left the steel beam underneath exposed to the elements and it appeared to be corroded, figure 4.26. There was also evidence of water staining on the walls of this room.

Figure 2.4.26 Beam in Electrical Transformer Room

2.4 Façade

Following a visual review of the facade, a Site Observation report for the Tower building was prepared by Arup, dated April 18, 2012 which discusses the building envelope condition. The complete report is attached as Appendix A. The report concluded that the existing curtain wall on the Tower Building is in very poor condition, outlined options for repair, upgrade and/or replacement and identified one issue of immediate concern. A summary of the existing conditions identified in the report is provided below;

The existing curtain wall system has poor thermal performance.

- The glazing is body tinted monolithic (non-insulating) glass on an aluminum frame that is not thermally broken.
- The original gaskets in the window systems appear to have hardened and have become brittle and therefore are no longer providing effective seals at the perimeter.
- The spandrel panels have minimal or no insulation. The insulation in the penthouse was observed to have deteriorated and become detached from the façade. It is possible this condition occurs at other locations.
- The air infiltration rate from the exterior and the air between floors is very high. There is no air seal on the interior side of the mullion which allows air to travel up through the mullion into the building.
- The perimeter mechanical systems, i.e. unit ventilators and wall exhaust fans, are integrated into the curtain wall system. The unit ventilators are difficult to maintain and cannot be replaced without completely demolishing the unit. The wall exhaust fans are not operational and their back draft dampers have failed allowing unconditioned air to enter the building.

The existing curtain wall is in very poor condition.

- The alignment of the vertical mullions is no longer plumb in many locations.
- The exterior snap caps appear to be twisted, sliding down and/or dislodging from the face of the curtain wall in several locations.
- Since this report, the exterior snap caps have been mechanically fastened throughout the entire curtain wall to eliminate the previously identified snap cap movement.
- Parapet height is typically very low and coping on top of the curtain wall appeared to have failed at the joints between coping panels. Thermal movements appeared to have sheared the joint in locations resulting in a source of potential water leakage to the interior spaces below.
- There are extensive signs of water infiltration on the interior.

Previous repair work to re-anchor the curtain wall appears to be deficient.

- At least one of the steel stiffeners on the penthouse curtain wall has become disengaged from the glazing frame. This does not appear to have been fixed when the repairs were performed.
- The repair work created a breach of the perimeter fire containment detail as the perimeter plate, which provided an air/smoke seal between floors was cut away to allow for installation of a new steel base plate.
- The exposed thread on the post-installed drill-in anchor bolts appeared to be excessive in exposed length and calls into question whether the full embedment depth was achieved.

The expansion bolt with the expanding spreader end removed was observed to be loosely positioned upside down where the anchor bolt should have been properly installed.

Figure 2.5.1 General Elevation of the Tower prior to the snap cap fastening

2.5 Structural Systems

In addition to the site walkthrough, this assessment is based on the structural drawings provided by DCAMM, dated May, 1972.

2.5.1 Foundations

The foundation of the building consists of driven piles with concrete pile caps and 18” thick basement structural slab connecting the pile caps. There are large pile caps under the stairs and elevator pits which support multiple columns.

The basement perimeter walls consist of concrete walls ranging from 10” to 18” thick.

2.5.2 Superstructure

The existing superstructure consists of structural steel framing. The floor framing construction is typical concrete slab on steel deck supported by steel beams and columns. The roof framing construction is similar to the floor construction with concrete slab on steel deck. There is an elevator machine room and a cooling tower above the elevator core. Exposed steel beams are generally encased in concrete and hidden beams are protected with fireproofing.

The columns are generally W14 columns with flange thickness of up to 3”. The main floor beams are generally W21 or W24 beams spanning the 27’-0” typical grid.

Lateral stability of the building against wind and seismic loads is provided by rigid steel moment frames with fully welded beam to columns connections.

2.5.3 Existing Design Criteria

The existing building was designed in accordance with the City of Boston Building Code, 1970 edition and Uniform Building Code (UBC), 1967 edition.

The building lateral load resisting system was designed to resist wind load of 20 psf and seismic loads per UBC zone 2. While these lateral design loads have been modified over the years in accordance with the changes in building codes, these loads have not increased dramatically from the original design loads.

The existing building lateral system was designed to meet code requirements in effect at the time. Current lateral system requirements are more stringent. However, the requirements for upgrades, and their extent, are contingent on the seismic design category, specific scope of work undertaken and subsequent level of alteration category (i.e. 1, 2, or 3) per the Existing Building Code. The seismic design category applicable to the Tower is Category B.

In general, seismic upgrades are not triggered by minor local repairs, small opening infill or miscellaneous floor openings. However, if significant floor area is added or if the building moment frame system, i.e. columns and beams is modified, seismic upgrades would probably be required. The need for seismic upgrades therefore, can only be accurately assessed once a proposed scope of work is determined.

The original design floor and roof loads meet or exceed the design loads in the current code for the intended occupancies. The original design floor and roof loads are as follows:

Live Loads	Tower Building	Current Code
Mechanical Rooms	150 psf	
Basement Floor	200 psf	
Theater	150 psf (stage) 100 psf (auditorium)	
Terrace / Lobby	100 psf	
Level 2	150 psf (bookstore) 100 psf (auditorium)	
Level 3	100 psf	
Level 4	100 psf (floor) 50 psf + snow drift (low roof)	
Levels 5 – 14	150 psf	
Roof snow load	30 psf + snow drift	
Building wind load	20 psf	

Level 5 thru Level 14 were designed for library occupancy (150 psf). The design load of 150 psf is suitable for regular library use while high density shelves would require a design load of 250 – 300 psf.

2.5.4 Observations

The existing structure was found to be in generally good condition. There is a water penetration problem in the ceiling of the electrical vault in the basement located at gridlines C/D and 10/11 under the exterior terrace, causing the steel beams to rust / delaminate and spalling the concrete encasement. There had been prior repairs to patch the exterior concrete beam encasement in various locations.

2.6 Mechanical Systems

2.6.1 Central Plant

2.6.1.1 Heating System

The Tower central heating system consists of two shell and tube steam to hot water heat exchangers, condensate return pumps and Heating Hot Water (HHW) pumps and distribution. Steam is provided by a central campus steam distribution system, located remote from the tower building. Low pressure steam is supplied to the building and converted to HHW at the mechanical penthouse on level 14, through two shell and tube heat exchangers, shown below in figure 7.1. Steam is also used for reheat coils and humidifiers at select areas within the building. The rest of the building is provided with HHW service from the steam to HHW heat exchangers.

Figure 2.7.1 Steam to HHW heat exchangers

Steam condensate is returned to the campus system in two locations. A condensate return tank and duplex condensate return pumps are located in the basement chiller room. A second condensate return tank and duplex condensate return pumps are located in the mechanical penthouse on level 14 adjacent to the steam to HHW heat exchangers.

Separate HHW distribution is provided for unit ventilators and HHW reheat coils. The unit ventilators are served by two 30 hp pumps in a duty / standby configuration sharing a Variable Frequency Drive (VFD). HHW reheat coils are served by a single 3 hp pump.

The steam to heating hot water heat exchangers are original to the building and are approximately 40 years old. Steam to hot water heat exchangers can expect a service life of 20 years. Therefore, the equipment in the Tower building is substantially past their useful service life.

2.6.1.2 Chilled Water System

A central Chilled Water (CHW) plant is located in the basement. The central chilled water plant consists of two chillers; one 450 ton Trane Centrivac electric driven centrifugal chiller and one 350 ton Thermo Power Corp natural gas driven chiller. Both chillers were installed in 1998 and operate as duty standby, which means one chiller operation is required at any given time. The Thermo Power natural gas chiller was rebuilt in 1999 and has been characterized by the building staff as requiring high maintenance. The Trane chiller was not characterized by the building staff as having any operational issues. Annual chiller maintenance, including mechanical condenser cleaning, is performed by the campus staff.

Chilled water distribution is variable primary, with two duty 50 hp CHW pumps and one standby 50 hp CHW pump. The duty/duty standby configuration operates two duty pumps under normal building load conditions, with a redundant third standby pump provided as backup, in the event one of the duty pumps is offline for maintenance or repairs. All pumps are provided with Variable Frequency Drives (VFDs). The chilled water pumps were rebuilt in 1999. The chilled water system is drained down in winter. The central chilled water plant, including chillers and pumps are shown below in figures 7.2 and 7.3.

Figure 2.7.2 Chiller plant, Thermo Corp chiller shown

Figure 2.7.3 CHW pumps

An exhaust fan and refrigerant leak detection system are present at the chiller room and operational but are not connected to each other. This arrangement is not compliant with current code, which requires the exhaust and leak detection systems to be connected. A self-contained breathing apparatus is located outside of the chiller room.

Corrosion of HHW and CHW piping has occurred in the basement near the chiller room, resulting in localized piping replacement.

The chillers are approximately 14 years old. Chillers can expect a service life of 25 years.

2.6.1.3 Condenser Water System

A three cell counter flow blow-through Cooling Tower is located on the roof. The cooling tower was installed in May 2012, shown below in figure 7.4. The new cooling tower has three cells, each with total capacity of approximately 1900 tons.

Figure 2.7.4 Cooling Tower

The cooling towers are less than 1 year old and under warranty. Cooling towers can expect a service life of 15 years.

2.6.1.4 Pumps

Many of the building pumps are original and are approximately 40 years old, however many have been rebuilt over the years. Pumps can expect a service life of 20 years.

2.6.2 Fuel Oil Distribution

An emergency generator is located on the roof. Two 275 gallon diesel storage tanks are located in the basement, with spill containment, feeding a 60 gallon day tank located in the level 14 mechanical penthouse.   Based on input form the building staff, the storage tanks and containment, shown below in figure 7.5, are 5 to 6 years old.

Figure 2.7.5 Diesel storage tanks

2.6.3 HVAC Distribution

Different strategies are provided for the perimeter and interior HVAC distribution. The building perimeter utilizes exhaust fans and 4 pipe unit ventilators installed at the perimeter, while the interior zones are served by central air conditioning units, most of which are constant volume, cooling only with space mounted reheat coils.

2.6.4 Interior Mechanical Systems

Heating, ventilation and air conditioning is provided to the core areas and interior spaces through centrally located Air Conditioning (AC) units, with duct mounted reheat coils, where required for heating.   AC units consist of a supply fan, chilled water cooling coil, filtration section and mixing box with outside air connection. Return fans are provided separately from the main AC units.

Both steam and heating hot water reheat coils are installed depending on the location of the coils. Specific project or occupancy requirements, such as humidification requirements provided by steam humidifiers, or installation proximity to steam and condensate distribution during design and construction may have influenced the original design to provide both steam and hot water reheat coils. It is more common to utilize one source for distributed heating within a building, with heating hot water more common than steam. However as design requirements vary from project to project so will the HVAC strategies implemented.

Core areas on levels 1 through 7 are provided with steam reheat coils. Office areas on levels 5 through 7, levels 8 through 13 are provided with HHW reheat coils. The existing AC units and the areas they serve are listed in the table below.

AC Unit	**Area Served**
AC-1, AC-2	Lower lobby, upper lobby, and Tower 2 (south and west zones)
AC-3	Auditorium
AC-4	Public safety on T-2 (unit is new)
AC-5	Levels 5,6,7, (north zone)
AC-6	Level 3
AC-7	Level 4
AC-8	Level 5, 6, 7 (south and west zone)
AC-9, AC-10	Level 6, fashion offices and lab
AC-11	Level 11,12,13 west and south zone
AC-12	Level 8,9,10

AC-12	Level 11,12,13 north zone
AC-14	Level 8 data room

AC-4 was installed recently, during a second floor renovation to the public safety office. The remaining AC units are original to the building. Air handling equipment has a service life of approximately 20 years; hence most AHUs are past their useful service life.

2.6.5 Perimeter Mechanical Systems

Four pipe perimeter unit ventilators provide heating and cooling and ventilation air ducted directly from outdoors. Maintenance of the units is possible through access panels on the interior unit faces; however, replacement of the units is not possible without demolishing the unit. There are approximately 175 unit ventilators installed throughout the building.

In addition to the unit ventilators, wall exhaust fans are also installed along the perimeter. The wall exhaust fans are not operational. Back draft dampers at wall exhaust fans have failed, allowing unconditioned air to enter the space during heavy winds. A typical unit ventilator and exhaust fan installation is shown below in figures 2.7.6 and 2.7.7.

Figure 2.7.6 Unit ventilator

Figure 2.7.7 Exhaust fan at perimeter

The perimeter mechanical systems throughout the building are connected to the façade louvers for intake and exhaust.

The perimeter unit ventilators are original to the building and are 40 years old. Unit ventilators, i.e. fan coil units, can expect a service life of 20 years; hence, they are past their useful service life.

2.6.6 Smoke Control Systems

The building does not currently have any smoke control systems or stair pressurization systems. The building is classified as a high rise building. While the existing building systems were installed under an older version of the Massachusetts Mechanical Code, and assumed to be compliant at the time of installation, the current code version would require a stair pressurization system for each stairwell and main entrance may require smoke control measures if classified as an atrium. Requirements for stair pressurization and smoke control systems are included in the Massachusetts State Building Code section 909 and International Mechanical Code section 513.

2.6.7 Specialty Exhaust Systems

A wood shop exhaust duct is routed on the exterior of the building and terminates on a low roof. The wood shop exhaust termination is shown below in figure 2.7.8. Ductwork routed on the exterior of the building is indicative of tenant renovations installed after the original building construction and has the potential to impact building aesthetics.

Figure 2.7.8 Wood shop exhaust

Two large kitchen exhaust fans are abandoned in the mechanical penthouse located on level 14. The abandoned kitchen exhaust fans can be demolished and removed under any future renovation work.

2.6.8 Building Controls

Building controls are currently a mix of pneumatic controls original to the building and Direct Digital Controls (DDC) installed as building upgrades have been completed. DDC controls are Automated Logic provided locally by Yankee Technology. In 1999 the unit ventilators were provided with DDC controls. These legacy DDC controllers installed at the unit ventilators are obsolete and replacement requires upgrading to the current Automated Logic controller. The second floor public safety offices (served by AC-4), where recent renovation work has been completed, are where the most current Automated Logic DDC controllers have been installed. The building staff is currently working with Automated Logic / Yankee Technology to develop a plan and budget for a comprehensive building controls upgrade.

2.7 Electrical Systems

2.7.1 Electrical Primary Service

The existing primary electrical service consists of two 13.8kV, 3 phase, 3 wire, incoming underground electrical service feeds. The feeds terminate in a 15kV utility-owned service entrance switchgear. The 15kV service entrance switchgear then feeds the NSTAR owned 15kV distribution switchgear which in turn feeds the Tower, MCAD gymnasium building and Collins building.

All equipment is located in the basement electrical room. The utility owned 15kV service entrance and distribution switchgear equipment are only a few years old and appear in good condition.

Figure 2.8.1: Existing utility owned 15kV switchgear

2.7.2 Secondary Electrical Distribution

All electrical equipment downstream from the utility owned 15kV switchgear is customer owned and maintained.

The utility owned 15kV distribution switchgear feeds two main switchboards, (MS1 and MS2) serving the MCAD Tower building, one switchboard serving the MCAD gymnasium building and a feed out the Collins building via fused load break switches. All switchboards are located within the basement electrical room.

The electrical service to the Tower building is stepped down from 13.8kV to 480Y/277V, 3 phase, 4 wire via a double ended substation consisting of two (2)

2500 ampere switchboards (MS1 and MS2) and two (2) 1500kVA transformers. The electrical service to the gym building is stepped down from 13.8kV to 208Y/120V, 3 phase, 4 wire via a 500kVA transformer within the switchboard serving the gym building. The main disconnect was removed from switchboard MS1 and the associated 1500kVA transformer is not currently powered. Power is provided to switchboard MS1 through the tie-breaker of switchboard MS2. This was provided originally as a redundant feed; however, it is currently the only available power feed to switchboard MS1.

From the two main switchboards, power is distributed to the upper floors via two main 480V, 3 phase, 4 wire plug-in bus duct risers located within two dedicated electrical closets at each floor. From the risers, power is distributed to all normal building power and lighting loads via plug-in bus duct fused disconnect switches, power panelboards and step-down transformers, located in the electrical closets at each level.

Two motor control centers (MCC’s) are provided on the 14th floor and are fed from main switchboards MS1 and MS2 via dedicated bus duct risers. Both MCC’s are original and are beyond their useful service life.

Some electrical equipment including panelboards and transformers were installed more recently, within 10 to 15 years, and are in fairly good condition. However, the majority of existing electrical equipment including the substations and all Federal Pacific Electric secondary distribution equipment, MCCs, feeders and bus-duct risers are original to the building and are beyond their useful service life. Additionally, because most of this equipment is over 35 years old and Federal Pacific Electric is no longer in business, replacement parts are not readily available.

It was highlighted to us that a fault and failure occurred in December 2012 to one of the aluminum bus ducts and required repairs. Additionally, facilities maintenance personnel noted there is a combination of aluminum and copper wiring and bussing used in the buildings electrical distribution system. All the original bus-ducts and some original wiring are aluminum; however some copper wiring and bussing have been added throughout the years. Using both aluminum and copper wiring, equipment and associated fittings throughout the same electrical distribution system has the potential to cause electrical failures over time due to the corrosive effects of connecting dissimilar metals.

Figure 2.8.2: Existing MCAD Switchboard is old and beyond its useful service life.

Figure 2.8.3 Typical FPE panelboard is old and beyond its useful service life.

2.7.3 Small Power

All receptacles throughout the Tower were original to the building. Small power electrical equipment including disconnects and motor starters in some mechanical spaces appeared to have been installed more recently, within 10 to 15 years, and were in fair to good condition. However, the majority of small power equipment is original and beyond its useful service life. Additionally, it is unknown if a dedicated ground wire exists for all the small power circuits, i.e. conduits could have been used as a ground path. Because many of the conduits are rusted and corroding, a ground path may not exist.

The new public safety area on Level 2 is the most recently renovated space within the Tower and has new receptacles and small power electrical equipment installed.

Figure 2.8.4: Receptacles are original and beyond their useful service life.

Figure 2.8.5: Some newer VFD’s and motor controllers have been installed over the years.

2.7.4 Emergency Power

The existing emergency power distribution system consists of a 300kW Cummings generator (based on drawings). It is located on the tower roof and is original to the building. According to facilities management, the generator was re-built in 1999. It is tested regularly and is in fairly good condition.

All major emergency electrical distribution equipment located within Level 14 emergency electrical room was replaced during the 1999 electrical upgrades. All distribution equipment including the automatic transfer switch (ATS), main distribution board, generator and all secondary equipment was replaced with new Square D equipment. All this updated equipment is in good condition.

An automatic transfer switch was originally provided within motor control center MCC1 located on Level 14. The normal source to the ATS was believed to have been tapped off the bus of MCC1. The emergency source to the ATS was supplied from the engine generator. From the ATS, emergency power was provided to emergency panelboards located throughout the building (one emergency panel located every 3rd floor) for emergency lighting and miscellaneous emergency loads. When the new emergency electrical distribution equipment was installed, the system was reconfigured to feed the emergency panelboards and miscellaneous emergency loads from the new emergency switchboard via the new ATS (both in the 14th floor emergency electrical room).

Existing mineral insulated metal sheathed (MI) cable is installed for feeds to emergency loads as well as the fire pump and appears to have been installed at the same time the emergency electrical distribution equipment was replaced (1999). MI cable is utilized to provide fire rating to the cabling which serves emergency and standby systems. This cable is installed from the 14th floor emergency electrical room and feeds out to all the life safety loads throughout the building. During the walk-through, it was observed that the MI cable was installed in conduit and routed outside along the 13th floor roof to feed life safety loads on the other side of the building.

In addition to emergency lighting being fed from the emergency panelboards throughout the building, it was noted in the electrical systems observation report prepared by Thompson engineering company (October 19, 2007) that some areas of the tower were served by emergency wall pack light fixtures (with self-contained battery packs) and it was unknown if they were regularly tested and maintained. A regular maintenance and testing schedule for this type of self-contained emergency lighting is a critical requirement to ensure emergency lighting is always available. It is unknown if the emergency lighting is providing adequate coverage throughout the tower; however, with older buildings such as this, it is unlikely that all spaces are provided with adequate emergency light levels as required per current NFPA 101 and IBC code requirements.

The emergency power panelboards serving the emergency lighting and miscellaneous emergency power loads for the tower are located in the same electrical closets as the normal power panelboards. A dedicated 2-hour fire rated space is required for all emergency system panelboards per latest code requirements. Additionally, for the system to be current code compliant, all emergency loads should be separated from the standby loads and optional standby loads.

Figure 2.8.6 Several pieces of emergency electrical distribution equipment were replaced around 1999 and are in good condition.

Figure 2.8.7 MI cable installed for emergency loads.

2.7.5 Lighting System

The existing light fixtures throughout the building are original to the facility and are beyond their useful service life. However, during a campus wide update of 1999, all the existing original fixtures were retrofitted with newer electronic ballasts and lamps were changed to more efficient T8 or compact fluorescent types. Most exit signs appeared to be original incandescent lamp type fixtures. Lighting controls throughout the building consisted mainly of local wall switches.

The new public safety area is the most recently renovated space within the Tower and has new light fixtures installed with occupancy sensors.

Of the few spaces that were observed during the walk-through, most exit signs appeared to be original to the building and used an incandescent lamp.

Figure 2.8.8 Existing light fixtures are original and are beyond their useful service life

Figure 2.8.9 Some light fixtures are missing lenses and falling apart.

2.7.6 Fire Alarm System

The following fire alarm system analysis were observed during our site observation tour and were noted in the electrical systems observation report prepared by Thompson engineering company (October 19, 2007) and in the Building Study for the Center for Design + Media report prepared by ennead architects LLP (January 13, 2011).

The existing fire alarm system is non-addressable and consists of an Edwards fire alarm control panel and a combination of Simplex and Edwards fire alarm devices. These devices include an annunciator, initiating devices (smoke detectors, heat detectors, pull stations) and horns/strobe notification devices. All alarm, supervisory and trouble signals are transmitted to the campus security office.

The amount of audio/visual devices within the classrooms and corridors is not sufficient based on current ADA and NFPA code requirements. No fire alarm devices are provided within the auditorium. The mounting heights of some of the fire alarm devices do not meet current MAAB code requirements. Additionally, no selective voice evacuation system is installed in the tower, which is a current requirement for high-rise buildings per IBC Article 907.2.13.

A few areas were observed where the fire alarm wiring was routed through raceways used for power wiring instead of having dedicated raceways. This is not compliant with NFPA 70, article 760.

During the site observation tour, it appeared that all fire alarm system devices are original to the building and therefore, beyond their useful service life.

Figure 2.8.10 Existing fire alarm devices

Figure 2.8.11 Fire alarm wiring is routed in raceway used for power wiring.

Figure 2.8.12 Existing fire alarm device appears to be abandoned.

Figure 2.8.13 Existing original heat detectors are still being used and are beyond their useful service life.

2.7.7 Telecommunication

The existing telecommunication system consists of an original telephone system and telephone outlets located throughout the building. Based on conversations with the facilities employees, dedicated telecommunications closets or electrical closets are used on each floor for the telecomm cable risers and rack equipment. They also noted that additional telecommunications equipment has been added throughout the years including telephone/data outlets and backbone cabling. During the walk-through, one telecommunication closet was surveyed and it was observed that some of the patch panels and cabling appeared to be fairly old while some of the patch panels and cabling appeared to be newer and in good condition.

The following telecommunications system observations were noted in the electrical systems observation report prepared by Thompson engineering company (October 19, 2007). It was noted that the tower is served by a Avaya PBX telephone system. The tower is fed from a campus wide fiber optic data network and the head end telecommunications equipment is located within the Collins building. The data network consists of Cat 5 wiring and least one intermediate distribution frame (IDF) closet is located on each level of the tower. Each IDF room is connected to the main distribution frame (MDF) room with multi-strand fiber optic cable. A wireless data network appears to be installed in most areas of the Tower.

Figure 2.8.14 Existing telephone outlets are original and beyond their service life.

Figure 2.8.15 Surface mounted tel/data outlets and surface raceway have been installed over the years.

Figure 2.8.16 Typical telecomm closet with a mixture of newer and older patch panels and cabling

2.8 Plumbing Systems

2.8.1 Domestic Cold Water

The building's domestic water system is supplied by an incoming 6" water main, with meter and reduced pressure zone (RPZ) type backflow preventer.

The domestic cold water runs through a duplex booster pump, Syncroflo Model 55C7.5 rated for 162 GPM, 45 PSI and 7.5 HP. The system includes a hydro accumulator located in the mechanical room on Level 14. This booster pumping system was installed about 1 year ago and appears to be in working order.

Figure 2.9.1. Duplex booster pump

Based on visual observations only the cold water distribution system looks to be in working condition, piping was partially replaced, but insulation, and identification in some places is missing and needs to be provided and repaired.

2.8.2 Domestic Hot Water

The domestic hot water system was altered in 1998 when the original steam hot water heater in the basement was taken off line and a new gas fired water heater was added on Level 2.

We do not have any existing drawings of this renovation and during our site visit we were unable to trace out the system completely to fully understand how it operates. During the visit we noticed the water entering the gas water heater was 140°F and the leaving water was at 180°F. These are extremely high temperatures for a domestic water system. Typically domestic hot water is heated to 140°F and blended down to 120°F for circulation throughout the building, temperatures can be higher in food service application which is not applicable to this building.

Through conversations with the facility department we understand the building has a recirculated hot water system, which explains why the water temperature entering the gas water heater is at 140°F. However it seems the water heater is still boosting the water temperature another 40°F. This may indicate the temperature sensors on the water heater are not working or they are set too high.

Additionally, we understand the leaving 180°F hot water is then routed back down to the basement into the old steam water heater, which is being used as a holding tank. After the tank the water is reduced in temperature to 140°F through a master mixing valve before it is circulated throughout the building. It is not clear where the cold water make-u feed to the domestic hot water system is introduced.

Boosting the water to 180°F is not only dangerous and can cause scalding if the master mixing valve were to fail, it is also wasting energy and gas.

Figure 2.9.2 Original steam water heater

Figure 2.9.3 Gas fired water heater

2.8.3 Natural Gas System

The building is supplied with a metered 4” gas service with a gas pressure booster located in the basement plumbing room. The gas supplies the domestic water heater located on level 2 and the mechanical chillers located in the basement. The gas system appears to be in working order.

Figure 2.9.4 Incoming gas main and booster.

2.8.4 Sanitary Drainage

The sanitary system includes a gravity piping system for the majority of the building and a forced main from a duplex sewage ejector system for the basement drainage. The force main discharges into the gravity system. The ejector system is about 8-10 years old and appears to be operating without problems.

2.8.5 Storm Water Drainage

The building's storm water drainage system is a gravity system which appears to be functioning correctly and without problems. There have been some roof leaks reported near roof drains; however our understanding is this has been typically a roofing problem and not a storm water system issue.

The roof areas do not have any secondary drainage system, scuppers or other relief method.

2.9 Fire Protection Systems

The MCAD Tower building is a fully sprinklered high-rise building. The fire protection system in the building is in working condition. The system is fed from an independent incoming 8” fire main, with double check valve backflow preventer, located in the fire pump room in the basement.

Figure 2.10.1 Incoming 8” fire main with double backflow preventer.

2.9.1 Fire Pump

The building’s electric fire pump is located in the fire pump / plumbing room in the basement. The fire pump is an Allis Chalmers 1,000 GPM, 208 FT HD and 80 HP.

In speaking with the facility staff we understand the fire pump is tested annually and is in working order. However upon our site visit we notice the pump is leaking from the casing. While leaks are common this leak seems to be extensive and going on for quite some time as it is starting to corrode the fire pump casing and supports.

Figure 2.10.2 Fire pump leaking from casing

Figure 2.10.3 Corroded casing and supports for the fire pump

2.9.2 Standpipe System

In reviewing the existing drawings it seems the building's standpipe system consists of three (3) risers, one in each of the main egress stairs. Two (2) of the standpipes are called out as 6" and the other is called out as 4". These risers are located within the block wall of the stair and could not be seen during our site visit.

Each standpipe riser has a 2½" hose valve connection located at every floor level; however these connections are located within the occupied floor space and not within the stair enclosure, as required by NFPA 14.

In reviewing the existing drawings it seems the standpipe system was part of the original construction of the building. As built, the connections include a 1½" hose connection, with hose reel, at each floor landing. Today some of these hose stations have been removed, leaving only the 2½" hose valve connection, and in other areas both still remain.

Figure 2.10.4. Hose valve connection at Level 14

Figure 2.10.5. Hose valve cabinet with hose reel

2.9.3 Sprinkler System

The building was retrofitted with sprinklers in 1984. The sprinkler system was connected to the existing standpipes.

During our site visit we noticed some areas of the building, such as below ductwork in the mechanical rooms, where the sprinkler coverage is not adequate.

Some of the fire alarm devices installed in the sprinkler system, such as flow switches, are not connected to the fire alarm system.

Figure 2.10.6. Flow switch not connected to fire alarm.

2.10 Sustainability

As a public college, MCAD buildings are subject to meeting the goals of Executive Order 484 (EO 484), signed by Governor Deval Patrick, effective 18 April 2007. EO 484 established the following energy targets for Agency Buildings;

Executive Order 484 Goals	2012	2020	2050
Reduce GHG Emissions (from FY 2002 levels)	25%	40%	80%
Reduce Energy Consumption (from FY 2004 levels)	20%	35%	-
Procure (%) energy from renewable sources (from on-site generation or RECs)	15%	30%	-
Utilize bioheat products with min. blend of (%) bio based materials for heating that use #2 fuel oil	10%		
Reduce potable water use (from 2006 levels)	10%	15%	-
All new construction and major renovations must meet the Mass. LEED Plus green building standard			

These targets establish the primary framework for sustainability as it relates to this assessment of the Tower building. Only if a major renovation were to be undertaken, would the final target noted, i.e. the Mass. LEED Plus green building standard, be applicable. As such, this sustainability assessment will focus on the Tower building contributing to the targets and identifying the challenges to and opportunities for meeting the targets.

2.10.1 Energy

As discussed in the mechanical assessment, i.e. section 7, considerable portions of the mechanical systems are original to the building and past their useful life. They are likely considerably less energy efficient than current equipment and systems.

An energy management system was installed in the Tower in the 1999 renovation. Facilities staff schedule lighting and AHUs based on MCAD class schedules, which was noted to be up to 14+ hours a day. As described in the walk through, it has worked well to monitor and provide a basic level of control but has limited capabilities. For instance, there are only five (5) lighting zones in the entire 13 story building and many AHUs serve more than one level.

#2 fuel oil was not identified to be used in the Tower.

No on-site renewable energy systems were observed to be installed in the Tower. Facilities staff confirmed that MCAD does not have any on-site renewable energy systems installed nor does it purchase renewable energy credits. Therefore, MCAD is procuring 0% of its energy from renewable sources.

Both the building envelope and interior layout are not designed to daylight spaces. As such, the Tower building is reliant on artificial lighting. While T8 lamps and electronic ballasts were installed in the 1999 renovation to increase energy efficiency, the light fixtures themselves are original to the building. Except for the most recent public safety renovation and a few bathrooms, occupancy sensors are not installed in the building.

2.10.1.1 Building Envelope

As previously identified, the thermal performance of the facade is significantly below current energy code requirements for thermal performance. Specific glazing data was not made available, but the existing glass appears to be bronze tinted monolithic glass, likely ¼”. No shading is provided on the façade.

While the glazing provides some solar shading, a property identified as solar heat gain coefficient (SHGC), due to the tint of the glass, the thermal transmittance through the glass is high compared with today’s standards. The glazing also likely provides low visual light transmittance (VLT), meaning little daylight is allowed to interior spaces making them reliant on artificial lighting.

The mullions are also likely not thermally broken as the interior mullions were very cold to the touch during the walkthrough. This also contributes to poor thermal performance.

The spandrel panels are also likely insulated below current code requirements. As seen in the 13th floor mechanical room, the insulation is delaminating or completely off of the enclosure panels as the adhesive has failed, figure 2.11.1. Efforts to secure the insulation have been made, figure 2.11.2, but the insulation is still clearly detached from the exterior panel. Hence, the performance of the insulation has been compromised and is providing little to no protection from thermal transfer. Water infiltration damage was also evident in the insulation at several locations, refer to figure 2.11.1.

Figure 2.11.1

Figure 2.11.2

Additionally, the building envelope also has considerable air and water infiltration issues and the perimeter air vents do not have functioning dampers. These all further contribute to poor thermal performance.

The roof of the Tower building appears to be a membrane roof assembly, black in color, figure 2.11.4. In our walk through, it was identified that only the Level 13 roof has been replaced within the last 2 years, which represents a small portion of the total roof area. The new roof is in very good condition but the remaining roof areas were noted to be in poor condition with adhesion, water ponding and leakage issues. There is a green roof installation on the Level 11 roof, figure 2.11.3.

Figure 2.11.3

Figure 2.11.4

Black membrane roofs have become much less common as they absorb large amounts of solar radiation, typically reflecting only 23%, which contributes to heat gain into the building as well as heat island effects at the roof level. Alternately, white membrane systems have become increasingly common as they reflect a much higher amount of solar radiation, up to 69% and result in minimal rise of surface temperatures. In addition, green roofs are increasingly implemented as they not only have high thermal performance and mitigate heat island effects but also have stormwater reduction and attenuation as well as aesthetic and other environmental benefits.

Currently, the Tower faces significant challenges to meeting the energy and GHG emissions reduction targets in EO 484 due to dated mechanical systems, limited or non-existent control capabilities, and poor building envelope performance. All these issues increase the demand for energy use on the building and subsequent related GHG emissions.

2.10.2 Water

MCAD has implemented water saving measures in the Tower building as part of the 1999 renovation. Toilets with automatic flushometers, urinals and metered faucets were installed throughout the building and meet the 1992 Energy Policy Act (EPAct) requirements. As such, the Tower building currently meets minimum requirements for water fixtures. However, current practice typically exceeds these requirements as more efficient fixtures have become commonplace.

These measures were completed prior to 2006, which establishes the baseline for water use reduction in EO 484. Therefore, these measures are already captured in the baseline usage and additional water saving measures will likely need to be implemented in order to contribute towards meeting the 15% reduction target for 2020.

3 Mandatory Interim Scope

3.1 Summary

Building on the issues identified in the existing conditions assessment, a mandatory interim scope has been developed. It is necessary that the Tower continues to operate and be occupied, in the short and medium term. As such, money will need to be spent, separate from typical deferred maintenance, to keep the building running while a long term solution is developed.

Accordingly, the mandatory interim scope defined here has three components; **required**, **recommended** and **triggered** upgrade.

- The ***required*** scope addresses risks to life safety, and/or immediate operational issues.
- The ***recommended*** scope includes upgrades which focus on energy efficiency. They can that can be implemented without extensive work and typically have short payback periods, i.e. 5 years or less.
- The ***triggered upgrades*** scope addresses code issues, such as accessibility and path of egress issues that may potentially be required depending on the actual scope and schedule of work undertaken.

For context, the current 2013 CAMIS value of the Tower is $98,127,074.00 The Massachusetts Architectural Access Board (MAAB) 30% trigger for full accessibility compliance within the Tower is a three year rolling value of $29,438,122.00.

It is also important to note, the mandatory interim scope of work defined is different from typical deferred maintenance that buildings of this type and age require. As such, items that fall under deferred maintenance are not included.

The scope items and the “order of magnitude” construction costs are summarized in the table below. Costs are stated in 2013 dollars and are based on a concept level of design only. For example, an escalation contingency has been included at 4% over 1 year.

Any projects initiated as a result of this analysis should apply appropriate inflation factors to develop a project Estimated Construction Cost (ECC) at the anticipated point of construction.

Please refer to Appendix A.1 for full cost details and explanation of assumptions.

Required Scope

Section	Scope Item	Priority	Cost[1] ($)
3.3.1	Main Switchgear Replacement	**Immediate Operations** Life Safety	1,875,900.00
3.3.2	Egress Stair Pressurization	Life Safety	354,900.00
3.3.3	Freight Elevator Pressurization	Life Safety	89,570.00
3.3.4	Hose Valve Connections	Life Safety	33,800.00
3.3.5.a	Fire Alarm Devices	Life Safety	13,520.00
3.3.5.b	Fire Alarm System[1]	**Immediate Operations** Life Safety	980,000.00[2]
3.3.6	Fire Pump Replacement	**Immediate Operations** Life Safety	67,600.00
3.3.7	Domestic Hot Water Heater	General Safety	12,675.00
3.3.8	Refrigerant Leak Detection System	Life Safety	123,370.00
3.3.9	Open Railings in Multi-Story Space	Life Safety	50,700.00
3.3.10	Structural Beam Repair	Safety Concern	59,150.00
3.3.11	Detail Fireproofing Survey	Potential Life Safety	25,350.00
		TOTAL	3,673,015.00[3]

Recommended Scope

Section	Scope Item	Priority	Cost[1] ($)
3.4.1	Occupancy Sensors	Energy Performance	109,850.00
3.4.2	Solar Control Window Film	Energy Performance	202,800.00
		TOTAL	312,650.00

Triggered Upgrades

Section	Scope Item	Priority	Cost[1] ($)
3.5.1	Accessibility Upgrades	Code - Accessibility	-
3.5.2	Accessible Entry at Huntington Ave	Code - Accessibility	-
3.5.3	Path of Egress	Code - Life Safety	-

[1] Cost numbers noted are for order of magnitude purposes only. They include all mark-ups (totaling 64%) and represent normal working hours. Refer to Appendix A.1 for more details.

[2] During the course of this analysis, we understand that the fire alarm system in the Tower had a faulty test (9/2013) and the fire alarm panel has failed. The entire fire alarm system in addition to the panel has been priced for replacement by DCAMM separate from this study. The quotation for full replacement has been provided for reference.

3The total cost noted does not include costs for connecting the fire alarm devices (3.3.5.a) as a full system replacement (3.3.5.b) would address this item.

3.2 Introduction

3.2.1 Approach

The Existing Building Assessment highlighted the significant issues faced by the Tower. It is necessary that the Tower continues to operate and be occupied, in the short and medium term. As such, money will need to be spent, separate from typical deferred maintenance, to keep the building running while a long term solution is developed. The proposed mandatory interim scope therefore has three components;

- Minimum Immediate (required): Code, life safety, and/or immediate operational issues that are highly recommend be done now.
- Minimum Medium Term (recommended): Recommended upgrades which could be undertaken within the next 10 years assuming funding isn't available for the major renovation in this timeframe.
- Triggered Upgrades (potentially required): Triggered upgrade scope items include accessibility and path of egress upgrades that may or may not be required depending on the actual scope of work undertaken.

Additionally, we have recommended that two (2) detailed studies be conducted to further investigate the extent of a waterproofing failure and determine the extent of fireproofing coverage throughout the building, refer to Sections 3.3.10 and 3.3.11 respectively. These studies would determine whether further action is required.

3.2.2 Mandatory Interim Scope and Deferred Maintenance

The mandatory interim scope of work defined herein is fundamentally different from typical deferred maintenance that buildings of this type and age require. As such, items that would fall under deferred maintenance are not included in this report as DCAMM has a separate program to address these items.

For example, the Existing Buildings Assessment identified the air distribution system is in very poor condition and all but one of the thirteen (13) air handling units (AHUs) are original to the building. While we recognize the AHUs are well past their useful life and need to be replaced, their replacement is neither a life safety nor an immediate operations concern and is therefore not included from this report. Other examples of items identified in the Existing Buildings Assessment but classified as deferred maintenance are roof replacement(s), heat exchanger replacement, pipework replacement, and bus duct failure.

3.3 Mandatory Interim Scope of Work : Required

The following nine (9) scope items address issues or deficiencies that were identified in the existing building assessment. These items pose a significant risk to life safety, general safety, accessibility compliance and/or immediate operations of the Tower building. Therefore, these scope items are identified as required and should be addressed as soon as possible.

3.3.1 Electrical Switchgear

Issue

During our site visit we observed the main electrical room with a double-ended, secondary unit substation that has exceeded its useful life, is manufactured by Federal Pacific Electric (FPE) which is obsolete; and is currently operating with one transformer and tie circuit breaker closed which results in a high risk of future prolonged failure.

Figure 3.3.1 Existing switchboard

Priority: Immediate Operations & Life Safety

Electrical

MCAD is at a significant risk of a switchgear failure which would likely result in a considerable amount of downtime (i.e. weeks) of the Tower not in operation. The Tower building main electric room also feeds the Collins, East, North and Gym buildings on the MCAD campus. The Design Center, currently under construction, will also continue to be fed from the Tower. Please refer to figure 3.2 below. These buildings could also potentially be at risk in the event of failure.

Figure 3.3.2 Buildings fed from the Tower Building in blue

The Tower was designed with a double-ended, secondary unit substation which has two 1500kVA transformers, two distribution sections and a tie breaker section. Typically, such systems are designed to provide redundancy and allow the system to switch between sources and transformers in case one fails. It seems that one transformer has failed and currently the entire Tower is powered by one transformer. Therefore, the designed redundancy does not exist. The equipment is original to the building and past its useful life. Additionally, the equipment was manufactured by Federal Pacific Electric (FPE). FPE is no longer in business and therefore replacement parts are difficult to obtain.

Additionally, the main electrical room is not per current standards and it does not comply with OSHA Standards and current Codes. Some of noted non-compliant issues include the room condition and equipment placement. The room is dark and below IES recommended illumination levels for the space. Ground wire penetrations and abandoned equipment including one switchboard and several equipment pads are located throughout the room. This reduces the required working clearances and present hazards to maintenance personal. Additionally, the main electrical room currently houses both 13.8kV utility equipment and 600 volt owner equipment. Per current codes all Medium Voltage distribution equipment should be located in three hour rated vaults.

Mechanical

The existing exhaust fan has exceeded its expected service life and may not be adequately sized for the new equipment loads associated with the replacement of the main electrical switchgear. In addition, the newly configured electrical rooms created by separating the primary utility and secondary switchgear will most likely require separate air conditioning systems. To ensure proper operating conditions for the new switch gear rooms, new split air conditioning units are recommended.

Scope of Work

Electrical

All of the secondary electrical distribution equipment should be replaced in kind. The new distribution equipment will be located in a separate room from the utility primary switchgear, to allow for a phased switchover. A new space for the main electrical room needs to be identified. Ideally the new electrical room should be located near the vault to reduce the secondary feeder length and system losses. This in turn may require other systems in the adjacent spaces to be displaced.

All primary distribution equipment will remain in the existing electrical room which will now be dedicated as a utility company vault. The vault needs to be rebuilt to have a 3 hour rating including the floors, ceiling, walls and doors. In addition, the vault needs to be equipped with a new mechanical ventilation system, see below.

A new main electrical room will also require a 2 hour rating and dedicated mechanical system, see below. New secondary unit double ended substation with two 1,500kVA transformers, draw out, insulated case main and secondary circuit breakers and tie breaker will be required. The substation will require dual feeds to each section from the utility vault, and dual primary switches. New 13.8kV feeders will be required to the substation from the utility vault, the feeders need to extend under the slab or in a 3 hour rated enclosure.

Alternatively, secondary metered electrical service can be provided, where the service transformers are owned and maintained by the utility company. This option will require the transformers to also be installed in the vault. Based on the current room layout we do not anticipate that the vault needs to be increased in size, but this work would need to be coordinated and agreed with the utility company.

New feeders also need to extend from the new substation location to the buss duct risers and other existing to remain feeds which feed all of the buildings equipment. Work needs to be coordinated, phased to minimize down time and performed during vacations or off hours.

Other secondary distribution options include sizing, the new electrical distribution equipment to also feed the buildings that are currently fed from the existing vault. A more robust system could be designed with future expansion capacity and redundancies. This alternative is dependent on the determination of the long term commitment to the Tower building.

All of the existing secondary distribution, from the substation may remain but needs to be tested. Infrared scan all accessible equipment and hot pot test all feeders. Pending the results of the testing, replace or repair equipment as required.

Mechanical

New split type air conditioning units will be provided for the primary utility switchgear room and the secondary electrical distribution equipment room.

The split air conditioning units will consist of a ducted indoor evaporator unit connected to an outdoor air cooled condensing unit and refrigerant piping. Primary and secondary condensate drains will be provided. Fire and smoke dampers (FSD) at both supply and return ductwork penetrations through rated walls in the electrical rooms are required. The mechanical systems will connect to both the fire alarm system (FAS) and building management system (BMS).

Order of Magnitude Construction Cost

The cost for this scope of work is $1,875,900.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

It is important to note that the costs associated with this scope of work are independent of the building and any potential major renovation so that the money spent is not a sunk cost but is rather an investment to the MCAD campus electrical infrastructure.

3.3.2 Pressurization of Egress Stairs

Issue

During our site visit we observed that although the building is classified as a high rise building, the three (3) egress stairs do not have stair pressurization systems.

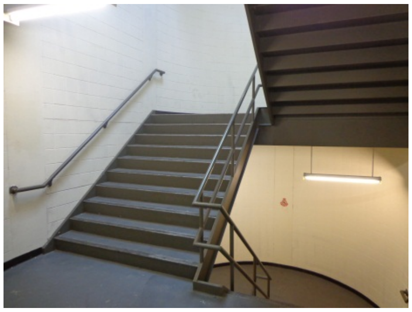


Figure 3.3.3 Typical egress stair

Priority: Life Safety

The Tower was built before classification and requirements for high rise buildings were implemented in the building code. Current code requires a stair pressurization system for each egress stairwell.

Pressurized egress stairwells keep exit routes smoke free in the event of a fire, prevent the passage of smoke throughout the building and provide a smoke free route for first responders to fight the fire.

Requirements for stair pressurization and smoke control systems are included in the Massachusetts State Building Code section 909 and International Mechanical Code section 513.

Scope of Work

Mechanical

Provide stair pressurization systems for each of the three egress stairs. Stair pressurization systems will consist of a roof mounted supply fan with a variable frequency drive (VFD) and distribution ductwork. All ductwork serving the elevator pressurization system will require a motorized damper at intake and a separate rated enclosure with an equivalent rating of the elevator enclosure. Elevator pressurization fans require 1.5x the required number of service belts and a service factor of at least 1.15.

The system will connect to both the fire alarm system (FAS) and building management system (BMS).

Electrical

In order to provide a code compliant system, the stair pressurization will be on stand-by power. The existing emergency distribution system can be used but standby loads need to be separated from emergency and optional emergency loads. This requires providing additional automatic transfer switches. For this project, we assume 260Amps 4 pole, and standby emergency distribution system for the stair pressurization system. The standby distribution provided will include a normal feed from the main switchboard and emergency standby from the existing emergency distribution system, which is located on the roof.

3.3.2.1 Order of Magnitude Construction Cost

The cost for this scope of work is $354,900.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.3 Pressurization of Freight Elevator

Issue

During our site visit we notice the freight elevator is adjacent to one of the egress stairs and this shaft is not pressurized.

Figure 3.3.4 Freight elevator and Stair 1.

Priority: Life safety

The freight elevator is located adjacent to egress stair 1, which is remote from the main elevators at the core of the building.   This elevator shaft does not have a pressurization system and as such is a risk to fire and smoke spreading in the event of a fire. Additionally, the area out front of the stair and freight elevator is not an enclosed rated elevator lobby. This relationship could compromise the path of egress for stair 1 in the event of fire.

Requirements for stair pressurization and smoke control systems are included in the Massachusetts State Building Code section 909 and International Mechanical Code section 513. A pressurized elevator shaft would prevent the passage of smoke throughout the building in the event of a fire and would help to preserve the egress path for stair 1.

Scope of Work

Provide elevator pressurization system for the existing freight elevator. Elevator pressurization systems will consist of a roof mounted supply fan with a VFD and distribution ductwork. All ductwork serving the elevator pressurization system will require a motorized damper at intake and a separate rated enclosure with an equivalent rating of the elevator enclosure. Elevator pressurization fans require 1.5x the required number of service belts and a service factor of at least 1.15.

The system will connect to both the FAS and BMS systems.

Order of Magnitude Construction Cost

The cost for this scope of work is $89,570.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.4 Hose Valve Connections

Issue

Each standpipe riser has a 2½” hose valve connection located at every floor level; however these connections are located within the occupied floor space and not within the stair enclosure, as required by NFPA 14.

Figure 3.3.5 Hose valve connection outside the stair enclosure

Priority: Life Safety

Hose valve connections are required to be located within the stair enclosures so that during a fire event the Fire Department personnel can connect their hoses while in a rated enclosure.

Having these connections located outside the stair enclosures require the Fire Department personnel to exit the projected enclosure into a potentially hazardous area to connect their hoses.

Scope of Work

Remove the hose valve connection from the building side of the stairs. Extend the pipe connection from the risers located within the block wall into the stair enclosures. Add hose valve connections at every floor level within the inside stair enclosures.

Order of Magnitude Construction Cost

The cost for this scope of work is $33,800.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.5 Fire Alarm Devices & System

Issue

3.3.5.a – Fire Alarm Devices

Some of the fire alarm devices installed in the sprinkler system, such as flow and tamper switches, control valves, etc. are not connected to the fire alarm system.

3.3.5.b – Fire Alarm System

During the course of this analysis, the fire alarm system in the Tower had a faulty test (9/2013) and the fire alarm panel has failed.

Figure 3.3.6 Fire alarm device not connected to fire alarm system

Priority: Immediate Operations and Life Safety

3.3.5.a - Without these devices connected to the building's fire alarm system, there is no way to notify occupants of a water flow, closed valve, etc. which would put the life safety of the building's occupants at risk.

Additionally, these devices have no way of notifying the Fire Department of an emergency in the building which will result in delay to Fire Department's response time.

3.3.5.b - Without a working fire alarm panel, the entire system in compromised and not in operation. This presents an immediate operational issue and risk to the life safety of the building's occupants in the event of fire.

Scope of Work

3.3.5.a - Connect all fire alarm devices to fire alarm system.

3.3.5.b - Replacement of the entire fire alarm system.

Order of Magnitude Construction Cost

3.3.5.a - The cost for this scope of work is $13,520.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.5.b – DCAMM obtained a quotation for full replacement of the fire alarm system separate from this analysis. The quotation was for $980,000.00.

3.3.6 Fire Pump

Issue

During our site visit we noticed that the fire pump is leaking from the casing. The leak appeared to be extensive and showed evidence of starting to corrode the fire pump casing and supports.

Figure 3.3.7 Fire pump corroded casing and supports

Priority: Life Safety & Immediate Operations

In speaking with the facility staff, we understand the fire pump is tested annually and is in working order. However, with the fire pump support currently compromised and the leak was observed to be continual, it is only a matter of time before the pump comes loose from its support. This would take out the entire fire protection system in the building and is therefore an area of immediate concern.

Scope of Work

The scope of work required is to replace the 1,000 GPM, 208 FT HD and 80 HP fire pump and base.

Since this is an in-kind replacement of equipment and the equipment will not be relocated to another space, no code upgrades are required.

Order of Magnitude Construction Cost

The cost for this scope of work is $67,600.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.7 Domestic Hot Water System Temperature

Issue

During our site visit we noticed that the water entering the gas water heater was 140°F and the leaving water was at 180°F. These are extremely high temperatures for a domestic water system. Typically domestic hot water is heated to 140°F and blended down to 120°F for circulation throughout the building.

Figure 3.3.8 Gas fired water heater with 180°F leaving water

Priority: Safety Concern

Producing 180°F hot water is dangerous and can cause immediate scalding if the master mixing valve were to fail and this water was delivered to a faucet, shower or other hot water outlet.

According to the American Society of Plumbing Engineers data book water over 140° F causes skin damage in less than 1 second.

Scope of Work

Verify temperature sensors are accurate, i.e. water leaving the water heater is at 180° F. If the sensors are accurate, the hot water heater settings should be adjusted to produce 140° F hot water. Additionally the master mixing valve setting should be adjusted to limit the hot water being circulated around the building to 120° F.

Order of Magnitude Construction Cost

The cost for this scope of work is $12,675.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.8 Refrigerant Leak Detection System

Issue

During our site visit, we observed an exhaust fan and refrigerant leak detection system are present in the chiller room and operational but are not connected to each other.

Figure 3.3.9 Existing Refrigerant Monitor Panel

Priority: Life Safety

Refrigerant leak detection and monitoring, and adequate machine room ventilation are important for conserving expensive refrigerants, protecting expensive refrigeration equipment and protecting staff that access the space. The current leak detection system and the exhaust fan are not integrated and the exhaust fan runs constantly whenever the chiller is in use.

The 2009 International Mechanical Code includes normal and emergency exhaust requirements for refrigeration machinery rooms in Chapter 11 Refrigeration, Section 1105 and Section 1105.6 Ventilation. The emergency exhaust requirement is based on the type and quantity of installed refrigerants and is higher than the normal exhaust requirement.

In the event of a refrigerant leak, the monitoring system activates the exhaust fan to emergency mode, for additional exhaust. Without the exhaust fan and detection system connected, the emergency operation of the exhaust fan is not possible. In addition, a new system would signal an audible and visual alarm outside of the refrigeration machine room, alerting staff not to enter the room.

Scope of Work

Provide a new refrigerant leak detection system and exhaust capable of normal and emergency exhaust. The refrigerant leak detection system will consist of a refrigerant monitor, air sampling system with tubing and an audible and visual alarm.

Refrigerant machine room exhaust will consist of a VFD controlled exhaust fan and make up air ductwork / louvers. The exhaust and make up ductwork will include motorized dampers at intake and exhaust. The system will also be connected to the BMS.

Order of Magnitude Construction Cost

The cost for this scope of work is $123,370.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.9 Open Railings in Multi-Story Space

Issue

During our site visit, it was observed that the railings in the multi-story space that connect Level 2, the Upper Level, Ground Level and Level 1 do not meet the requirements for graspability, nor does it provide guards. The existing construction is painted, flat bar stock. In addition, the railings do not provide guardrail protection to the levels below.

Figure 3.3.10 Multi-story space

Priority: Life Safety

The current code requires handrail graspability which is defined as a circular cross section that has an outside diameter of at least 1.25 inches and not greater than 2" or that provides equivalent graspability. It also requires a guard to be located along any open-side walking surface, stairways, landings, etc. that are located more than 30 inches above the floor or grade below. This guard shall not be less than 42" high. In its current state, the railings present a danger to occupants and visitors.

Scope of Work

Provide 1-1/2" dia painted steel guardrail assembly (center of pipe @42" high). Infill with painted steel bar stock pickets @4" o.c.. Provide 1-1/2´ dia painted steel handrail @34" and code compliant handrail extensions.

Order of Magnitude Construction Cost

The cost for this scope of work is $50,700.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.10 Structural Beam Repair

Issue

During our site visit, a water penetration problem was observed in the ceiling of the basement electrical transformer room which has caused the steel beams to rust/ delaminate and spalling of the concrete encasement. This was located at gridlines C/D and 10/11. An exterior terrace is located above.

Figure 3.3.11 Fire pump corroded casing and supports

Priority: Safety Concern

This beam is in the main electrical equipment room and existing piping is being hung from the beam. The existing steel beam has lost significant area of its original cross section and the safety factor is unacceptable. Additionally, due to the extent of the deterioration, the water penetration is likely a long standing, persistent issue, which is of high concern in an electrical room.

Scope of Work

Replace the deteriorated steel beam and repair the exterior waterproofing system to prevent continuing water penetration. The exact extents of the waterproofing failure need to be determined as a detailed investigation has not been completed.

Provide temporary support of existing roof structure. Remove existing steel beam and install new beam and concrete encasement. The existing piping will need to be temporarily relocated and/or supported. New supports for the piping will be installed after the new beam has been installed.

Due to the electrical equipment and existing piping, careful consideration is required to protect the existing equipment while work is being undertaken. This work does not trigger seismic upgrades to the building.

Order of Magnitude Construction Cost

The cost for this scope of work is $59,150.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.3.11 Detailed Survey of Building Fireproofing

Issue

During our site visit, inconsistencies in fireproofing continuity were evident throughout the building.

Figure 3.3.12 Inconsistent fireproofing

Priority: Life Safety

Under the current building code, the construction classification has been identified as at least Type 1B. Floor assembly ratings require a 2 hour fire rating. It is unknown at this time if the building complies with the requirements for Type 1B construction. A detailed survey of the fireproofing in the Tower will allow deficiencies in the fireproofing to be identified.

Scope of Work

Engage a consultant to conduct a detailed survey to determine the extent of existing fireproofing in the Tower. This assessment will determine if any additional work will be required and the extent of the work.

Order of Magnitude Construction Cost

The cost for this scope of work is $25,350.00. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.4 Mandatory Interim Scope of Work: Recommended

The following two (2) scope items address energy efficiency issues identified in the existing building assessment that can be implemented without extensive work and typically have short payback periods. These items while important, do not pose a risk to life safety or immediate operations and are therefore, recommended to be undertaken within the next 5 -10 years.

3.4.1 Occupancy Sensors

Issue

During our site visit, it was confirmed that the Tower has very limited lighting controls. Only the recently completed Public Safety office and adjacent Classroom on Level 2 were indicated to be equipped with occupancy sensors.

Figure 3.4.1 Interior hallway with small offices, right

Priority: Energy Performance

Energy efficiency is an important sustainability issue and contributes towards meeting EO 484 energy targets in addition to saving money on electricity bills. Lighting is typically a significant consumer of a buildings' energy consumption. Lighting accounted for 25.5% of the energy end use for commercial buildings, according to the US Department of Energy (October 2008 study).

Wall switch occupancy sensors ensure that lights are turned off if the given space is unoccupied for a period of time but also allow an occupant to turn on or off the light like a regular switch.

Scope of Work

Replace existing wall light switches (on/off) with wall switch occupancy sensors, passive infrared type. Approximately 250 spaces were identified for replacement. These areas included offices, restrooms, conference rooms or other similar spaces around 550 square feet or less. No classrooms or studio spaces were included to keep the scope of work as minimal as possible.

Order of Magnitude Construction Cost

The cost for this scope of work is $109,850.00. The realized energy savings of occupancy sensors on lighting energy consumption ranges from 12% up to 40% depending on the specific type used and therefore payback periods also vary. ASHRAE energy modeling methodology allows for a 15% reduction in lighting power for areas with occupancy sensors installed. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.4.2 Solar Control Window Film

Issue

During our site visit, it was observed that the building envelope is in poor condition and likely has very poor thermal performance. An Arup report dated April 18, 2012 further identified and discussed deficiencies in the building envelope.

Figure 3.4.2 Tower curtainwall. Vision glazing is blocked up and/or blinds are drawn

Priority: Energy Performance

Energy efficiency is an important sustainability issue and contributes towards meeting EO 484 energy targets in addition to saving money on electricity bills. The building envelope plays a critical role in the energy demands of a building as it regulates thermal transmissions, i.e. gains or losses to the interior spaces. Solar control window films are a relatively low cost means of improving the thermal performance of the building envelope without requiring major upgrades. The films can also serve to mitigate glare issues and improve visual comfort at perimeter spaces.

Scope of Work

Install solar control window film, 3M Prestige series PR70 or similar, to the interior face of the glazing. The vision glazing areas identified to install the film are the southeast, south, southwest and west facing facades, approximately 12,000 square feet.

Order of Magnitude Construction Cost

The cost for this scope of work is $202,800.00. Typically, solar control window films have a 2.5 to 5 year payback period, but vary depending on the specific film installed. Please see Appendix A.1 for a detailed breakdown, including off-hours pricing and associated assumptions.

3.5 Triggered Upgrade Scope of Work

The following scope items have been identified as upgrades that may be triggered with particular scopes of work. Given that these items may or may not be required, a specific scope of work has not been developed, nor has costing been provided. Only the issues are discussed in this section.

3.5.1 Code Triggers

Seismic Upgrades

Seismic upgrade requirements and their extent are contingent on multiple factors; the seismic design category, specific scope of work and subsequent level of alteration category (i.e. 1, 2, or 3) per the Existing Building Code. The Tower is applicable to seismic design category B but without a specific scope of work to assess, whether or not seismic upgrades are required cannot be determined at this time.

Accessibility

There are two accessibility related requirements for upgrades to existing buildings, Massachusetts Architectural Access Board (MAAB) and ADA. MAAB provides ranges related to the dollar amount of work that triggers different levels of upgrades. The dollar figure is a 36 month rolling value for all building permit work done. This applies to the non-exempt total, the exempt total and the combined exempt and non-exempt. The categories are as follows:

1. Work < $100,000: The specific work area is required to meet all current accessibility requirements.
2. $100,000 < Work < 30% CAMIS value of the building only: The specific work area is required to meet all current accessibility requirements AND an accessible toilet and public entry, and telephone and water fountain (if applicable) must be provided.

   The following types of work may be deducted from the cost of alterations unless the cost of the work exceeds $500,000. Work which is limited solely to electrical mechanical, or plumbing systems; to abatement of hazardous materials; or retrofit of automatic sprinklers and does not involve the alteration of any elements or spaces required to be accessible. This is only if the total exempt and non-exempt work does not exceed 30% of the CAMIS value.

   If the exempt work being done is under $500,000, two building permits could be filed, exempt and non-exempt. But this would only be a course of action if the exempt work was under $500,000 and the non-exempt plus the exempt work is under 30% of the CAMIS values for the building. For example, if the exempt work is $378,000 and the non-exempt work is

$89,000. It would remain in Category 2 if two permits were filed, one for exempt and one for non-exempt.

3. If the exempt and non-exempt work in the building exceeds 30% of the CAMIS value, this triggers an entire building upgrade to current accessibility standards.

The current 2013 CAMIS value for the Tower building provided by DCAMM is $98,127,074.00 and therefore, the current 30% trigger is $29,438,122.00. The CAMIS value is revised annually by DCAMM, early in the year.

Alternately, ADA requires that up to 20% of the value of alterations to areas of primary function to be applied to improving the altered area and the path of access to altered areas. If it exceeds 20%, not all the work needs to be done. The ADA prioritizes the type of upgrades to be provided when the value of upgrades exceeds 20%. A primary function is defined as, “a major activity for which the facility is intended”, per the 2010 ADA Standards for Accessible Design, Section 36.403 (b).

3.5.2 Accessibility Upgrades

The ADA Compliance Plan, dated March 2011, prepared by the Institute for Human Centered Design (IHCD), identified the following areas that have non-compliance issues:

1. Entry, accessible routes, and paths of travel, including ramp slopes
2. Bathrooms and drinking fountains
3. Signage and wayfinding
4. Stairs and handrails
5. Seating areas
6. Door clearances, hardware and opening forces
7. Assistive listening devices

If an accessible toilet rooms is provided, an additional staff toilet room would be required per the plumbing code.

These are accessibility issues.

3.5.3 Accessible entry on Huntington Avenue

The Tower building has an accessible entrance on Evans Way that provides direct access to the building elevator core. However, the main entry to the Tower is located on Huntington Avenue. One entry on Huntington Ave is accessible and provides entry to the Auditorium, but does not provide access to the building elevator core.

As such, the Tower building meets accessibility requirements but does not provide equal access. Providing access to the elevator core from a Huntington Ave entrance would meet the threshold for equal access.

This is an accessibility issue.

3.5.4 Egress Compliance

A desk review of the current building plans indicate that there are egress noncompliance issues on multiple floors. As work is undertaken in the building these items may be required by the authorities having jurisdiction (AHJ) to be brought into compliance throughout the building and include;

- Door swings not in the path of egress travel
- Inadequate numbers of exit signs and/or emergency lighting
- Classrooms (greater than 750 SF) and/or Conference Rooms (greater than 1,000 SF) that do not have two means of egress and/or the egress doors provided are not the required distance apart.
- Egress paths that require passage through other rooms that are not allowed.

This is a life safety issue.

3.5.5 Hazardous Materials

Materials provided by DCAMM and MCAD document that asbestos is present and pervasive in the Tower building. The most recent report, *Asbestos Operations and Maintenance (O&M) Program*, dated September 2007 was prepared by Axiom Partners, Inc. Appendix D, titled 2007 Individual Building Asbestos Re-inspection Summary, specifically discusses the Tower Building.

Abatement work, in varying extents, may be required with the scope of works proposed in this report. However, without a fully designed project, the extent of any associated abatement work cannot be determined at this time.

4 Building Rehabilitation Options

4.1 Summary

The Existing Building Assessment conducted in January 2013 identified numerous deficiencies with the Tower building across the full range of building systems as well as poor energy performance The building rehabilitation options put forth in this section describe alternative approaches to a scope of work that seeks to address all of the deficiencies identified while also improving the building's layout efficiency, energy performance and system reliability.

Given the lengthy list of deficiencies, refer to Section 4.2 for full list, and stated aspirational goals the conclusion reached is that a significant intervention is required. These are summarized below;

Option 1: Retain Primary Structure and Complete Renovation

This option would strip the building back to its primary structure and completely rebuild the building. The benefit to this option is savings in terms of demolition costs and associated construction time and costs. Additionally, a preliminary assessment of space planning indicates with the given floor plates, a slight increase of 6,370 net square footage (i.e. usable square footage) could be achieved.

Three options for the phasing and construction approach for option 1 have also been suggested. These were developed with the assistance of Gilbane construction. Refer to section 4.3.1 for more details and Appendix D for Gilbane's full report.

1. **Unoccupied Renovation –** the building would completely relocate to another location during construction. This allows for the quickest construction but requires the most significant and lengthy relocation.
2. **Horizontal Phasing –** The building would remain partially operational with three floors offline at a time and the construction would move progressively up or down the building. This would allow the largest portion of the building to remain in occupation during construction but would require more numbers of relocation.
3. **Vertical Phasing –** The building would remain partially operational and be "split" in half vertically. Construction would occur on one half of the building and then switch to the other side. This allows the building to be partially occupied and minimize relocation

Option 2: Demolish and Rebuild

1. **Rebuild 318,299 GSF**

   This option would rebuild the same gross square footage as the existing Tower building. The benefit to this option is an increase of 16,521 square feet in net square footage, or usable square footage for MCAD as a result of increasing the efficiency of the space planning from 54.8% in option 1 to 60.0% in a rebuilt scenario.

2. **Rebuild 290,763 GSF**

   This option would rebuild the same net square footage as option 1, i.e. 174,458 square feet. The benefit to this option is a decrease of 27,536 in the gross square footage to be re-built and associated cost savings. Again, this would be as a result of an increase in space planning efficiency from 54.8% in option 1 to 60.0% in a rebuilt scenario.

It is assumed that the same program and uses will be provided in the proposed options as the current Tower building. Additionally, the electrical switchgear scope of work proposed in the mandatory interim scope is assumed to have been completed as proposed.

Furthermore, the systems proposed are to allow for order of magnitude pricing and while they do meet and/or exceed code and other applicable requirements, are not to be taken as a specific design proposal but rather to suggest what is possible given the recommendation that a major renovation take place.

The resulting costs associated with each option are identified in the table below. Refer to Section 4.3 for full details and discussion.

Building Rehabilitation Options: Summary Table

	Net Area (NSF)	Gross Area (GSF)	Efficiency[3] (%)	$/GSF	ECC[2]
Option 1: Retain Primary Structure and Complete Renovation					
Unoccupied renovation	174,458	318,299[1]	54.8	$461.80	$146,991,007
Horizontal phasing	174,458	318,299[1]	54.8	$494.37	$154,358,842
Vertical phasing	174,458	318,299[1]	54.8	$482.27	$153,506,294
Option 2: Demolish and Rebuild					
Rebuild 318,299 GSF	190,979	318,299[1]	60.0	$479.90	$152,750,287
Rebuild 290,763 GSF	174,458	290,763	60.0	$482.21	$140,210,393

[1] Areas noted have been provided by MCAD, and represent adjusted gross square footage (AGSF).

[2] The costs noted are 2013 dollars. The 2013 CAMIS value of the Tower is $98,127,074.00.

[3] Efficiency is the % of net square footage to total gross square footage

The order of magnitude costs are significant for all options. However, it is important to note that they also indicate that numerous options are viable, i.e. one is not immediately apparent as a preferable option based on the initial cost exercise conducted.

4.2 Existing Building Assessment

The Existing Building Assessment conducted in January 2013 identified numerous deficiencies with the Tower building across the range of systems. These deficiencies are summarized below;

Façade

- Very poor thermal performance
- Very poor condition, leaks air and water
- Significant repair work to the curtain wall has already been conducted and in places appeared to be deficient

Architectural

- Roofs are in very poor condition, except level 13 which was recently replaced.
- Interior layout is very inefficient, currently only 52.8% efficient.
- Vertical transportation system is inefficient
- Fireproofing and firestopping is inconsistent
- A waterproofing failure was observed in the basement Electrical Room
- The numbers of toilets are inadequate for the occupant loading and staff toilets are not provided as required by current code

Mechanical

- Perimeter systems (i.e. unit ventilators and exhaust fans) are not working and difficult to repair since they are integral to the curtain wall system
- 13 of 15 Air handling units (AHUs) are past useful life
- Air distribution system is a constant air volume (CAV) system which is inefficient.
- Chillers are approaching end of life
- Natural gas chiller is very high maintenance
- Building Management System (BMS) has limited capabilities

Electrical Systems

- Main switchgear is past its useful life and is in danger of failure
- Secondary distribution system is in poor condition. The equipment is Federal Pacific. Replacement parts are no longer manufactured or available.
- Emergency system doesn’t have emergency/standby/optional capabilities
- Lighting system and fixtures are original to the building and inefficient
- No lighting control systems are installed

Plumbing systems

- Domestic hot water temperatures are higher than allowable code limits and pose a safety risk
- Pipework is original to the building and is in very poor condition

Fire Protection

- No stair or elevator pressurization systems are installed in this high rise building (life safety)
- No smoke control systems are installed (life safety)
- Fire pump is leaking from its casing and its foundation is corroding
- Fire alarm devices are not connected to sprinklers
- Hose valve connections are located outside rated stair enclosures (code requirement)
- Sprinkler coverage is inadequate or non-existent, i.e. Auditorium
- Fire alarm system is antiquated and doesn't provide voice evacuation
- No Fire Command Center is provided
- Fire alarm panel is at/exceeded capacity. The fire alarm panel very recently had a faulty test

Accessibility *per the Institute for Human Centered Design Report, March 2011. The report identified deficiencies (non-compliances) with ADA and MAAB compliance.*

- Entry, accessible routes and paths of travel, including ramp slopes
- Bathrooms and drinking fountains
- Signage and wayfinding
- Stairs and handrails
- Seating areas
- Door clearances, hardware and opening forces
- Assistive listening devices

Hazardous Materials *per Axiom Partners 2007 report, refer to Appendix C.*

- Asbestos is present and pervasive in the building.

Code

- Handrails are not compliant
- Path of egress issues are present

To address the deficiencies identified above, replacement of each of these systems, i.e. façade, roofs, mechanical, electrical, lighting, plumbing and fire protection, is recommended. The structural system in the building is sound and in good condition.

It is important to note that piecemeal replacement of systems is not viable as most of the systems noted above are integral to one another and therefore cannot be addressed independently. For instance, if the façade were to be replaced, the mechanical systems would also require a complete overhaul and redesign since the perimeter systems are integrated in the curtain wall system.

4.3 Building Rehabilitation Options

4.3.1 Building Rehabilitation Option 1: Retain Primary Structure and Complete Renovation

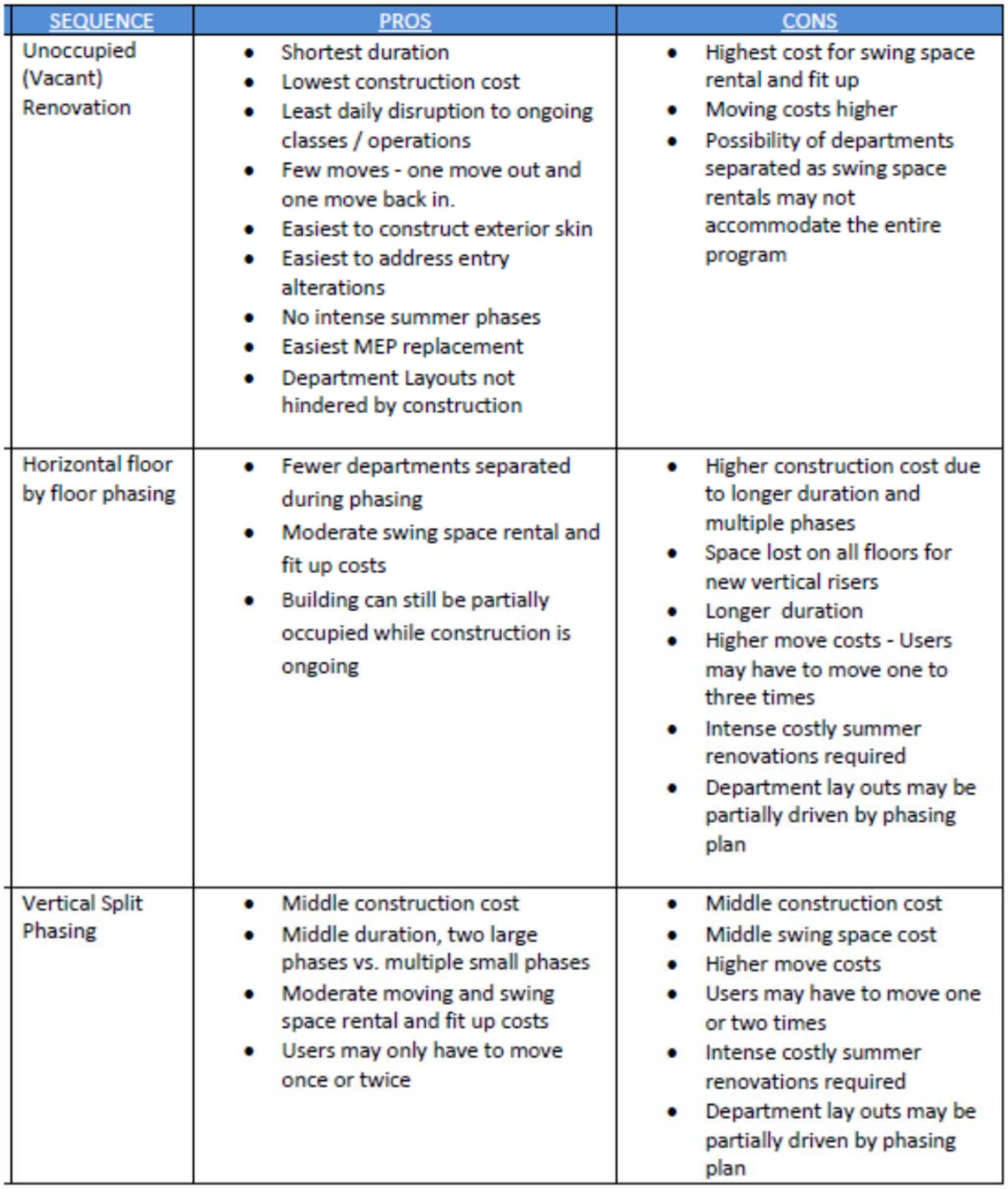
Per the existing building assessment, the structural system was found to be in good condition. Option 1 was developed with this in mind. It would strip the building back to its primary structure (i.e. steel and concrete) and completely rebuild the building.

The benefit to this option is in saving the existing structure and foundations of the building. There are savings in terms of demolition costs and associated construction time to rebuild the structure and costs.

Additionally, a preliminary assessment of space planning, section 4.3.6.2 indicates with the given floor plates, a slight increase of 6,370 net square footage (i.e. usable square footage) could be achieved.

Three options for the phasing and construction approach for building rehabilitation option 1 have been identified. These were developed with the assistance of Gilbane construction. Their full report is included in Appendix D and discusses each approach, implications to that approach and associated timelines.

The table below is a summary of each option;



SEQUENCE	PROS	CONS
Unoccupied (Vacant) Renovation	• Shortest duration • Lowest construction cost • Least daily disruption to ongoing classes / operations • Few moves - one move out and one move back in. • Easiest to construct exterior skin • Easiest to address entry alterations • No intense summer phases • Easiest MEP replacement • Department Layouts not hindered by construction	• Highest cost for swing space rental and fit up • Moving costs higher • Possibility of departments separated as swing space rentals may not accommodate the entire program
Horizontal floor by floor phasing	• Fewer departments separated during phasing • Moderate swing space rental and fit up costs • Building can still be partially occupied while construction is ongoing	• Higher construction cost due to longer duration and multiple phases • Space lost on all floors for new vertical risers • Longer duration • Higher move costs - Users may have to move one to three times • Intense costly summer renovations required • Department lay outs may be partially driven by phasing plan
Vertical Split Phasing	• Middle construction cost • Middle duration, two large phases vs. multiple small phases • Moderate moving and swing space rental and fit up costs • Users may only have to move once or twice	• Middle construction cost • Middle swing space cost • Higher move costs • Users may have to move one or two times • Intense costly summer renovations required • Department lay outs may be partially driven by phasing plan

Figure 4.3.1 Comparison of construction phasing approaches provided by Gilbane. Refer to Appendix D for full details.

The timelines associated with each phasing option as provided by Gilbane are indicated to be similar;

1. Option 1: Unoccupied Renovation (figure 4.3.2 below)
    - Building swing space: 4-6 months
    - Relocation: 3 months (summer)
    - Total Construction Duration: 24 months
    - Move-in: 3 months (summer)

2. Option 1: Horizontal or Vertical Phasing (figure 4.3.2 below)
    - Building swing space: 2-3 months
    - Relocation: 3 months (summer)
    - Total Construction Duration: 24-26 months
    - Move-in: 3 months (summer)

Figure 4.3.2 Indicative construction timelines for phasing options from Gilbane's report, Appendix D, page 16.

4.3.2 Building Rehabilitation Option 2: Demolish and Rebuild

As a point of comparison, an additional option has been provided which represents a full demolition and rebuilding of the Tower building. The intent is to provide context with which to assess Option 1: Retain primary structure and complete renovation since option 1 represents such a significant improvement over the current Tower building. Option 1, therefore, needs to be understood in the context of a new building, i.e. starting from scratch.

Option 2: Demolish and rebuild is equally high level and has been prepared based on the same description provided in section 4.

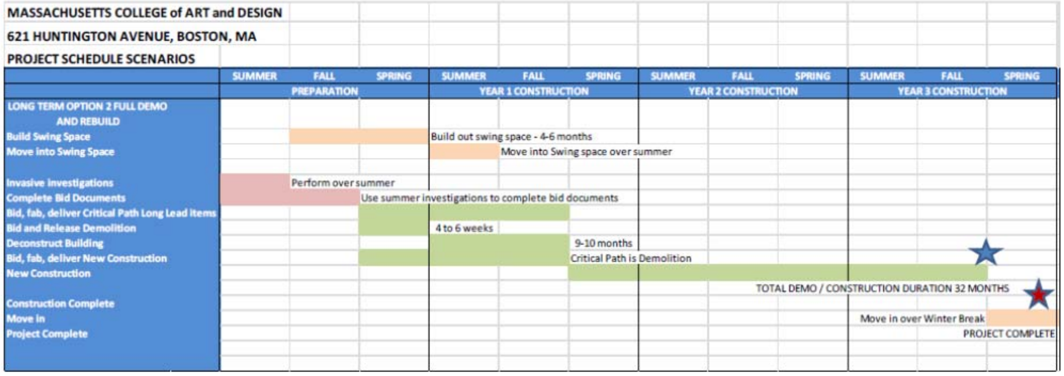


Figure 4.3.3 Indicative construction timelines for option 2 from Gilbane's report, Appendix D, page 19.

Per the timelines developed for option 1 and option 2, it is anticipated Option 2: Demolish and Rebuild would require an additional 6-8 months compared to Option 1: Retain primary structure and complete renovation. This is important as it also requires MCAD to lease space and remain in a temporary occupancy for this extended period of time, at added cost.

4.3.3 Additional Construction Considerations

In either of the building rehabilitation options, there are other phasing issues that need to be planned for ahead of the start of the above timelines. These include;

- The completion of the electrical main switchgear work as described in the mandatory interim scope of work. This work would remain for either option.
- The cooling tower of the Tower also serves equipment in the Pozen Auditorium located in the adjacent North Building. Either of the building rehabilitation options needs to allow for temporary heat rejection provisions in order for the Pozen Auditorium to remain operational construction.

4.3.4 Code Items

4.3.4.1 References

The building rehabilitation options discussed have been prepared according to the following current applicable codes and standards;

- 780 CMR 8TH Edition, as amended
- 2009 International Building Code [IBC] as amended
- 2009 International Existing Building Code [IEBC] as amended
- 2009 International Energy Conservation Code [IECC] as amended
    - 780 CMR Appendix AA "Stretch Energy Code"

- 2009 International Mechanical Code [IMC]
- 2011 NFPA 70, National Fire Protection Association National Electrical Code as amended
- 527 CMR Fire Prevention Code
- 524 CMR Elevator Code/2004 ASME A17.1
- 521 CMR 2006 Massachusetts Architectural Board Regulations
- ADA Design Standards 2010
- 248 CMR Plumbing Code
- MGL Chapter 148 s. 26G
- Executive Order 484

It is important to note that codes and standards are regularly updated and have shown to become increasingly stringent. Whichever building rehabilitation option is chosen, the project is likely to occur at least 5 or as many as 10 to 15 years in the future.

As such, the applicable codes and standards noted above will have likely gone through multiple updates which will affect the design and performance criteria required. For instance, Massachusetts is in the process of updating its Energy Code from IECC 2009 to IECC 2012, which requires higher energy efficiency. The building rehabilitation options proposed herein are based on current codes, standards and performance requirements.

4.3.4.2 Triggered Upgrades

Several compliance issues were identified in the Existing Building Assessment and mandatory interim scope as upgrades that may be triggered with a particular scope of work. These four issues are summarized below as they relate to the building rehabilitation options proposed;

Issue	Code	Upgrade/Compliance
Accessibility[1]	MAAB[2] and ADA	Required
Toilet Facilities, Staff Toilets	MA Plumbing Code 248 CMR	Required
Path of Egress	MA Building Code 780 CMR	Required
Seismic Upgrades	Existing Building Code	May or may not be required

[1] Accessibility refers to all the deficiencies identified in the IHCD report dated March 2011.

[2] Massachusetts Architectural Access Board (MAAB)

Accessibility

The Tower Building has numerous accessibility issues that have been documented in the Institute for Human Centered Design (IHCD) report dated March 2011.

The current 2013 CAMIS value of the Tower building is $98,127,074.00 The Massachusetts Architectural Access Board (MAAB) 30% trigger for full accessibility compliance within the Tower building is a three year rolling value of $29,438,122.00. Any of these building rehabilitation options provide a fully accessible building in addition to significantly exceeding the 30% trigger for full accessibility compliance.

Toilet Facilities

The Tower building does not have any fully accessible toilet facilities per MAAB and Federal ADA. Additionally, the Tower is now classified as a post-secondary educational occupancy per the Massachusetts plumbing code, 248 CMR. This requires separate staff toilets for all educational occupancies. The Tower does not have the required number of staff toilets.

The building rehabilitation options provide accessible toilet facilities and separate staff toilets to meet both MAAB and 248 CMR requirements, as discussed in section 3.2.1.

Seismic Upgrades

Seismic upgrade requirements and their extent are contingent on multiple factors; the seismic design category, specific scope of work and subsequent level of alteration category (i.e. 1, 2, or 3) per the Existing Building Code. The Tower is applicable to seismic design category B.

Seismic upgrade requirements are subsequently discussed as certain scopes of work do require upgrades and others do not. Where seismic upgrades are required, a specific description of the work involved is provided.

Path of Egress

The mandatory interim scope (refer to section 3.5.4) highlighted egress noncompliance issues on multiple floors in the Tower building. These included door swings not in the path of egress travel, inadequate numbers of exit signs and/or emergency lighting, classrooms greater than 750 SF and/or conference rooms greater than 1,000 SF that do not have two means of egress and/or the egress doors provided are not the required distance apart, and egress paths that require passage through other rooms that are not allowed.

The building rehabilitation options will fully comply with path of egress requirements and therefore address all of the noncompliance issues.

4.3.4.3 Hazardous Materials

Information provided by DCAMM and MCAD document that asbestos is present and pervasive in the Tower building. The most recent report, *Asbestos Operations and Maintenance (O&M) Program*, dated September 2007 was prepared by Axiom Partners, Inc. Appendix D of the report, titled *2007 Individual Building Asbestos Re-inspection Summary*, specifically discusses the Tower Building. This section provides identification of materials, locations and quantities of asbestos-containing materials, a list of past abatement projects, a cost estimate, site photographs, plans and inspection results.

The costs provided in Axiom's report have been used in this report, with an applied escalation factor, as full abatement is required as part of any of the building rehabilitation options proposed. Please refer to Appendix C for more information.

4.3.5 Salvageable Systems and Equipment

While the list of items identified as deficient is lengthy, there are items that are within their lifetime, and in good or new condition. These items include;

Equipment	Approximate Age	Expected Service Life
1. Cooling Tower	1 year	15 years
2. Domestic Cold Water Booster Pump	1 year	20 years
3. Level 13 Roof	2 years	25 years
4. Two (2) Chillers; Trane Centrivac Thermo Power Corp	 15 years 14 years	 20 years
5. Generator	14 years	25 years
6. Eight (8) Elevators and One (1) Freight Elevator	9 years	25 years

However, given that a major upgrade, like the one proposed, to a building such as the Tower takes time to be funded, studied, certified, designed, and constructed, realization of the chosen building rehabilitation option is at least 5 or as many as 10 to 15 years in the future. Bearing this in mind, in addition to the logistics and costs of salvage and expected efficiencies of equipment in the future, salvaging the equipment identified above is not recommended and has not been proposed in the building rehabilitation options.

As previously mentioned, the only systems and/or equipment that are recommended and assumed to be maintained in the building rehabilitation options discussed herein, is the building structural system. The work proposed in the mandatory interim scope to the main electrical switchgear is also assumed to have been completed and subsequently maintained in the building rehabilitation options.

4.3.5.1 Demolition

After our review of the existing building and its systems we have identified many deficiencies, refer to sections 2 and 4.2. In order to address all these deficiencies and try to increase the usable net square footage of the building, it is our conclusion that the building requires a major rehabilitation.

This will allow for the building improvements identified in the following sections to be implemented with many of the constraints of the existing building. Please refer to Appendix D for details on timelines.

4.3.6 Architecture Planning

The current floorplans have low usable floor area ratios. This can be attributed to inefficient core layouts and irregularly shaped spaces which respond to the overall mass of the building.

It is possible to gain additional, usable area by defining a more efficient core layout, decreasing excessive circulation and programmatically stacking larger portions of open program, such as studios, in areas with an irregular column layout.

4.3.6.1 New Core Layout

The existing core layout has been identified as inefficient in terms of space use and additionally, toilet facilities are inadequate for accessibility and staff toilet requirements. Providing a more efficient core layout will increase the floorplate efficiency and address the following issues:

- Meets the requirements of the Accessibility code (MAAB 521 CMR) for accessibility.
- Provides additional usable area around the existing Electrical Closet.
- Allows the existing restroom (South of the Elevators) to be re-purposed for other uses.
- This layout allows for the creation of a Fire Service Elevator Lobby (tied to Stair 2) which is a code requirement for high-rise construction.
- Meets the requirements of the Plumbing Code for Post-Secondary Education criteria for plumbing count plus additional fixtures for convenience, mop sinks and drinking fountains.

  The existing restroom fixture count on a typical floor is as follows;

  - Women: 3 W.C.’s , 3 lavatories and 1 laundry sink
  - Men:2 W.C.’s, 4 urinals, 3 lavatories and 1 laundry sink

  There appears to be an excessive number of fixtures for Men and no ADA compliant stalls in either gender. The requirements of the Plumbing Code are outlined in the table below:

Occupancy	Female WCs	Male WCs	Urinals	Lavatory	Drinking Fountain	Service Sink
Post Secondary	1 per 90	1 per 180	1 per 180	1 per 180	1 per 75	1 per floor
Staff	1 per 20	1 per 25	33%	1 per 40	1 per 75	-------

For discussion purposes, the highest Net Assignable Square Footage is approximately 19,630 SF. The occupancy per floor is determined by the building code occupancy category, which in this case is Business use;

- 19,630 SF divided by 100 = 196.3 occupants
- 196.3 divided by 2 = 98.15 occupant for Women & Men

The minimum # fixtures required by code is as follows:

- Women: 2 W.C.'s and 1 lavatory
- Men: 1 W.C and 1 lavatory

These counts reduce the existing number of fixtures below a threshold we believe is acceptable to the Owner. The proposed layout provides three fixtures and two lavatories for each gender.

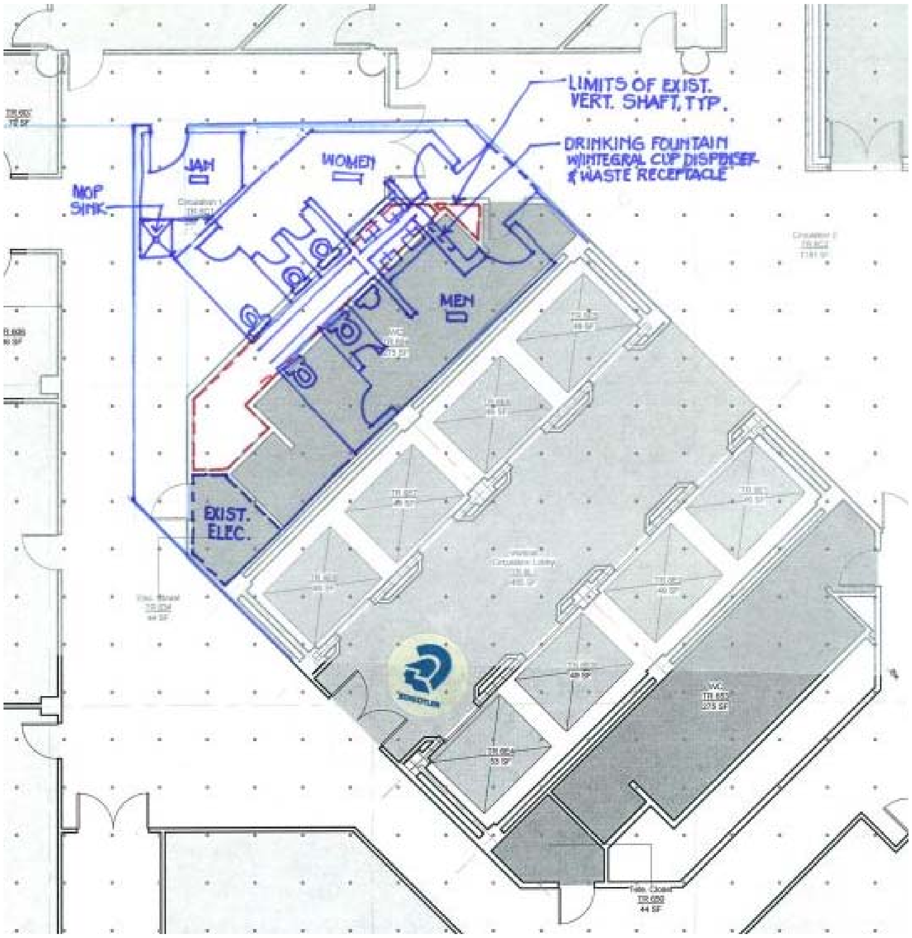


Figure 4.3.2 Proposed Core Layout

4.3.6.2 Stacking Diagram

Programmatically stacking similar pieces of program may also gain spatial efficiencies. This type of exercise is inherently tied into a more defined programming study which is not part of this analysis. Therefore, this analysis identifies areas which lend themselves well to general types of program. Please refer to Appendix D for plan diagrams and summary tables.

Refer to diagram sketch on the following page;

- Area North of G.L. ‘10” – Classrooms and Studios that require North light
    - This zone has depth of approximately 30’-0” which lends itself well to a classroom use.
- Area South of G.L. ‘10” – Office
    - This zone has a depth of approximately 22’-0” depth which lends itself well for Office use.
- Area South of Elevator Core – large open studios
    - This zone contains irregularly shaped spaces with a regular column grid. This type of space lends itself well to open studio types of spaces which do not have specific lighting requirements.
- Area West of G.L. ‘F’ – Classrooms
    - This zone has depth of approximately 30’-0” which lends itself well to a classroom use.

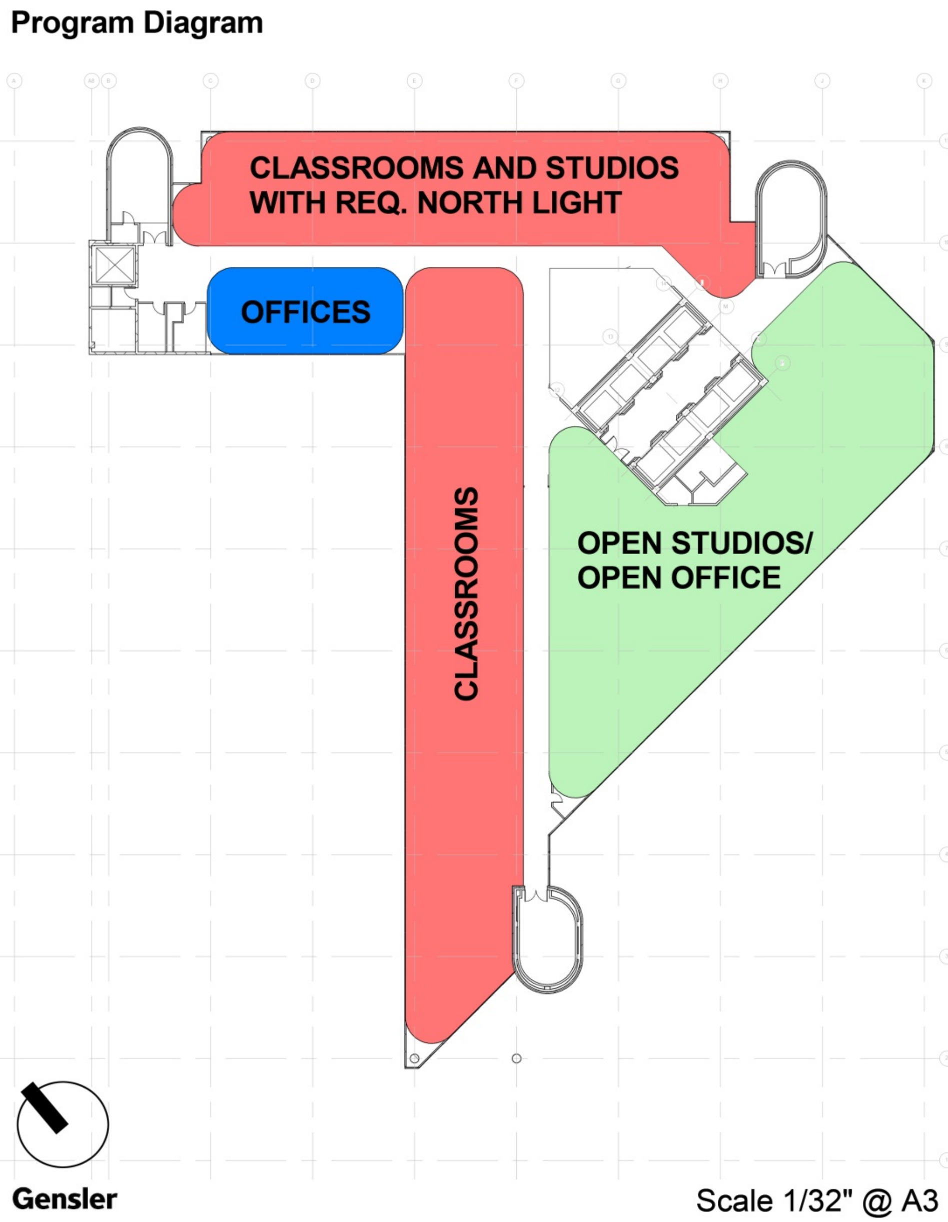


Figure 4.3.3 Proposed Program Diagram

4.3.7 Building Envelope

This section describes the building envelope system. Recommendations are based on a full replacement of the curtain wall system, totaling 97,200 SF per takeoffs from the REVIT model provided to the team.

The recommendation is to install a thermally broken unitized curtain wall system. Re-installing a stick system is not recommended as it has lower performance with respect to installation, movements and water drainage.

4.3.7.1 Existing Façade Anchors

The anchors fixing the aluminum framing to the slabs are of questionable structural integrity. Full access was not available to view the existing mullion anchors and we have not been able to determine the extent of the welds at the steel angle bracket to the cast-in steel channel at the slab edge.

From the limited access that was available, there did not appear to be excessive corrosion with the steel angle, however, additional investigations of the anchors are required to determine the current state of the slab edge anchors and potential load carrying capacity.

Once the façade framing has been removed and the weld fixing the steel angles to the cast in channels are found to be in good condition, both the angle and the cast in channel could potentially be reused. If they are found to be unusable, the steel angles would need to be cut off, leaving the cast in channels in site.

It would be beneficial to reuse these connections in their existing locations so that no further local outriggers would need to be added to the structural framing.

However, according to the structural drawings the outriggers appear to be at 6’-9” while the façade mullions are at 4’-6” therefore there may not be any coordination between these two items in plan.

4.3.7.2 Thermal Performance

The following table identifies the minimum code requirements for building envelope per the Massachusetts Energy Code, *IECC 2009 with Massachusetts Amendments* and the targeted performance values that represent a 20% improvement.

	U-Value (BTU/hr*SF*F)		SHGC[4]	
	Code	*Target*	Code	*Target*
Vision Glazing[1]	0.45	*0.36*	0.4	*0.32*
Opaque Elements -Wall, Spandrel[2]	0.064	*0.0512*	-	-
Storefront, Curtain Wall[3]	0.42	0.336	0.4	*0.32*

[1] Values are to center of glass, per 780 CMR Table 502.3
[2] Values are to center of insulation per 780 CMR 502.1.2
[3] Values are overall U-value per 780 CMR Table 502.3
[4] SHGC = Solar Heat Gain Coefficient

4.3.7.3 Design Loads

The façade system shall transmit all design loads to the building structure via points of attachment as designed and built, with an adequate margin of safety appropriate to each material and product.

Wind Load

Preliminary estimates of the wind load on the building have been generated using ASCE 7 design loads. Assuming the basic wind speed 110 mph, the typical wind load (pressure and suction) on the cladding is determined to be 45 psf.

This wind load is considered preliminary until cladding pressures from the wind tunnel test are received which happens later in the design process.

Seismic Load

Based on preliminary load estimations, seismic acceleration forces on cladding elements will be less than wind loads.

All cladding elements should be fixed and jointed to allow for a building frame seismic sway of span/400, without being subject to unintended imposed displacements. Final seismic sway values will be coordinated with the project structural engineer.

Thermal Load

Each cladding system shall accommodate displacements resulting from changes in temperature in any of its parts or supporting framework without any reduction in the performance below the minimum levels required. The following preventative measures will be taken by the contractor:

- Ensure that no glass or glazing combination develops stresses that may lead to damage of glass, glazing materials, components and/or framing systems

- Conduct a thermal stress analysis, undertake thermal calculations, and make due allowance for any heat-treated glass which may be required, and submit these for review
- Take into account shading stresses that might occur from adjacent components and buildings including shading devices

Building Maintenance Unit (BMU) Restraint

If a building maintenance unit is incorporated, the façade cladding will need to be designed to support the final system. Examples include a monorail, a fixed tower and boom, and BMU with Intermittent Stabilization Anchors (ISA).

4.3.7.4 Weatherproofing

All cladding systems, including all joints between the systems composing the building skin, shall prevent water penetration into the interior of the building from the outer face of the assembly, under the action of wind pressure kinetic energy, gravity, surface tension, or capillary action. It shall also prevent water from entering into those parts of the cladding that would be adversely affected by the presence of water. Performance requirements include:

- Air seal continuity, especially critical to the areas where the façade system meets the slab and joins into other façade systems
- Employment of a silicone gasket as a rear air and water seal and a gasketed front pressure plate and cap, acting as a rain seal
- The construction of a custom sub sill, sub head and sub jambs to create an end dam and tray under the sill extrusion, to catch and drain any water entering the system
- Weep holes directing water from aluminum channels out towards the front face of the glazing
- Structurally glazed units with gaskets acting as a rain deterrent between units

Condensation Control

Internal surface condensation can, in general, be dealt with several ways:

- Improved thermal insulation of vision and framing systems
- Active monitoring and control of internal space conditions via the mechanical system
- Management of condensation through drainage systems
- Local heating of the façade through heat tracing, or radiators

Condensation occurrence, if frequent, can lead to a variety of building and maintenance issues. These can include increased maintenance due to staining, organic material degradation, water accumulation on floors and sills, and the potential for microbial growth. Infrequent occurrences of condensation (primarily due to non-typical weather) generally result in periodic increased maintenance and temporary aesthetic issues.

Given the cold climate during the winter months, we recommend that high performance glazing and thermally broken framing systems be used to maintain a proper level of insulation and minimize condensation risk.

Vapor Barrier

Further to condensation control, the façade design must also ensure a continuous vapor barrier to stop the flow of moisture across exterior and interior spaces. The façade sections and details shall be designed to allow for an adequate and continuous vapor barrier.

Vapor control layers shall maintain their performance and properties for the expected service life of the system. They shall resist the deleterious effects of water vapor, temperature variations expected from the specified temperature ranges, gaseous pollutants (including ozone), weak acids derived from gaseous pollutants dissolved in water, and UV radiation to which they may be exposed during installation and in service.

4.3.7.5 Cladding Systems

Glazing

The glazing will be double glazed insulated units with a triple silver low e coating on surface 2 as follows:

Outside lite: ¼” heat strengthened clear glass with low e coating on surface 2
Gap: ½” air gap
Inside lite: ¼” heat strengthened clear glass with low e coating on surface 2

The coatings suggested below all aim for maximum visible light transmittance (VLT) with very good solar heat gain coefficients (SHGC).

	SHGC			U-value*	
Coating		*Target*	VLT (%)		*Target*
Viracon VNE 1-63	0.29	*0.32*	62	0.29	*0.36*
Guardian SNX 62/67	0.27	*0.32*	62	0.29	*0.36*
PPG Solarban 70XL	0.27	*0.32*	63	0.29	*0.36*

*Values noted are center of glass

Spandrel

To meet code requirements, we recommend a target spandrel insulation R value of 25 (corresponding to U value of 0.04). Insulation options in order to achieve R25 are as follows:

Type of Insulation	R value / inch	Thickness Required (inches)
Rigid Urethane board	6.2	4
Extruded Polystyrene	5.6	5
Rigid Fiberglass board	4.0	6.25

Final insulation selection is subject to flame spread and smoke development requirements as well as available depth of selected framing system in the spandrel zone. Overall spandrel U values will be increased greatly from the target value of 0.0512 once frame and backpan effects have been incorporated.

Framing

It is recommended that the curtain wall system be a standard, off the shelf unitized and thermally broken aluminum suite. Shading proposed whether it be external or an internal lightshelf would likewise be standard, off the shelf systems and sizes per the specific manufacturer.

Approximate unitized curtain wall unit size would be 12’-6” tall, which corresponds to the typical floor to floor height, by 5’-0” wide to keep glass to typical stock sizing. Alternate widths of 4’-6” to align with existing anchor locations, or 6’-0” to deliberately miss hitting the anchors in plan are also viable options. Final module width is to be determined during the design process.

Options for framing all assume a thermally broken unitized system and include;

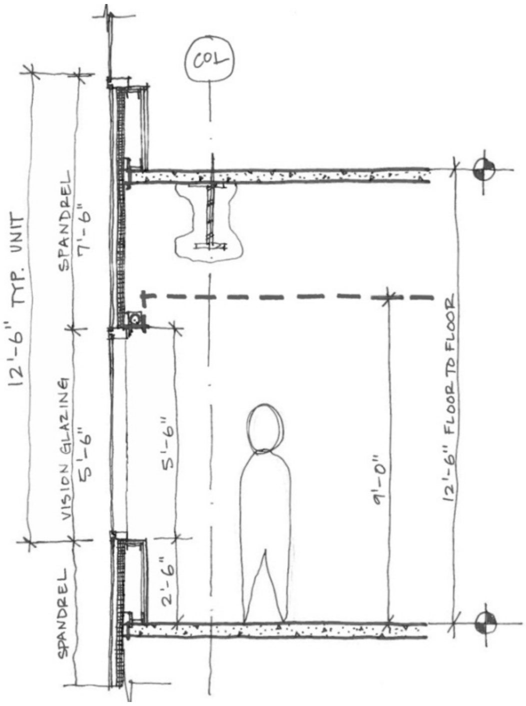
Manufacturer	Size	Overall U-value / Center of Glass*
EFCO 8750XD	3” x 7.5” depth	0.37 / 0.3
Kawneer 2500 PG Unitwall	2.5” x 7.5” depth	0.42 / 0.3
Wausau 7250i-UW	3.75” x 7.25” depth	0.39 / 0.3

*Values based on NFRC sample size of 78.5” x 78.5” or 80” x 80” as noted by the manufacturer

The final curtain wall overall U values will be dependent on system selection, final panel size and width and window to wall ratios. The curtain wall system may require steel stiffeners to handle maximum wind loads at typical and local maximum locations.

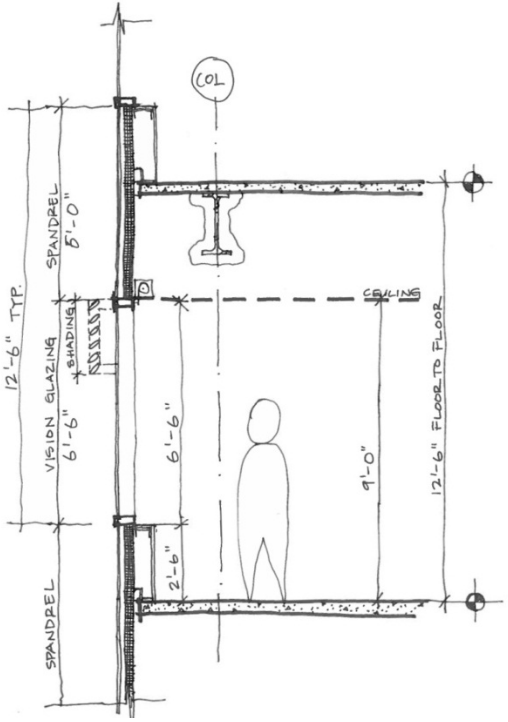
4.3.7.6 Façade Sections

Due to the very high level of this study, a single façade option has not been provided but rather multiple options are put forth to suggest options of what could be realized. As such, the following typical façade sections represent options that meet the performance criteria described above while also improving area of vision glazing, daylight penetration and glare control to varying degrees. The respective window to wall ratios (WWRs) are provided as well. For reference, the code benchmark is set at 40% window area.



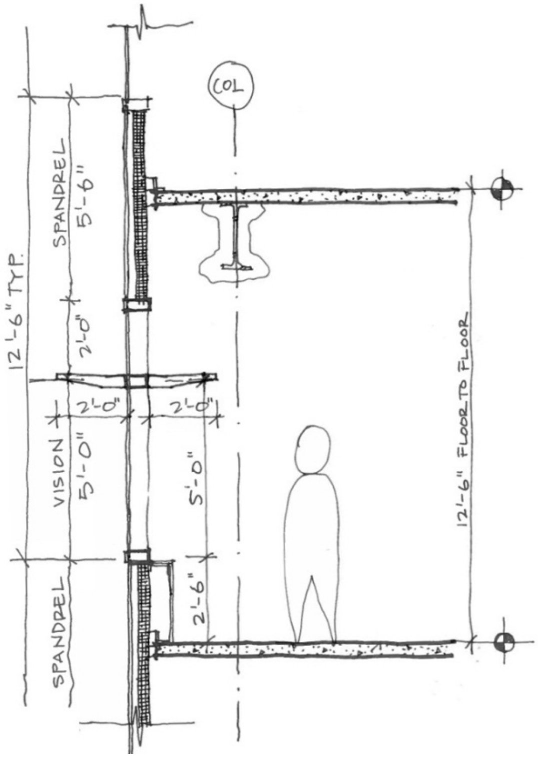
Continuous Strip Windows
-Window to Wall Ratio: 44%

Option 1. Prescriptive Compliance



External Shading
-Window to Wall Ratio: 52%
Additional opaque wall area would need to be added to lower the overall glazed area and overall WWR.
-External shading devices would be added to reduce heat gains and internal glare. –The shading devices would be integrated into the curtainwall system.

Option 2. Parallel Shading



Option 3. Horizontal shading and lightshelf with exposed ceiling.

Horizontal Shading and Lightshelf
Window to Wall Ratio: 56%
-Additional opaque wall area would need to be added to lower the overall glazed area and overall WWR.
-The horizontal shading and internal lightshelf would be integrated with the curtainwall system.

4.3.5 Structural Systems

The practical scope encompasses only minor modifications to the existing structure and building. This scope of work falls within the permitted modifications and therefore does not trigger structural seismic upgrades. The full list of permitted modifications is:

- Change of occupancy which does not require heavier design loads
- Stairs and/or shafts infill
- New shafts and equipment openings without cutting existing main floor beams or columns
- New floor finishes, partitions and/or ceilings
- New building service (MEP) systems
- New elevators
- New curtain wall system
- New entrance ramps and wall openings without cutting existing main floor beams or columns

4.3.5.1 Building Envelope

The new curtain wall will be supported on the existing concrete cantilever slab edges with new anchors. There are existing diagonal steel outriggers extending from the bottom flange of the perimeter steel beams to support the slab edges at the existing curtain wall support points. It is assumed that the support points of the new curtain wall system will be different from the existing system, therefore new outriggers will be required. These are assumed to be L3x3x5/16 diagonal outriggers at 5’-0” on center.

The new curtain wall system (dead load) will be heavier than the existing system due to the upgrade from single glazing to double glazing. We estimate the new load will be 20 pounds per square foot (psf) as opposed to the estimated 15 psf of the existing curtain wall.

The existing floor beams and columns are capable of supporting this additional weight. Additionally, seismic upgrades will not be triggered by replacement of the curtain wall system.

4.3.6 Mechanical Systems

This section describes the proposed mechanical (HVAC) systems for the practical scope. Capacities for the HVAC systems are based on a program area of 318,299 GSF / 250,000 NSF and are designed to meet or exceed the minimum requirements per Mass LEED Plus.

Typical in any building re-use are certain inherent design constraints based on maintaining the existing floor to floor heights and floor plates which influences the system choices available and subsequent decisions.

4.3.6.1 Central Heating and Chilled Water Systems

Chilled Water Plant

A new 450 ton chilled water plant will be provided. The chilled water plant will include two high efficiency water-cooled electric centrifugal chillers utilizing oil free magnetic bearing compressors. The chillers and associated equipment will be located in a basement level mechanical room, consistent with the original design.

Primary chilled water pumps will be provided in a duty/standby arrangement. Two secondary chilled water loops will be provided: one low temperature chilled water loop serving the Air Handling Units (AHU) distribution and one high temperature chilled water loop serving the Active Chilled Beam (ACB) distribution. Pumping for each loop will be provided in a duty/standby arrangement with VFDs.

A new condenser water (heat rejection) system will be comprised of a new roof-mounted, variable speed, induced draft cooling tower. Condenser water pumps with VFDs will be provided in a duty/standby arrangement.

Major chilled water system components:

- Two (2) centrifugal flooded chillers with oil free magnetic bearing compressors, 225 tons each
- Open, induced draft cooling tower
- Two (2) primary chilled water pumps w/ VFDs
- Four (4) secondary chilled water pumps w/ VFDs
- Two (2) condenser water pumps w/ VFDs
- Ancillary equipment – air separators, expansion tank, chemical water treatment
- Complete Direct Digital Control (DDC) Building Automation System (BMS) including meters for all main utilities will be provided to control and monitor all central systems in the building.

Heating Hot Water System

The existing connection to the campus steam system will be maintained, however all existing steam and Heating Hot Water (HHW) conversion equipment and distribution will be replaced.

Two new steam to hot water shell and tube heat exchangers will be provided with a total heating capacity of 6,500 MBH plus additional capacity for domestic hot water usage. The heat exchangers and associated equipment will be located in a basement mechanical room. Heating hot water pumps will be provided in a duty/standby arrangement with VFDs serving AHUs heating coils, chilled beams and miscellaneous terminal heating units including finned tube radiators, unit heaters, etc.

Steam and condensate flow and pressure meters will be installed in the main low pressure steam line and main condensate return line to measure the steam and condensate usage and will be monitored by the BMS.

Major heating hot water system components:

- Two (2) shell & tube steam to hot water heat exchangers (HX).
- Two (2) HHW water pumps w/ VFDs
- One (1) duplex condensate return pump package
- Steam, steam condensate, steam vent piping and associated valves & fittings, including expansion joints and pipe guides (where needed).
- Steam and condensate accessories including steam traps, safety relief valves, PRV assembly, flash tank
- Ancillary equipment – air separator, expansion tank, chemical water treatment
- Complete Direct Digital Control (DDC) Building Automation System (BMS) including meters for all main utilities will be provided to control and monitor all central systems in the building.

Building Terminal Unit Strategies

An Active Chilled Beam (ACB) system will be used throughout the building. ACBs are terminal devices that include chilled water coils and induce re-circulated room air across these coils as fresh air from the base building air handling units is supplied overhead. Certain occupancy types where ACBs may not be applicable due to condensation and airflow issues include, but are not limited to, large vestibules, atriums and other spaces with large temperature variance, gyms and other spaces where activities within the room create or require large latent loads, or double height spaces with a large floor to ceiling height. In these types of spaces, an overhead Variable Air Volume (VAV) system will be provided.

Due to the shallow floor to floor height of the existing structure multiple HVAC shafts will have to be incorporated into the building in order to minimize main supply and return duct depth. Multiple AHUs will be located in mechanical penthouses at the roof level. Estimated AHU CFM capacities for each level are provided in the table below.

AHU Capacity by Level

Level	Supply & Return Capacity (CFM)
B	13,000
1	8,800
2	7,400
3	14,900
4	14,100
5	13,600
6	13,600
7	10,000
8	9,200
9	10,200
19	9,100
11	7,700
12	7,700
13	6,600
14	5,100
TOTAL	**151,000**

AHUs will be comprised of variable speed supply and return fan walls, heating and cooling coils, energy recovery wheel, economizer, UV treatment and filtration (MERV 13 minimum).

Ventilation air and exhaust air will be provided at the AHU locations, in mechanical rooms at the roof level, and at miscellaneous mechanical rooms located on floors or basement. Intake and discharge louvers will be separated by minimum 10 ft.

Active Chilled Beam

Perimeter zones will be provided with single duct, variable air volume (VAV) terminal air units serving 4-pipe chilled beams. Interior zones will be provided with single duct, VAV terminal air units serving 2-pipe chilled beams. The upper floors on each building tier will be provided with 4-pipe chilled beams to account for roof heat losses.

Variable Air Volume

Perimeter and interior zones shall be served by single duct, VAV terminal air units. VAV boxes serving perimeter spaces and upper floor spaces will be provided with terminal heating to account for envelope / roof heat losses.

4.3.6.2 Controls

A new Building Management System (BMS) will be provided to control and monitor all systems in the building. The system will be of the electronic Direct Digital Control (DDC) type and provide for full modulation of all elements in the Mechanical Systems.

The building management system will operate the building during occupied hours, providing heating and cooling as required to maintain building design conditions listed in section Internal Design Conditions, above.

CHW, HHW and steam metering will be provided for measurement and verification capability.

4.3.7 Electrical Systems

This section of the report describes the proposed electrical systems for the building renovation options for the MCAD Tower. The electrical systems are based on a program area of 318,299 GSF / 168,088 NSF and are designed to meet or exceed the minimum requirements per Mass LEED Plus.

4.3.7.1 Design Assumptions

It is assumed that all electrical work proposed within the mandatory interim scope will have been completed. This includes the separation of the utility owned 13.8kV primary electrical distribution equipment and MCAD owned 600V secondary electrical distribution equipment into dedicated 3 hour and 2 hour rated spaces, respectively.

The MCAD secondary unit double ended substation with two 1,500kVA transformers, draw out, insulated case main and secondary circuit breakers and tie breaker is assumed to have been replaced.

Also, the MCAD secondary switchgear with one 500kVA transformer and secondary distribution section, feeding the Gym and Collins buildings, is assumed to have been replaced.

4.3.7.2 Secondary Electrical Distribution

A new secondary power distribution system will be installed and shall include the following key design items/equipment:

- Two new 1,200A, 277/480V, 3 phase, 4 wire copper bus-duct risers will be provided from the new double-ended substation and run up the entire tower to feed all 277/480V panelboards throughout the building.
- 277/480V, 3 phase, 4 wire panelboards will be provided throughout the tower to feed all lighting and small mechanical loads.
- Separate 277/480V panelboards will be provided throughout the facility and be dedicated to feeding large mechanical loads (½ HP and larger). The panelboards will be fed from the 1,200A bus-duct risers via tap-offs.
- 120/208V, 3 phase, 4 wire power will be provided via two 250kVA step down transformers located in the main electrical room and will be fed from the double-ended substation.
- The step down transformers will feed two new 1,000A, 120/208V, 3 phase, 4 wire copper bus-duct risers which in turn will feed all 120/208V panelboards throughout the building.
- Small power and general purpose 120/208V power panelboards will be provided throughout the building to feed all small power loads. The panelboards will be fed from the 1,000A bus-duct risers via tap-offs.

- New 277/480V, 3 phase, 4 wire motor control centers will be provided in the penthouse as required by the new mechanical equipment arrangement. The MCCs will be fed from the double-ended unit substation.

4.3.7.3 Standby Electrical Distribution

A new emergency and Standby electrical distribution system will be provided and include the following key items/equipment:

- New 500kW, 277/480V, 3 phase, 4 wire diesel engine generator set (including day tank) will be provided on the MCAD Tower roof.
- New 480Y/277V, 3 phase, 4 wire switchboard with barriers (for physical separation of vertical sections) will be provided for distribution of emergency “life-safety”, legally required stand-by, and optional standby electrical systems Per current NEC requirements.
- Three new automatic transfer switches will be provided for the emergency “life-safety”, legally required stand-by and optional standby electrical systems. New feeds will be provided from the new double-ended substation and from the new generator.
- New 2 hour fire rated cables will be provided for all emergency “life safety” loads. Cables shall originate in the emergency switchboard section and be routed out to all emergency loads throughout the building.
- New 2 hour rated fire pump feeds shall be provided from both the utility transformer and the new generator.
- Each floor shall be equipped with 277/480V, 3 phase, 4 wire emergency lighting panelboards located in 2 hour rated enclosures. Additional panelboards will be installed, where required, to provide 277/480V power to standby and optional standby loads.
- 120/208V, 3 phase, 4 wire emergency panelboards will be provided as required by the emergency 120V loads (for fire alarm and other emergency systems). Additional panelboards will be installed, where required, to provide 120/208V power to standby and optional standby loads. Panelboards will be fed from local step down transformers.
- The legally required standby electrical distribution system will be required to feed mechanical loads including stair pressurization systems, smoke removal and other standby loads. The standby distribution system will be fed from the second automatic transfer switch.
- Optional emergency distribution system shall be provided for the telecommunications system, via 120/208V, 3 phase, 4 wire panelboards on all levels and within the telecommunication closets. Panelboards will be fed from local step down transformers.
- Emergency power shall be provided to all elevators via a selector switch.

4.3.7.4 Small Power

Small receptacle power will be provided as follows:

- General purpose grounding type duplex receptacles will be provided throughout the facility to accommodate the building and occupant needs.
- Offices will be provided with minimum of one duplex receptacle on each wall up to 8' in length. Additional receptacles will be provided on longer walls and/or if required by any equipment.
- Work stations will be provided with minimum of two duplex receptacles per work station. Additional receptacles will be provided as required by the equipment.
- Conference rooms will be provided with minimum of one duplex receptacle on each wall up to 10' in length. Additional receptacles will be provided under the conference table and as required by specific equipment.
- Grounding type duplex receptacles will be provided in all general purpose areas and other spaces as required by that space. As a general rule, all spaces up to 150 square feet will have a minimum of one duplex receptacle; larger spaces will have more as required.
- Ground fault interrupter receptacles will be provided in toilets, basement and exterior wet locations. Exterior receptacles will be provided with an in-use weatherproof enclosure.
- A minimum of two general purpose duplex receptacles will be provided in each communication room and closet. Additional optional emergency duplex receptacles will be provided as required by the telecommunication equipment and be fed from the dedicated telecommunication system optional emergency power distribution system noted above.
- Duplex receptacle(s) will be provided in mechanical equipment and electrical rooms.

Refer to Table 4.3.7.5 for a list of each space type within the Tower.

4.3.7.5 Lighting System & Controls

An energy efficient lighting system will be provided throughout the building and will include the following:

- Classrooms, offices and library spaces will mainly consist of high efficiency, linear suspended direct/indirect fluorescent type fixtures with electronic ballasts.
- Corridors and common spaces will mainly consist of recessed 2x2 high efficiency fluorescent type fixtures.
- Corridors or spaces where art work may be displayed shall be provided with dual circuit track lighting and a combination of LED and HID heads.

- Fixtures shall utilize T5 fluorescent lamps or shall be LED, where possible.

Central lighting controls and daylight harvesting will be provided utilizing microprocessor based, low voltage, programmable relay and central time clock system. The system will be provided with occupancy sensors and photocells for automatic controls and local over-ride low voltage switches. Interior lighting near exterior windows will be equipped with dimmable ballasts and tied into the system to reduce the fixture's light level output based on the available natural lighting levels.

Conference rooms and public gathering places shall be equipped with a preset dimming and pre-set lighting controls system similar to Lutron GRAFIK Eye.

Lighting control panels will be located throughout the Tower and will be tied together via data connection. The lighting control panel will be tied into the building management system (BMS) for further building control and functionality options.

The table below lists all spaces within the Tower categorized by space. Appropriate lighting power densities and control strategies for each space type will be developed to meet and/or exceed minimum requirements. These will also be coordinated with daylighting strategies.

Table 4.3.7.5 Building Space Types

• Space Type
• Assembly
• Classroom
• Corridor
• Electrical Room
• Library
• Mechanical Room
• Office
• Storage
• WC/Janitor

4.3.7.6 Grounding System

A main ground bar will be provided in the new electrical room MCAD owned 600V secondary electrical distribution equipment. The ground bar will be connected to ground electrodes per NEC requirements. The grounding system will be designed to provide effective grounding to enable protective devices to operate within a specified time during fault conditions, and to limit touch voltage under such conditions.

All extraneous conducting metal work within the building will be bonded. Grounding cables will be distributed from the main building ground bar to the ground bus in each of the MCAD owned 600V secondary electrical distribution equipment located in the electrical room which consists of both units of the double-ended substation and the switchboard feeding the Gym and Collins buildings). Grounding for all the panelboards throughout the building is provided via tap-offs from the bus-duct risers which have ground connections tied back to the double-ended substation ground bus.

Ground bars will be provided in all MDF and IDF rooms and will be connected back to the main building ground bar.

A UL master label listed lightning protection system will be provided on the MCAD tower roof and installed per NFPA 780 requirements. The system shall consist of air terminals, main and bonding conductors, all of which will be class II materials per NFPA requirements for buildings exceeding 75ft in height. The structural steel will be used as down lead conductors per NFPA requirements.

4.3.7.7 Fire Alarm System

A complete addressable fire alarm system that will comply with NFPA 72 for high rise buildings will be provided for the entire building.

Complete voice evacuation system as well as other fire alarm notification devices will be provide for the entire building per current codes for a high rise building.

Manual fire alarm devices will be provided at all egress doors.

Fire alarm initiation devices consisting of smoke and heat detectors will be provided in all mechanical rooms, electrical rooms, telecommunication rooms, storage rooms and all high hazard storage rooms. Automatic fire alarm devices consisting of flow switches, tamper switches, smoke detectors for elevator recall will be provided. Addressable input and output modules will be provided, as required, for the monitoring of specific events and for the control of specific equipment (such as mechanical equipment shut down and control of stair pressurization or smoke evacuation systems).

The fire alarm system will be connected to the building management system (BMS) to allow further flexibility of control, monitoring and communication between the two systems.

4.3.7.8 Telecommunication System

The Information Technology and Telecommunication (ITT) infrastructure design strategy is to provide a complete solution that supports the Data and Voice systems of the facility. To achieve this goal the infrastructure requirements of the systems will be integrated into the architectural and engineering design of the building.

The ITT infrastructure will be designed to consist of Category 6 horizontal distribution. One Main Distribution Frame (MDF) room will be provided will have fiber optic and copper links to all IDF rooms.

Intermediate Distribution Frames (IDF) rooms will be provided on each level of the tower to serve all the telecommunication loads and to limit the horizontal cable runs to 280’. IDF’s shall be interconnected by 50 pair Category 3 copper and 12SM/6MM fiber optic backbone cables.

Horizontal distribution throughout the building shall utilize Category 6 cables to all workstations via raceway, cable trays and j-hooks.

Each workstation shall be provided with 2 data/1 voice outlets. Additional data and voice outlets will be provided as required by specific equipment.

4.3.8 Plumbing Systems

4.3.8.1 Domestic Water Systems

Cold Water

A complete new domestic water distribution system will be provided to feed the bathrooms, kitchenette areas, drinking fountains, all other plumbing fixtures, and make-up water to mechanical equipment throughout the building.

A duplex booster pumping system will be required to provide the furthest most with a minimum of 30 - 35 psi residual pressure.

Hot Water

Hot water for all plumbing fixtures will be provided by natural gas storage type water heaters. A hot water recirculation system will be provided and will distribute to all plumbing fixtures and uses described for cold water.

A hot water temperature for plumbing fixtures will be maintained at 120°F, although the water will be stored at 140°F and blended down to 120°F for distribution to fixtures.

4.3.8.2 Drainage Systems

Sanitary and Vent System

A complete and fully vented soil and waste system will be provided to drain all plumbing fixtures and equipment rooms throughout the building. The new sanitary system will discharge by gravity to the municipal sanitary sewer system.

The basement plumbing fixtures will need to be drained to a sump pit containing an ejector pump set. The ejector will pump the drainage up to the elevation where the forced main can connect into the soil and waste gravity system.

Storm Water Drainage

The storm water from the roofs will be collected in roof drains and routed through the building to the exterior via gravity and connected to the municipal storm water system. The roof areas will also be provided with a secondary drainage system that will collect built up storm water in separate roof drains or scuppers and discharge above grade in a clearly visible location to alert maintenance personnel.

4.3.8.3 Natural Gas

A new gas service will be provided consisting of the incoming gas main, meter, regulator, pressure booster and distribution piping. Gas will be provided to the domestic water heater and any other gas needs in the building.

4.3.9 Fire Protection Systems

4.3.9.1 Water Supply

The fire protection service will consist of a dedicated 8-inch fire main brought from the municipal water main in the street.

It is anticipated that the seismic design category of the building is a Category B, however if the seismic design category of the building once designed is a Category C, D, E or F then a secondary on-site water supply will be required for a 30 minute duration of the hydraulically calculated demand, which will result in a large tank being required on site.

4.3.9.2 Fire Pump

Because the building is a “high rise” a residual pressure of 100psi at the highest hose valve outlet is required per NFPA unless the AHJ has over-riding requirements. A fire pump will be required for this building and it is expected to require a 1,000 GPM fire pump which will require the pump controller to have an automatic transfer switch with an emergency power supply. The fire pump should be an electric motor driven, horizontal split case centrifugal type.

4.3.9.3 Sprinkler System

A complete sprinkler system including risers, sprinkler heads, floor control valve assemblies, tamper and water flow alarm devices will be provided throughout the buildings in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. Each floor of the building will be served from a minimum of two separate flow control assemblies which will consist of a supervised flow valve, check valve, shut-off valve with tamper switch and test drain with sight glass.

4.3.9.4 Standpipe System

A class 1 automatic wet standpipe distribution system will be provided throughout the building. The system includes a combination sprinkler/ standpipe riser, test drain risers, hose valve connections and control valves. Each standpipe will consist of a 6” riser and 3” test drain located in each escape stairway with a 2½” hose valve connection at each landing.

4.3.10 Sustainability

The building rehabilitation options defined in this report represent a major renovation and are therefore applicable to the Mass LEED Plus green building standard established by Executive Order 484 (EO 484). Per EO 484, a major renovation is defined as "*those projects that include a complete overhaul of a significant portion of the original structure and where the cost of the renovation is greater than 50% of the assessed value of the building*". The current 2013 CAMIS value of the building is $98,127,074.00 and the resulting 50% threshold is $49,063,537.00.

The Mass LEED Plus standard comprises five (5) requirements, all of which are related to LEED requirements whether directly or indirectly. The Leadership in Energy and Environmental Design (LEED) program is an independent green building rating system established by the United States Green Building Council (USGBC) and administered by the Green Building Certification Institute (GBCI).

LEED is a point based system structured around seven (7) categories;

- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy & Atmosphere (EA)
- Materials & Resources (MR)
- Indoor Environmental Quality (IEQ)
- Innovation in Design (ID)
- Regional Priority (RP)

Each category has a number of mandatory requirements, i.e. prerequisites, and voluntary credits that earn points. There are also eight (8) minimum project requirements (MPRs). A project must meet all the MPRs, prerequisite requirements and can elect to achieve any number of credits/points to achieve a desired level of certification. There are four levels of certification based on a 100 point scale, certified (40-49 points), silver (50-59 points), gold (60-79 points) and platinum (80+ points).

Regional Priority credits are bonus points that are awarded if a project achieves designated credits identified as priority issues for a specific location. Six (6) credits are designated and up to four (4) points can be achieved. For Boston, the regional priority credits are;

- SS Credit 3 Brownfield Redevelopment
- SS Credit 6.1 Stormwater Design – Quantity Control
- SS Credit 7.1 Heat Island Effect – Non-roof
- SS Credit 7.2 Heat Island Effect - Roof
- EA Credit 2 In-Site renewable Energy – 1%
- MR Credit 1.1 Building Reuse – Maintain Existing Walls, Floors and Roof

This assessment is applicable to LEED-NC or LEED for New Construction and Major Renovations version 2009. The USGBC has recently approved LEED version 4 and its launch is anticipated in November of 2013. . It represents considerable changes to the system and more stringent credit thresholds however, this assessment and discussion is based on the current version since version 4 has not yet been formally released.

4.3.10.1 Mass LEED Plus

The five (5) Mass LEED Plus requirements and their related LEED-NC counterpart are listed below;

Mass LEED Plus Criteria	**LEED-NC Credit**
1. LEED for New Construction and Major Renovations (LEED-NC) certification	LEED Certified
2. Energy Performance exceeding Massachusetts Energy Code requirements by at least 20%	EA Credit 1 *Optimize Energy Performance*
3. Independent 3rd party commissioning	EA Credit 3 *Enhanced Commissioning*
4. Two (2) Water Efficiency criteria;	
a. Reduction of outdoor potable water consumption by 50%	WE Credit 1 *Water Efficient Landscaping*
b. Reduction of indoor potable water consumption by 20% relative to the standard baseline	WE PR 1 *Water Use Reduction-20% Reduction*
5. Meet 1 of 4 Smart Growth Criteria;	
a. Construct or renovate on a previously developed site	SS Credit 2 *Development Density and Community Connectivity*
b. Construct or renovate on a brownfield site	SS Credit 3 *Brownfield Redevelopment*
c. Construct or renovate on a site with public transportation (train or bus)	SS Credit 4.1 *Alternative Transportation – Public Transport Access*
d. Maintain 75% of the existing building walls, floors and roof	MR Credit 1.1 *Building Reuse – Maintain Existing Walls, Floors and Roof*

It is anticipated that the building rehabilitation options would achieve 2 and possibly 3 of the 4 smart growth criteria noted above, a, b and d, which meet the minimum required.

a. Achievement anticipated. The Tower building is located in a densely populated, developed area of Boston and would meet the threshold for surrounding density

b. Achievement not anticipated. No documentation or information has been provided that identifies the site as a brownfield.

c. Achievement anticipated. The Tower building is less than ½ mile from the Green Line Longwood Medical Area T stop and less than ¼ mile from 4 bus line stops.

d. Achievement anticipated for option 1, not for option 2. A preliminary calculation based on option 1, indicates that greater than 75% of the walls, floors and roof would be maintained (by area). For the purposes of this calculation, glazing is exempt.

Option 2: Demolish and rebuild would obviously not achieve this.

4.3.10.2 LEED-NC certification

The following section provides a more detailed discussion of LEED-NC certification. The four other Mass LEED Plus requirements, 1 – 4 identified above, are also included in the discussion.

It is important to note the LEED-NC checklist and assessment herein is only preliminary and is intended to demonstrate that any version of the building rehabilitation options could meet the minimum requirements set forth by Mass LEED Plus. It provides a range of points rather than an absolute total due to the lack of a specific design at this stage. As such, it in no way should be taken as a specific recommendation or represent a best case scenario for certification.

The assessment and corresponding checklist represent the information known about the specific project site, credit requirements that are essentially standard practice in the industry, knowledge of local codes or requirements that are more stringent than LEED credit requirements and general knowledge of LEED credits that are most commonly achieved.

Accordingly, the tables provided for each category below identify prerequisite requirements, and credits and their corresponding points that are anticipated for achievement or possibly available. Credits that are unlikely to be achieved are not identified. A full LEED-NC checklist is provided in Section 4.3.10.3.

Sustainable Sites (SS)

Sustainable Sites (SS)		Possible	Anticipated Points
PR 1	*Construction Activity Pollution Prevention*		*Required*
CR 1	Site Selection		1 point
CR 2	Development Density & Community Connectivity		5 points
CR 4.1	Alternative Transportation – Public Transportation Access		6 points
CR 4.2	Alternative Transportation – Bike Storage and Changing Rooms		1 point
CR 4.4	Alternative Transportation – Parking Capacity		2 points
CR 6.1	Stormwater Design – Quantity Control	1 point	
CR 6.2	Stormwater Design – Quality Control	1 point	
CR 7.1	Heat Island Effect – Non-Roof		1 point +1 point RP
CR 7.2	Heat Island Effect - Roof		1 point +1 point RP
CR 8	Light Pollution Reduction		1 point
	Total s	2 points	18 points
	Total Available		26 points

Items in blue contribute to Mass LEED Plus prescriptive requirements

Items designated with +1 point RP are identified as LEED regional priority credits and achievement of the credit results in an additional bonus point.

There is one (1) prerequisite requirement and eight (8) credits, representing 26 points in the sustainable sites category. The prerequisite requirement, *Construction Activity and Pollution Prevention*, requires projects to implement an erosion and sedimentation control plan during construction based on the 2003 EPA Construction General Permit or local code, whichever is more stringent. This requirement is easily achieved and has become standard practice in the industry.

We anticipated that 18 points can be achieved with an additional 2 points potentially available. The two credits related to Mass LEED Plus are considered as achieved since they relate to the location of the Tower and its surrounding density and proximity to the Green Line and MBTA bus stops along Huntington Avenue. Please refer to the LEED-NC checklist for more details.

Water Efficiency (WE)

Water Efficiency (WE)		Possible	Anticipated Points
PR 1	*Water Use Reduction-20% Reduction*		*Required*
WE 1	Water Efficient Landscaping	4 points	
CR 3	Water Use Reduction	4 points	
	Total	8 points	
	Total Available		10 points

Items in blue contribute to Mass LEED Plus prescriptive requirements

There is one (1) prerequisite requirement and three (3) credits, representing 10 points in the water efficiency category. The prerequisite requirement, *Water Use Reduction – 20% reduction*, requires projects to reduce potable water consumption by 20% as compared to the baseline. Baseline flow rates for fixtures are established in the 1992 Energy Policy Act (EPAct,), EPAct of 2005, and 2006 edition of the International Plumbing Code and include toilets, urinals, lavatory faucets, kitchen faucets, showers and pre-rinse spray valves.

The 20% threshold is typically easily achieved since it can be accomplished through solely installing low flow fixtures. Compliance with this prerequisite also meets Mass LEED Plus requirement 4b.

Depending on the specific design of the project, credit 1 *Water Efficient Landscaping* may or may not be applicable. This is why it is designated as possible even though it is a requirement for Mass LEED Plus. Should the credit be applicable, the Mass LEED Plus threshold of a 50% reduction in potable water use would be achieved, resulting in 2 points.

The 2 points anticipated for achievement represent an additional 10% reduction in potable water consumption, to a total 30% reduction. This threshold is typically achieved by providing a combination of low flow fixtures with water recycling systems. It is anticipated that 6 points are potentially available depending on the water fixture flow rates selected, implementation of water recycling systems and plant selection for the green roof installation.

Energy and Atmosphere (EA)

Energy and Atmosphere (EA)		Possible	Anticipated Points
PR 1	*Fundamental Commissioning of Building Energy Systems*		*Required*
PR 2	*Minimum Energy Performance*		*Required*
PR 3	*Fundamental Refrigerant Management*		*Required*
CR 1	Optimize Energy Performance	2 points	7 points
CR 2	Enhanced Commissioning		2 points
CR 3	Enhanced Refrigerant Management		2 points
CR 6	Green Power	2 points	
	Total	4 points	11 points
	Total Available		35 points

Items in blue contribute to Mass LEED Plus prescriptive requirements

There are three (3) prerequisite requirements and six (6) credits, representing 35 points in the energy and atmosphere category. The first prerequisite requirement, *Fundamental Commissioning of Building Energy Systems*, requires projects to implement a basic level of commissioning. Mass LEED Plus requires projects to achieve EA Credit 3 Enhanced Commissioning which requires a higher level of commissioning, i.e. larger scope of services, so the prerequisite will be achieved.

The second prerequisite, *Minimum Energy Performance,* requires projects to demonstrate a 5% improvement in the proposed building performance (i.e. practical scope) for major renovations to existing buildings as compared to a baseline which is per ASHRAE 90.1-2007 standard. Please see below for a more detailed discussion of energy performance.

The third prerequisite, *Fundamental Refrigerant Management*, requires projects to use no CFC-based refrigerants in HVAC systems. This is easily achieved and has become standard practice in the industry.

While credit 6 *Green Power* is not regularly achieved, it is noted as possible since it would contribute to MCAD meeting its larger EO 484 targets for both renewable energy as well as GHG emissions reductions. The credit requires projects to purchase a minimum of 35% of its annual electricity consumption (based on energy model results) from renewable sources. This can be achieved through the purchase of renewable energy credits (RECs).

Energy Performance

The practical scope option would provide a significantly more energy efficient building than the current Tower, refer to Section 3.9.4. Mass LEED Plus requires 20% energy efficiency over the Massachusetts Energy Code. The energy code is the International Energy Conservation Code (IECC) 2009 with Massachusetts amendments. This base code is more stringent that ASHRAE 90.1-2007 and the further 20% threshold only further exceeds ASHRAE 90.1-2007.

The LEED-NC prerequisite requirement for energy performance requires 10% efficiency beyond ASHRAE 90.1-2007 for new buildings and 5% efficiency for major renovations to existing buildings. Therefore, the minimum required energy efficiency in Massachusetts is significantly more efficient than the baseline in LEED-NC.

Mechanical systems efficiencies would be greatly improved while also improving comfort, controllability and air quality for occupants within the building in addition to enhanced control and measurement capabilities via the building management system (BMS) for facilities staff.

Building envelope thermal performance would be considerably improved while also providing larger glazed (i.e. vision) area, more daylight into spaces as well as increased visual comfort as glare issues would be addressed.

The lighting systems would maintain required lighting levels in a more efficient design. It is likely that the original building was designed at 1.5 watts per square foot (W/SF) or higher for office and classroom uses. IECC 2009 requires a maximum of 1.0 W/SF for these uses and 0.8 W/SF is increasingly common.

Additionally, lighting systems would be designed in connection with daylight via photo-sensors and switching controls such that artificial lighting use and associated energy use would be minimized during daytime hours. Occupancy sensors would be installed throughout to further minimize energy use associated with lighting.

Materials and Resources (MR)

Materials and Resources (MR)		Possible	Points
PR 1	*Storage and Collection of Recyclables*		*Required*
CR 1.1	Building Reuse-Maintain Existing Walls, Floors, and Roof		2 points + 1 point RP
CR 2	Construction Waste Management		2 points
CR 4	Recycled Content	1 point	1 point
CR 5	Regional Materials	1 point	
CR 7	Certified Wood	1 point	
	Total	3 points	5 points
	Total Available		14 points

Items in blue contribute to Mass LEED Plus prescriptive requirements

Items designated with +1 point RP are identified as LEED regional priority credits and achievement of the credit results in an additional bonus point.

There is one (1) prerequisite requirement and seven (7) credits, representing 14 points in this category. The prerequisite requirement, *Storage and Collection of Recyclables*, requires projects to provide facilities to collect and store five (5) categories of recyclable materials; glass, metals, plastics, paper and corrugated cardboard. This requirement is easily achieved as recycling has become standard practice. MCAD already has a recycling program and facilities in place.

We anticipate that 6 points can be achieved with an additional 2 points potentially available depending on actual materials selections. As defined in MR Credit 1.1 Building Reuse, the project would likely meet the threshold for reusing over 75% of existing walls, floors and roof resulting in 2 points. Compliance with this credit is also a defined smart growth criterion and therefore also contributes to Mass LEED Plus requirements.

Indoor Environmental Quality (IEQ)

Indoor Environmental Quality (IEQ)		Possible	Points
PR 1	*Minimum Indoor Air Quality Performance*		*Required*
PR 2	*Environmental Tobacco Smoke (ETS) Control*		*Required*
CR 1	Outdoor Air Delivery Monitoring		1 point
CR 3.1	Construction Indoor Air Quality Management Plan: During Construction		1 point
CR 3.2	Construction Indoor Air Quality Management Plan: Before Occupancy		1 point
CR 4.1	Low-Emitting Materials-Adhesives and Sealants		1 point
CR 4.2	Low-Emitting Materials-Paints and Coatings		1 point
CR 4.3	Low-Emitting Materials-Flooring Systems		1 point
CR 4.4	Low-Emitting Materials-Composite Wood and Agrifiber Products	1 point	

CR 6.1	Controllability of Systems-Lighting	1 point	
CR 6.2	Controllability of Systems –Thermal Comfort		1 point
CR 7.1	Thermal Comfort-Design		1 point
CR 7.2	Thermal Comfort-Verification		1 point
CR 8.1	Daylight and Views-Daylight	1 point	
CR 8.1	Daylight and Views-Views	1 point	
	Total	4 points	9 points
	Total Available		15 points

There are two (2) prerequisite requirements and eight (8) credits, representing 15 points in this category. The first prerequisite requirement, *Minimum Indoor Air Quality Performance*, requires projects to meet the minimum requirements of sections 4 – 7 of ASHRAE 62.1-2007 Ventilation for Acceptable Indoor Air Quality. ASHRAE 62.1 identifies standards for acceptable outdoor air quality, treatment of outdoor air (if required) and ventilation rates for spaces. These requirements are easily achieved and have become standard practice.

The second prerequisite requirement, *Environmental Tobacco Smoke (ETS) Control*, requires projects to not allow smoking inside the building and to not allow smoking within 25 feet of entrances, operable windows and/or air intakes. These requirements are easily achieved and have become standard practice.

We anticipate that 9 points can be achieved with an additional 4 points potentially available depending on actual material selections, façade and internal layout design.

Innovation in Design (ID)

There are 5 points available under Innovation in Design which can be achieved by exceeding the maximum defined threshold for particular credits, i.e. exemplary performance, or implementing a measure that has a quantifiable sustainability impact that is not identified in the LEED-NC system. This is also applicable to a project achieving a LEED credit from another LEED rating system such as Commercial Interiors. Projects typically achieve at least 3 credit/points of the 5 available in this category

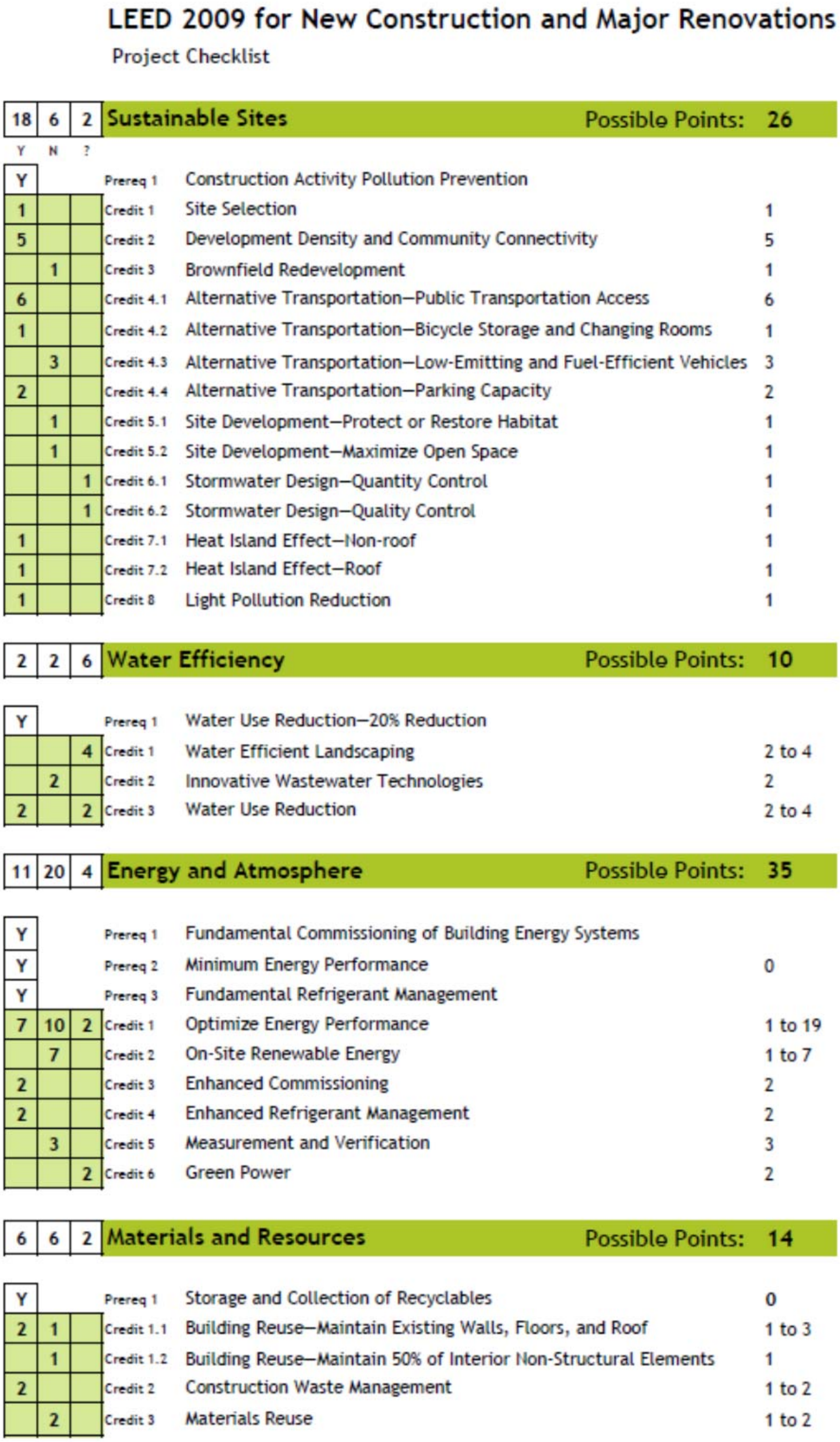
One credit/ point is achieved through having a LEED Accredited Professional as part of the project team. This is easily achieved.

Summary

Our preliminary assessment indicates that the project would be able to easily achieve the minimum certified threshold of 40-49 points per Mass LEED Plus. The checklist provided below indicates that Silver certification, 50-59 points is within reason and potentially even Gold certification, 60-79 points.

LEED certification at higher levels is highly dependent on a specific design as well as the decisions of the owner but it is important to note that levels of LEED certification beyond the minimum required are a reasonable expectation.

4.3.10.3 Preliminary LEED-NC Checklist



LEED 2009 for New Construction and Major Renovations

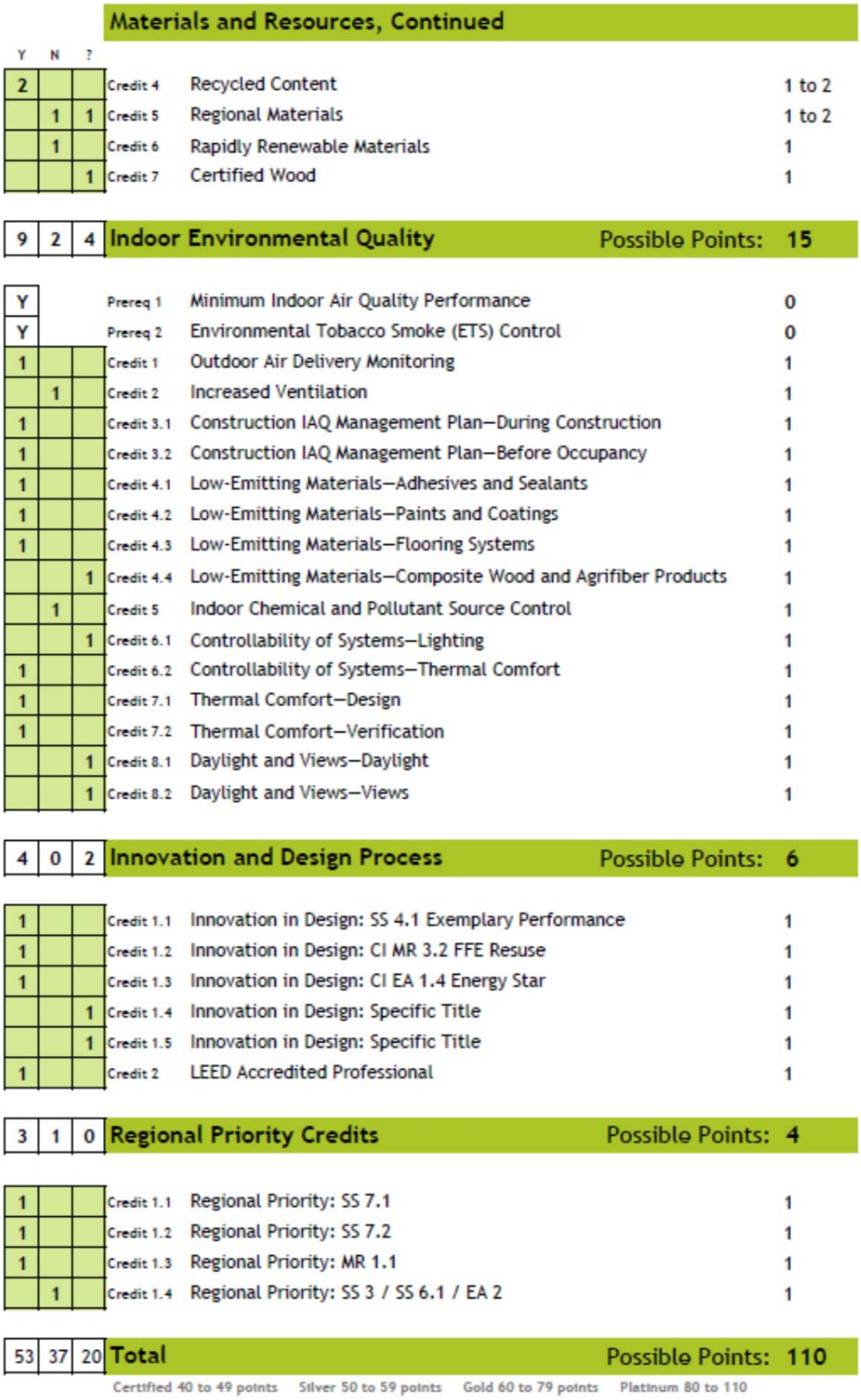
Project Checklist

18	6	2		Sustainable Sites	Possible Points: 26
Y	N	?			
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
5			Credit 2	Development Density and Community Connectivity	5
	1		Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
	3		Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation—Parking Capacity	2
	1		Credit 5.1	Site Development—Protect or Restore Habitat	1
	1		Credit 5.2	Site Development—Maximize Open Space	1
		1	Credit 6.1	Stormwater Design—Quantity Control	1
		1	Credit 6.2	Stormwater Design—Quality Control	1
1			Credit 7.1	Heat Island Effect—Non-roof	1
1			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1

2	2	6		Water Efficiency	Possible Points: 10
Y			Prereq 1	Water Use Reduction—20% Reduction	
		4	Credit 1	Water Efficient Landscaping	2 to 4
	2		Credit 2	Innovative Wastewater Technologies	2
2		2	Credit 3	Water Use Reduction	2 to 4

11	20	4		Energy and Atmosphere	Possible Points: 35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	0
Y			Prereq 3	Fundamental Refrigerant Management	
7	10	2	Credit 1	Optimize Energy Performance	1 to 19
	7		Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
	3		Credit 5	Measurement and Verification	3
		2	Credit 6	Green Power	2

6	6	2		Materials and Resources	Possible Points: 14
Y			Prereq 1	Storage and Collection of Recyclables	0
2	1		Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
	1		Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
	2		Credit 3	Materials Reuse	1 to 2



Y	N	?			
				Materials and Resources, Continued	
2			Credit 4	Recycled Content	1 to 2
	1	1	Credit 5	Regional Materials	1 to 2
	1		Credit 6	Rapidly Renewable Materials	1
		1	Credit 7	Certified Wood	1
9	2	4		**Indoor Environmental Quality** Possible Points:	15
Y			Prereq 1	Minimum Indoor Air Quality Performance	0
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	0
1			Credit 1	Outdoor Air Delivery Monitoring	1
	1		Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
		1	Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
	1		Credit 5	Indoor Chemical and Pollutant Source Control	1
		1	Credit 6.1	Controllability of Systems—Lighting	1
1			Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
		1	Credit 8.1	Daylight and Views—Daylight	1
		1	Credit 8.2	Daylight and Views—Views	1
4	0	2		**Innovation and Design Process** Possible Points:	6
1			Credit 1.1	Innovation in Design: SS 4.1 Exemplary Performance	1
1			Credit 1.2	Innovation in Design: CI MR 3.2 FFE Resuse	1
1			Credit 1.3	Innovation in Design: CI EA 1.4 Energy Star	1
		1	Credit 1.4	Innovation in Design: Specific Title	1
		1	Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1
3	1	0		**Regional Priority Credits** Possible Points:	4
1			Credit 1.1	Regional Priority: SS 7.1	1
1			Credit 1.2	Regional Priority: SS 7.2	1
1			Credit 1.3	Regional Priority: MR 1.1	1
	1		Credit 1.4	Regional Priority: SS 3 / SS 6.1 / EA 2	1
53	37	20		**Total** Possible Points:	110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

4.3.11 Preliminary Energy Analysis

Energy modeling was conducted to estimate the energy consumption for the building rehabilitation option: option 1. The same building floor plates and massing were used, only with the systems efficiencies were changed per the scope of work described above.

Energy Usage Intensity

Energy Usage Intensity (EUI) is a unit of measurement that describes a building's energy use for comparison purposes. It is a measure of the total energy consumed in a year, measured in BTUs, divided by the gross square footage of a building. Hence, the lower the EUI, the better the energy performance.

Benchmarking

The U.S. Environmental Protection Agency (EPA) has developed the EPA energy performance rating for building projects. A project receives an EPA score which is an "apples-to-apples" comparison of a project's estimated or actual energy use to that of similar U.S. building types. The tool adjusts for primary drivers of energy such as building size, climate, operating hours, number of occupants, and computers.

The EPA score is on a 1 to 100 scale. For example, an office building that scores 50 performs at an average level, and one that scores 75 is more efficient than 75% of office buildings nationwide. Hence the score is essentially a percentile of your performance.

The data is based on the U.S. Department of Energy (DOE), Energy Information Agency's Commercial Buildings Energy Consumption Survey (CBECS). CBECS is a national sample survey that collects information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures. CBECS uses EUI as its reporting metric. The latest data is from 2003 but it is the only national database for benchmarking and hence remains a useful tool and reference.

The building types identified that are closest to the Tower building for comparison and benchmarking purposes are Education, College/University (campus level) and Office. The College/University data can be misleading as it aggregates campus buildings into one total. The result is buildings that widely vary in their typology are included in the total, i.e. laboratories, offices, classrooms, auditoriums, etc… The Tower building operates in between these two categories hence, data for both categories is provided.

Energy Model Areas

The areas noted above come from the areas provided from the Tower Revit file provided by MCAD. They represent the conditioned areas of the building per Arup's energy model. This is different than the identified gross square footage

(GSF) of the building, i.e. 318,299 GSF. In order to compare apples to apples, the Existing Tower area (258,260) represents the net usable square footage (NUSF) minus the vertical shafts (Vert) plus the elevator lobby area. Refer to the table below. The result is less than a 1% difference between the areas and as such represents equal areas to compare energy usage and EUI.

Column	**A**	**B**	**C**	**D**	**E**	**F**	**G**
	MCAD Data					**Energy Model**	**Difference**
Level	NUSF	Vert	(A) - (B)	Vert Lobby	(A) - (B) + (D)	Energy Model	(E) - (G)
Basement	26,289	1,157	25,132	-	25,132	25,203	71
Level 1	7,293	1,091	6,202	486	6,688	6,356	(332)
Ground	10,443	318	10,125	-	10,125	7,995	(2,130)
Upper	4,335	1,321	3,014	459	3,473	3,246	(227)
Level 2	15,371	2,848	12,523	459	12,982	12,265	(717)
Level 3	26,118	2,393	23,725	459	24,184	24,713	529
Level 4	24,680	2,008	22,672	455	23,127	23,391	264
Level 5	23,669	2,012	21,657	455	22,112	22,527	415
Level 6	23,778	2,142	21,636	455	22,091	22,531	440
Level 7	18,169	2,134	16,035	520	16,555	16,618	63
Level 8	16,368	1,753	14,615	520	15,135	15,167	32
Level 9	18,177	1,685	16,492	452	16,944	16,866	(78)
Level 10	16,335	1,687	14,648	454	15,102	15,047	(55)
Level 11	13,972	1,691	12,281	458	12,739	12,731	(8)
Level 12	14,219	1,804	12,415	458	12,873	12,823	(50)
Level 13	12,288	2,062	10,226	458	10,684	10,983	299
Level 14	9,053	739	8,314	-	8,314	8,498	184
Total	280,557	28,845	251,712		258,260	256,960	(1,300)

Tower Building Energy Usage Comparisons

	Area (SF)	Total Energy Use (kBTU)	EUI (kBTU/SF/yr)	Energy Cost ($)
Tower Existing Meter Data[1]	258,260	12,239,802.3	47.4	$348,896.90
Tower Existing Energy Model[4]	256,960	28,055,857.3	109.1	$976,932.54
Building Rehabilitation Option 1	256,960	16,871,770.0	65.6	$619,746.90
College/University[2]	256,960	26,723,840.0	104.0	$1,700,043.97
Office[3] EPA Score 50	256,960	48,822,400.0	190.0	$1,261,611.58
Office[3] EPA Score 75	256,960	36,231,360.0	141.0	$939,497.99
Office[3] EPA Score 90	256,960	26,980,800.0	105.0	$930,550.39

[1] All data was provided by MCAD and assumes an area of 258,260 GSF

[2] Data is from 2003 CBECS National Median Source Energy Use and Performance Comparisons by Building type – Median Site EUI

[3] Data is from EPA's Target Finder / Portfolio Manager tool

[4] Area for EUI calculation = 256,960 GSF, refer to explanation below.

Energy Cost

The energy costs provided use the following utility costs which were provided by MCAD. The proportion (%) for each energy use for the benchmark options noted above is based on the Tower Existing Energy Model (%).

Electricity	$0.16 per kWh	56.0% total energy use
Natural Gas	$1.48 per therm	39.6% total energy use
Steam	$0.02 per kBTU	4.4% total energy use

Energy Conclusions

The energy use in the Tower building as reported in the metering data provided by MCAD results in a EUI significantly smaller than anticipated. Low EUIs typically indicate an energy efficient building but in this instance, we know this is not the case. Our energy model based on the existing building construction and systems per the available information and assumptions indicates a much higher energy use than the metering data. We would expect the energy model of the Tower would be higher than the existing data since many systems and equipment in the Tower are currently not operational and therefore not consuming energy or are not operating efficiently, while these same systems and equipment are simulated as operating correctly per the design in the energy model.

Moreover, our energy model is concept level only and as such, a margin of error would be expected. The energy model has not modeled certain areas or systems. For instance, the elevators and toilet exhaust fans and their associated energy use are not included. The stairs are assumed to be unconditioned and as such not included in the model, yet these areas will have some energy consumption due to lighting that is not accounted for in the energy model.

However, taking these variances into account, the discrepancy in energy usage far exceeds the difference between the metering data and our energy model. Additionally, the benchmarking data in the table above differs greatly from the metering data leading us to conclude the metering data is likely inaccurate. Further investigation into the metering data has confirmed our conclusion that the data is inaccurate.

To estimate the energy cost for a building like the Tower, we would recommend using a range, rather than a specific figure for anticipated energy cost assuming all systems and equipment were working. The Office-EPA 90 and College/ University benchmark figures are likely at the low end (EUI = 104/105 and approx. 26,800,000 kBTU) and a EUI of 125 is probably at the high end (32,120,000 kBTU). Using these figures, the energy cost would range from approximately $935,000.00 to $1,120,000.00 annually. This range and subsequent energy cost we feel would be reasonable and defensible.

Given this range for the existing Tower, the building rehabilitation option 1: Retain primary structure and complete renovation would result in a decrease of 38.4 – 59.4 kBTU/SF/year. More importantly, this represents a savings of $315,253.10 to $500,253.10 per year.

4.4 Building Rehabilitation Option 1: Add-Alternates

The following section describes a series of options that could be implemented to most easily gain additional net, i.e. usable, square footage as part of or independent of the building rehabilitation option described above.

4.4.1 Option 1.1: Infill Level 13

There is currently a two-story atrium at level 12 in the Library stacks that has a communicating stair up to level 13. The resulting void space at Level 13, the grey area below, represents the area for proposed infill. It would provide approximately an additional 1,700 SF of new, usable space.

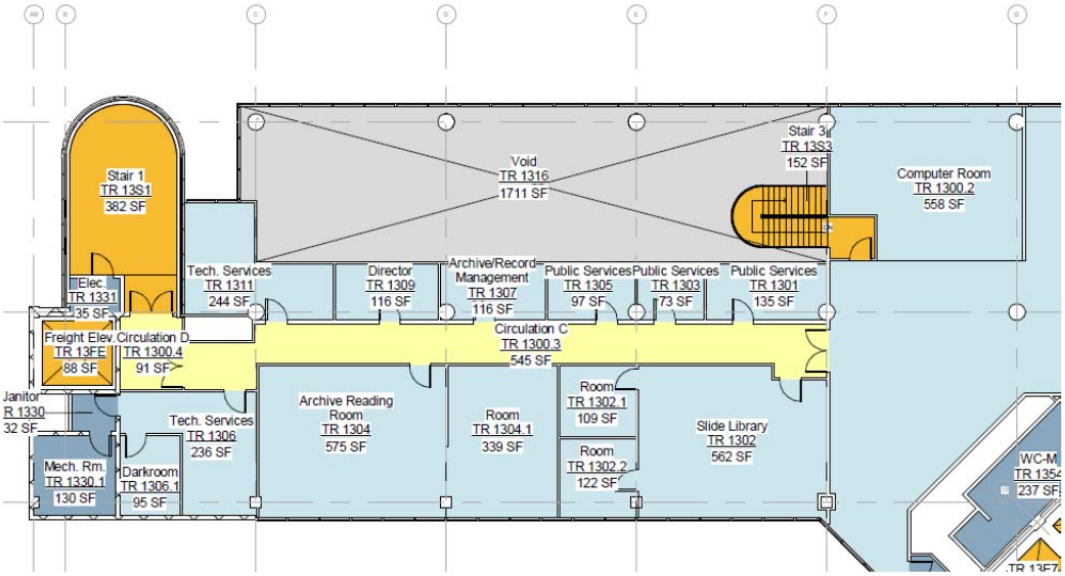


Figure 4.4.1 Level 13 partial plan.

4.4.1.1 Scope of work

The floor infill structure would consist of lightweight concrete on steel deck supported on steel beams. It is anticipated that the weight of the floor infill is less than 10% of the total floor weight per floor; therefore seismic upgrade would not be triggered. Local reinforcing of the existing steel columns and beams supporting the infill will be required. Since no specific program has been identified for this space, the intent for this scope of work is to fit-out as core and shell only. As such no finish materials, lighting or other systems have been priced.

Order of Magnitude Cost

The cost for this scope of work is $680,000.00, exclusive of mark-up. Please see Appendix A.2 for a detailed breakdown and associated assumptions.

4.4.2 Option 1.2: Infill Level 10

There is currently a two-story atrium at level 9 in the design studio. The resulting void space at Level 10, the grey area below, represents the area for proposed infill. It would provide approximately an additional 1,800 SF of new, usable space.

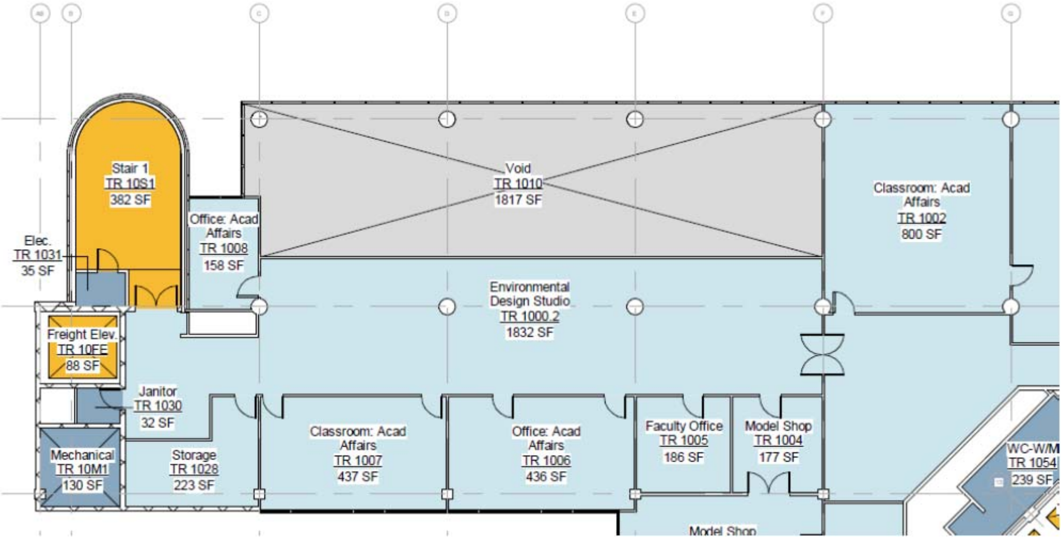


Figure 4.4.2 Level 10 partial plan.

4.4.2.1 Scope of Work

This is similar to the infill description of level 13 described above and if completed autonomously would again not trigger seismic upgrades. See section 4.4.4 below for the implications of combining multiple options.

Order of Magnitude Cost

The cost for this scope of work is $630,000.00, exclusive of mark-up. Please see Appendix A.2 for a detailed breakdown and associated assumptions.

4.4.3 Option 1.3: Addition at Level 7

An approximately additional 5,600 SF could be created at Level 7 if the roof area was enclosed. Hence, Level 7 would become identical to Level 6.

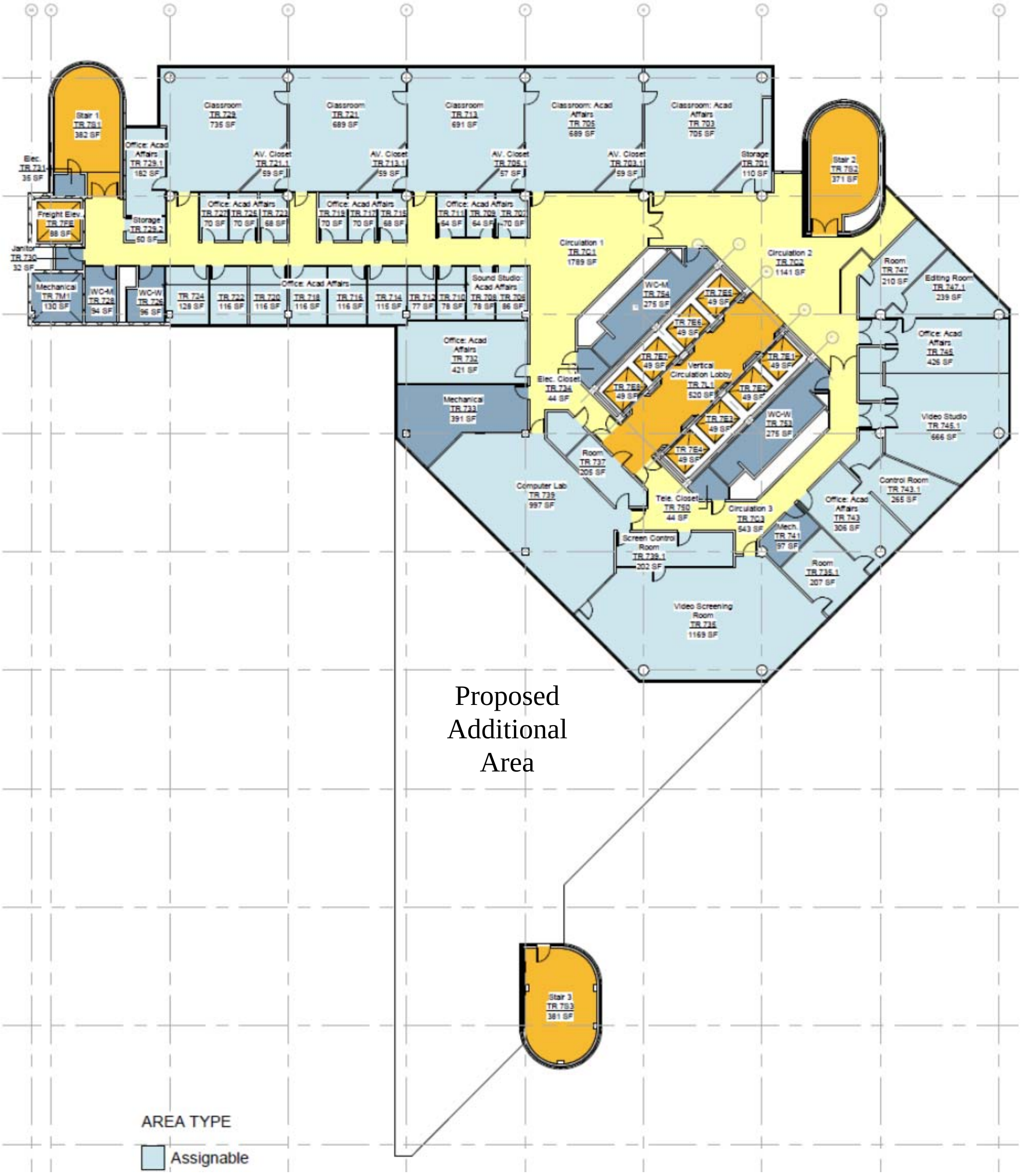


Figure 4.4.3 Level 7 plan

4.4.3.1 Scope of Work

Addition to the existing low roof would consist of steel framing, columns and beams, with steel roof decking. The existing columns can support the additional weight. However, the overall weight of the addition will trigger seismic upgrade of the building.

4.4.3.2 Seismic Upgrade

A seismic upgrade requires additional lateral load resistance of approximately 20%. This can be implemented by adding two braced frames in each direction at each floor of the building, for a total of 4 braced frames.

Existing columns and beams can be used, with reinforcing, to form the frames, and diagonal steel members can then be added to form the braced frames. New mini-pile foundations will be required under the columns of the frames. The location of the frames can be coordinated to suit the architectural layout.

Order of Magnitude Cost

The cost for the Level 7 addition scope of work is $1,960,000.00, exclusive of mark-up. Please see Appendix A.2 for a detailed breakdown and associated assumptions.

4.4.4 Combination of Additions

4.4.4.1 Options 1.1 & 1.2

If both infill options at Level 10 and Level 13 are implemented, new foundations under the affected columns will be required. It is anticipated that drilled mini-piles with 30 ton capacity would be suitable for the new foundations.

Seismic upgrade would not be triggered by the new mini-pile foundations.

Order of Magnitude Cost

The cost for this scope of work is $1,400,000.00, exclusive of mark-up. Please see Appendix A.2 for a detailed breakdown and associated assumptions.

4.4.4.2 Options 1.1, 1.2 & 1.3

If all of the proposed additions described above are implemented, seismic upgrade will be triggered.

Order of Magnitude Cost

The cost for this scope of work is $4,861,495.00, exclusive of mark-up. Please see Appendix A.2 for a detailed breakdown and associated assumptions.