
Technical Report 1 Part 2

Lighting Existing
Conditions and
Design Criteria

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Executive Summary

This report is a research of the existing building and an evaluation of the existing lighting condition of the Fraunhofer CSE office building at 5 Channel Center Street, Boston, MA.

Four spaces that are evaluated are:

- Circulation space—Lobby
- Special purpose space—Large Conference Room
- Large work space—Open Office
- Outdoor Space—Building Façade

The IESNA Lighting Handbook 10th edition and ASHRAE Standard 90.1-2010 are used as reference and criteria development.

Overall, the lighting design of this building is focused on high end technology and automatic building system solution. Most of the lighting fixture are used in the building are advanced LED fixtures. In order to establish a good working environment in the building, LED fixtures and automatic control systems ensures the space are adjust according the task and the outdoor condition.

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Building Overview

- Building Name: Fraunhofer CSE Project <http://cse.fraunhofer.org/>
- Location: 5 Channel Center Street, Boston, MA
- Occupancy Type: Offices and research laboratories (Group B) and conference room (Group A-3)
- Size: 42150SF
- Number of Stories above Grade: 6
- Project Teams:
 - Owner: Fraunhofer USA
 - General Contractor/Construction Manager: Gilbane Building Co. www.gilbaneco.com
 - Architects: DiMella Shaffer www.dimellashaffer.com
 - Structural Engineer: McNamara/Salvia, Inc. www.mcsal.com
 - MEP/FP/Tel Data Engineer: BR+A Consulting Engineers www.brplusa.com
 - Lighting Consultant: Lam Partners www.lampartners.com
 - Plumbing/HVAC Services: Northeastern Mechanical www.northeasternmech.com
 - Civil Engineer: VHB, Inc. www.vhb.com
 - Geotechnical Engineer: Haley & Aldrich, Inc. www.haleyaldrich.com
- Dates of Construction: Jan 2012— Apr 2013
- Actual Cost Information: Not clear
 - This renovation project is designed for Fraunhofer Building Technology Show Case (<http://cse.fraunhofer.org/5cc/>). For this specialness of the project, almost all the products and materials are donated by manufacturers. Therefore cost is hard to be estimated.
- Project Delivery Method: Base building—Tenant Fit-Up

1. Lobby/Reception

1.1 Existing Condition

The lobby is located on the ground floor/first floor on the north side of building. The lobby consists of two parts with two different floor heights. The lower part of the lobby with a small floor area serves as a transition area from vestibule to the reception area. The upper level of the lobby is the main reception area. The two parts are connected by a short length of stair case as well as a handicap wheelchair lift. The north side of the lower portion is the north wall of the building with large window area. A convertible partition glass wall is on the longitude side of the upper portion lobby separating the lobby and the large conference room. The south side of the lobby is the overlook window to the PV lab in the basement. A specially designed reception desk is on the upper level facing the large conference room. For plan see *Figure 1.2*.

The primary tasks of the lobby are reception, transition and showcase. The company is currently under the discussion of putting some touch screen table for future showcase purposes. By removing the movable wall between the large conference room and reception area, the large area can serve as a gallery for new products exhibition.

Room Dimensions

LOWER	UPPER (reception)
Length: 26'-6"	Width: 19'-10"
Width: 11'7 ½"	Length: 47'-8"
Height: 12'~15'	Height: 8'-10 ¼"

Room Finishing/Glazing

Table 1.1-Surface Material

	SURFACE	MATERIALS	FINISH	DESCRIPTION	REFLECTANCE
Lower Lobby F112	Floor	Tile	GT-1/PFT-1	10"x24" black color tile	0.3
	Wall	GWB	GT-2/PT-1,4,5	5/8" GWB-Type X, 3 5/8" Mtl. framing, 1HR rated	0.94, 0.6
		Glazing		15'-6 ½" by 12'-3 ½" glass window	
	Ceiling	Timber	PT-1	Exposed beams	0.8
Upper Lobby (Reception) F113	Floor	Rubber	RBT-1,2,3	Three color rubber finishing on 2 layers of ¾" ply wood subfloor	0.4, 0.7
	Wall	GWB/Glass	PT-1,ACC	5/8" GWB, 3 5/8" Mtl. framing furring wall/ Dorma Moveo moveable wall	0.94
	Ceiling	Timber, act panel	PT-1,3,4	Exposed beams, acoustical panel	0.8

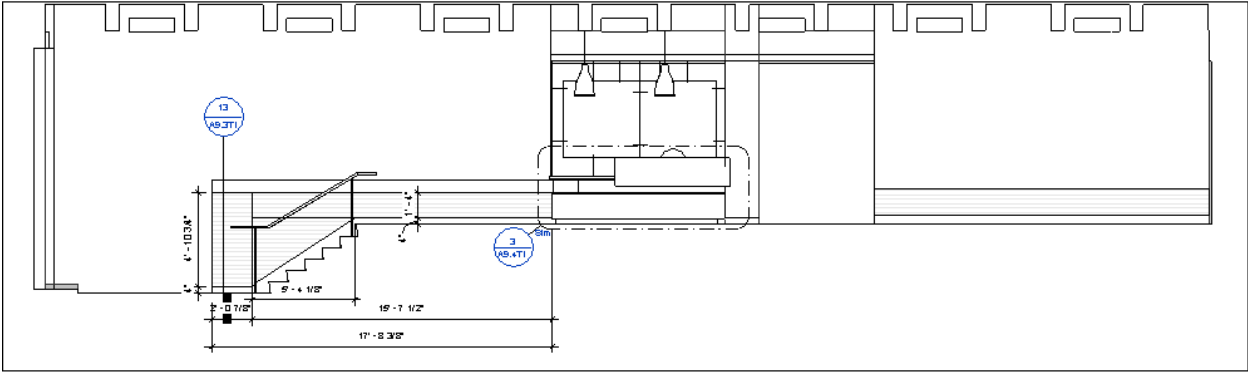


Figure 1.1-Lobby south looking section



Figure 1.2 -Lobby plan (left side is building north)

Figure 1.3 -Reception desk view (South looking)

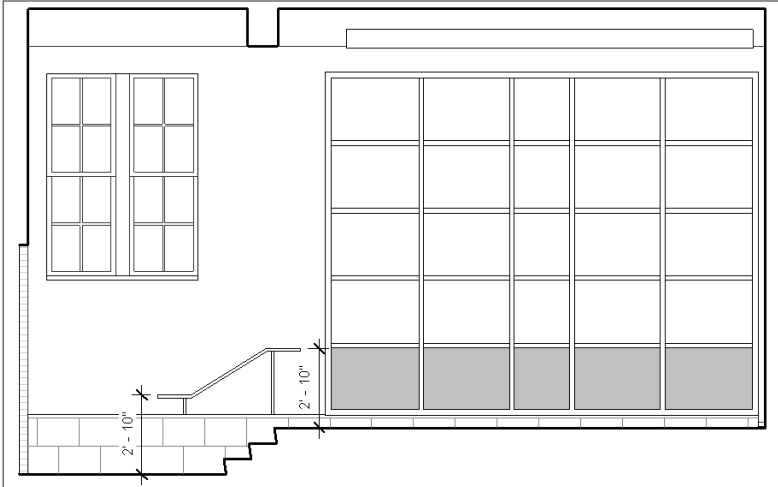


Figure 1.4-Lobby west looking section

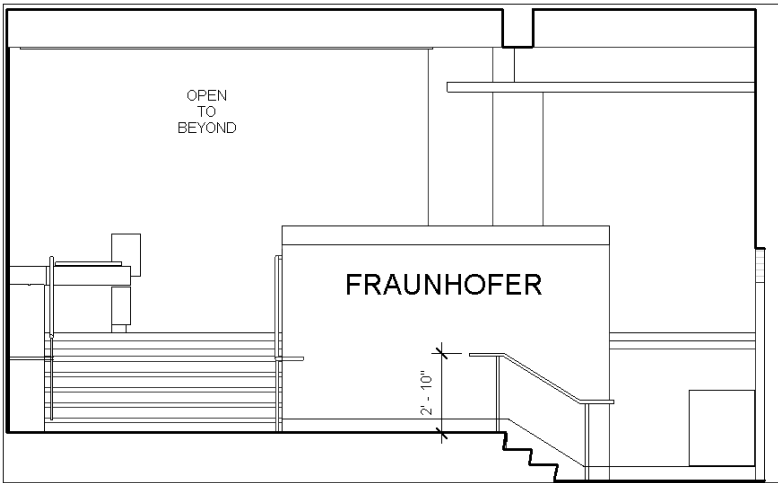


Figure 1.5-Lobby east looking section

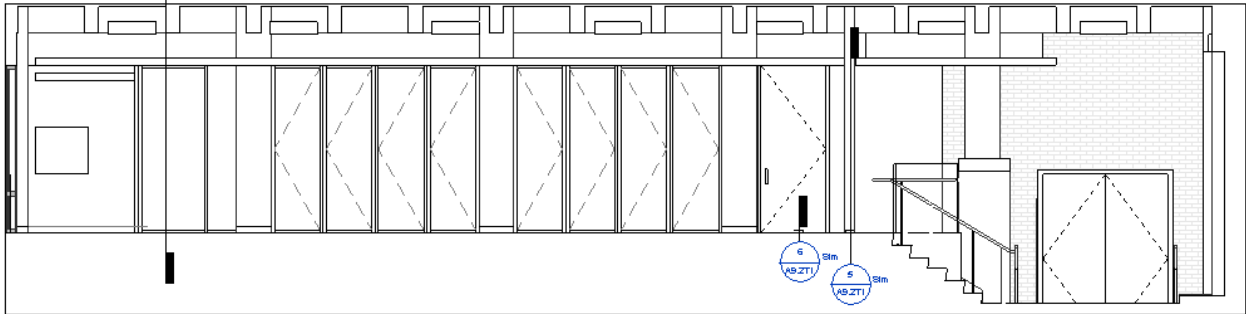


Figure 1.6-Lobby north looking section

EXISTING LIGHTING

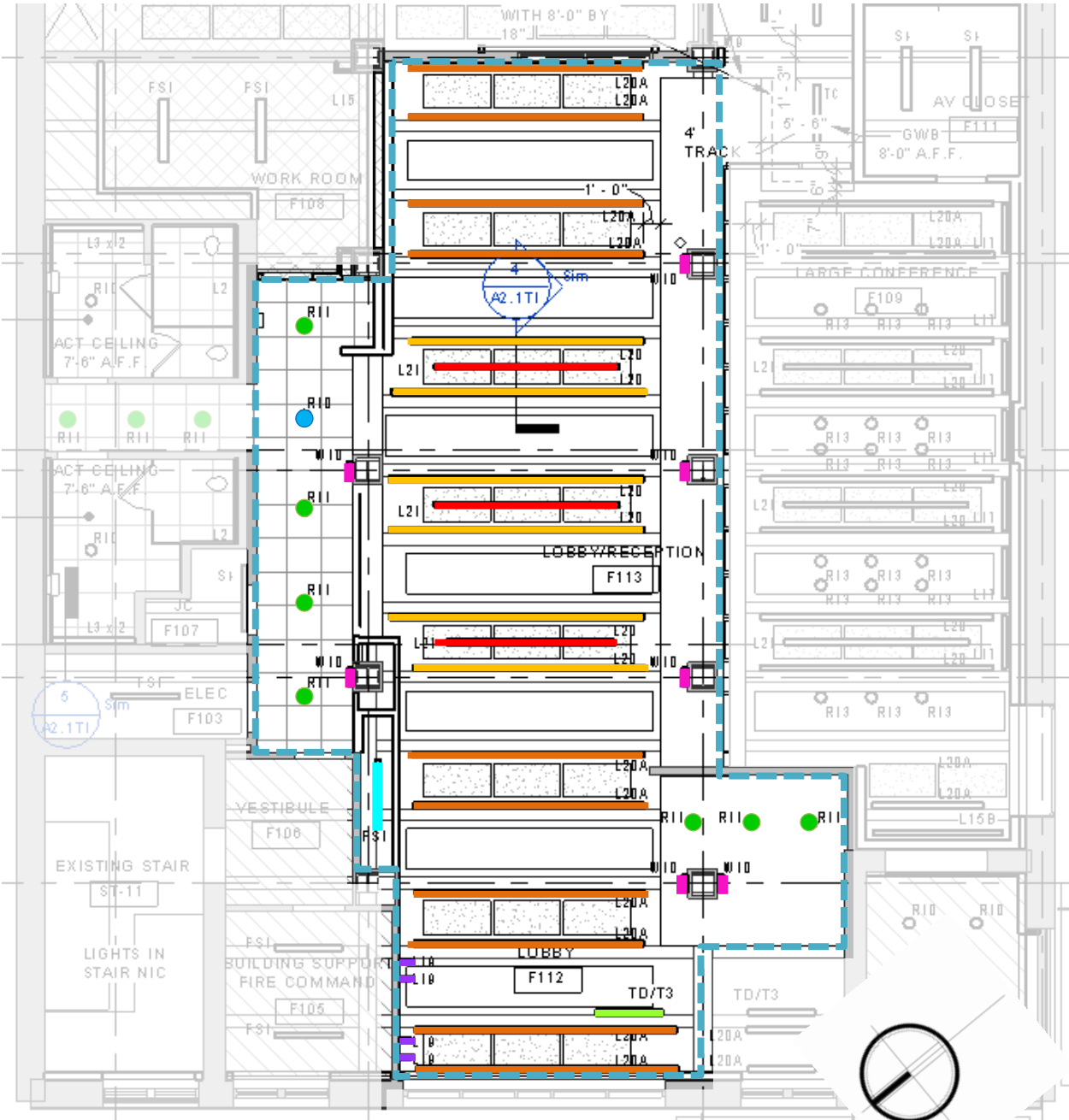


Figure 1.7 -Lobby lighting plan (left side is building north)

Table 1.2-Lighting Schedule

Type	Quantity	Description	Manufacturer	Model	Lamp	Watt	Volts
L19	4	Wall-surface-mounted continuous linear RGB-LED dimmable tubes with diffuse plastic lens	Color Kinetics PHILIPS	123-000018-01	RGB LED	10/ft	120
L20		Surface-mounted continuous linear RGB-LED dimmable 125"x120' cove uplight with integral line-voltage driver	Color Kinetics PHILIPS	123-000018-01	RGB LED	13	120
L20A		Surface-mounted continuous linear white-LED dimmable 110"x110" cove uplight with integral line-voltage driver	Color Kinetics PHILIPS	523-000004-14/523-000005-06	2700K LED	6	120
L21		Pendant-mounted continuous linear white-LED dimmable downlight with flush frosted acrylic lens and narrow-profile extruded aluminum box housing	Lightolier PHILIPS	MICROSQUARE MS-3-N-L-L-PC-12-J-U-A	3000K LED	38	277
R10	1	Recessed 6-in diameter with-LED dimmable downlight with semi-specular parabolic reflector and flange	Lightolier PHILIPS	C6L1520-DL-30K-W-CL-P + C6L20-N-1	3000K LED	39	120
R11	7	Recessed 6-in diameter white-LED dimmable wallwasher with semi-specular parabolic reflector and flange	Lightolier PHILIPS	C6L1520-DL-30K-W-CL-P + C6L20-N-1	3000K LED	39	120
W10	7	Wall-surface-mounted white-LED dimmable sconce with opal glass double cylinder diffuser and integral drive, and transformer	Lightolier PHILIPS	PIPPA SINGLE PPL5-PW-PN-N4W-T	2700K LED	4.8	120
FS1	1	4" pendant mounted lensed, enclosed, and gasketed fluorescent	Columbia BR+A	LU4-232-EU-HUBK	T8 (2)	32	T8
T3	1	Track-mounted white-LED dimmable adjustable accent with cylinder housing, narrow-flood distribution, and beam-softening lens	Lightolier PHILIPS	LLA0127WH + LLA01RNF SOL	2700K LED	/ 16	120

Light Loss Factor:

All the LED fixtures are assumed to have LLF=0.7. Assumption is made for the luminaire with the T8 fluorescent lamp as well with a LLF = 0.8.

1.2 Design criteria & Consideration

Lobby is the space where people gather. This lobby is a part of the entry passage of the building. It directly connects the vestibule. Therefore the lobby area presents the company image in a very crucial way. The color rendering and uniformity are two priority issues that needed to be considered. Also, since this space will also be used as a showcase/gallery area, aesthetic appearance plays a very important part in this space. More kinetic and high-tech lighting design should be considered of use to help improving the visual representation of the space. The reception desk area should be specially considered due to the fact that writing and reading tasks will be conducted around the reception area. The space should be designed with the consideration of the conference room design, because the two spaces are designed to have the possibility of joint use as an open exhibiting space.

IES Illuminance Recommendation

Table 1.3- Illuminance criteria

Space		Eh	Ev	Avg:Min
Lower Lobby (F112)		100 lux	30 lux	4:1
Upper Lobby (F113)	Reception Desk	150 lux	50 lux	4:1
	General Area	100 lux	30 lux	4:1

ASHRAE 90.1 (2010) Requirements

Power Density Allowance: 0.90 W/sf

Control requirements: The space shall have automatic shutoff control. The control shall be schedule basis or controlled by other signal from building automatic system. The automatic control device shall be manual on or automatically turn lights on to 50%.

1.3 Lighting Evaluation

An AGI32 model was created to analyze the existing lighting design. Room interior is simplified to avoid making too much assumption about the reflectance and for a better visual result. The model is created in AutoCAD and lighting fixtures ies files are imported into AGI32 to evaluate the lighting design and compare to the requirement from IES handbook Ed.10 and ASHRAE 90.1 2010.

Due to the fact that many fixtures in the lobby are color changing LED fixtures, the calculation result does not reflect the real situation. And the rendering from AGI32 is not able to show the real texture and color rendering in the lobby. However, the power density and the rough illuminance range should be a good estimate of the space.

Calculation results from AGI32 of the two areas of the lobby are:

Table 1.4-Calculation Result

Space		Illuminance (Fc)
Lower Lobby	Maximum	19.9
	Minimum	8.2
	Average	11.73
	Avg/Min	1.43
Upper Reception	Maximum	50.1
	Minimum	13.8
	Average	31.77
	Avg/Min	2.3

The illuminance results shows that the current design meet the criteria of the IES light level recommendation. All the values are within a reasonable range. The average illuminance in the upper reception area is higher than the IES suggested value. But in the real situation, not all the lights are on to the full output. And all the color changing LEDs are dimmer than the AGI model shows.

ASHRAE lighting power density allowance for lobby is 0.9 watts/sf. The lighting power density of the lobby is calculated as below:

Area=1430 sf

Total watts = 2716 watts

LPD = 1.9 watts/sf

The LPD value does not meet the ASHRAE criteria. The result exceeds the recommended value a lot. The large scare of using color changing LED to improve the visual appearance of the area is the main factor of large power density. However, since the space is designed to also used as an gallery/exhibiting area for the purpose of building technology showcase, it is in need of installing varies types of lighting fixtures

The following two pictures show the illuminance calculation result in the space. The isoline gives a better understanding of the exact calculation result in the space. In the Pseudo color rendering, the warmer color shows high illuminance level and the bluer color indicates the low illuminance level.

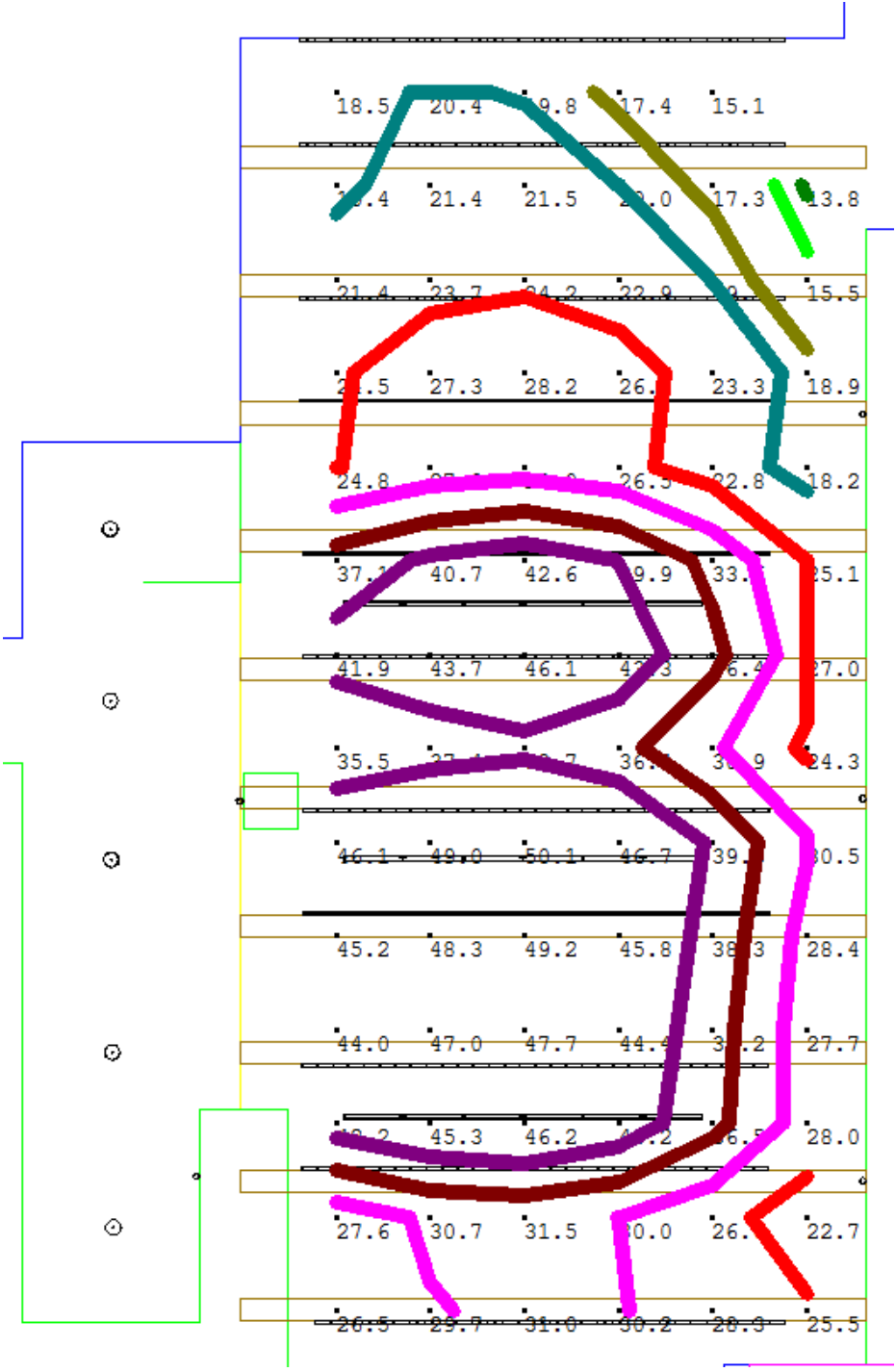


Figure 1.8- AGI32 Isoline calculation plan

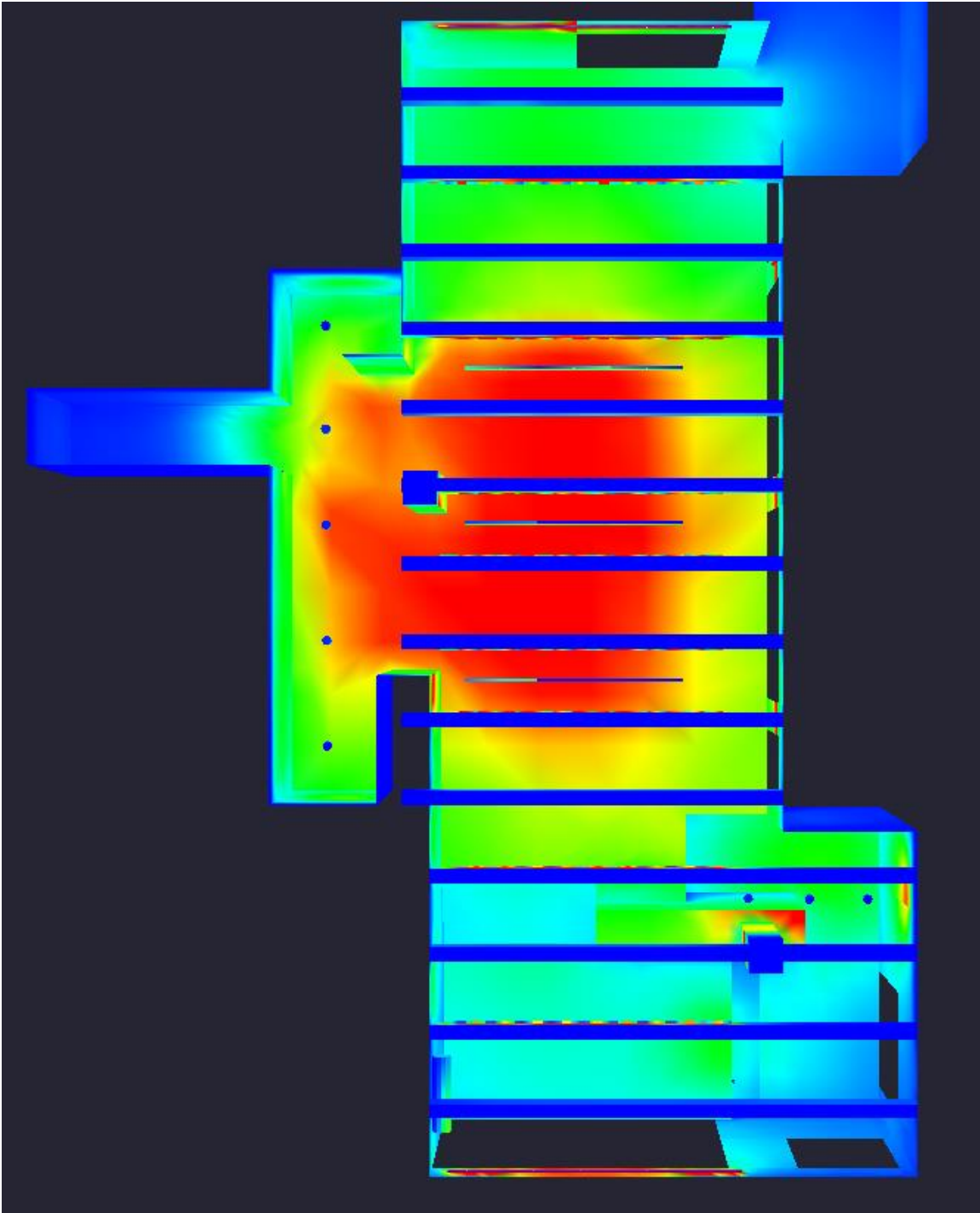


Figure 1.9 – AGI32 Pseudo color rendering



Figure 1.10 – AGI32 Rendering

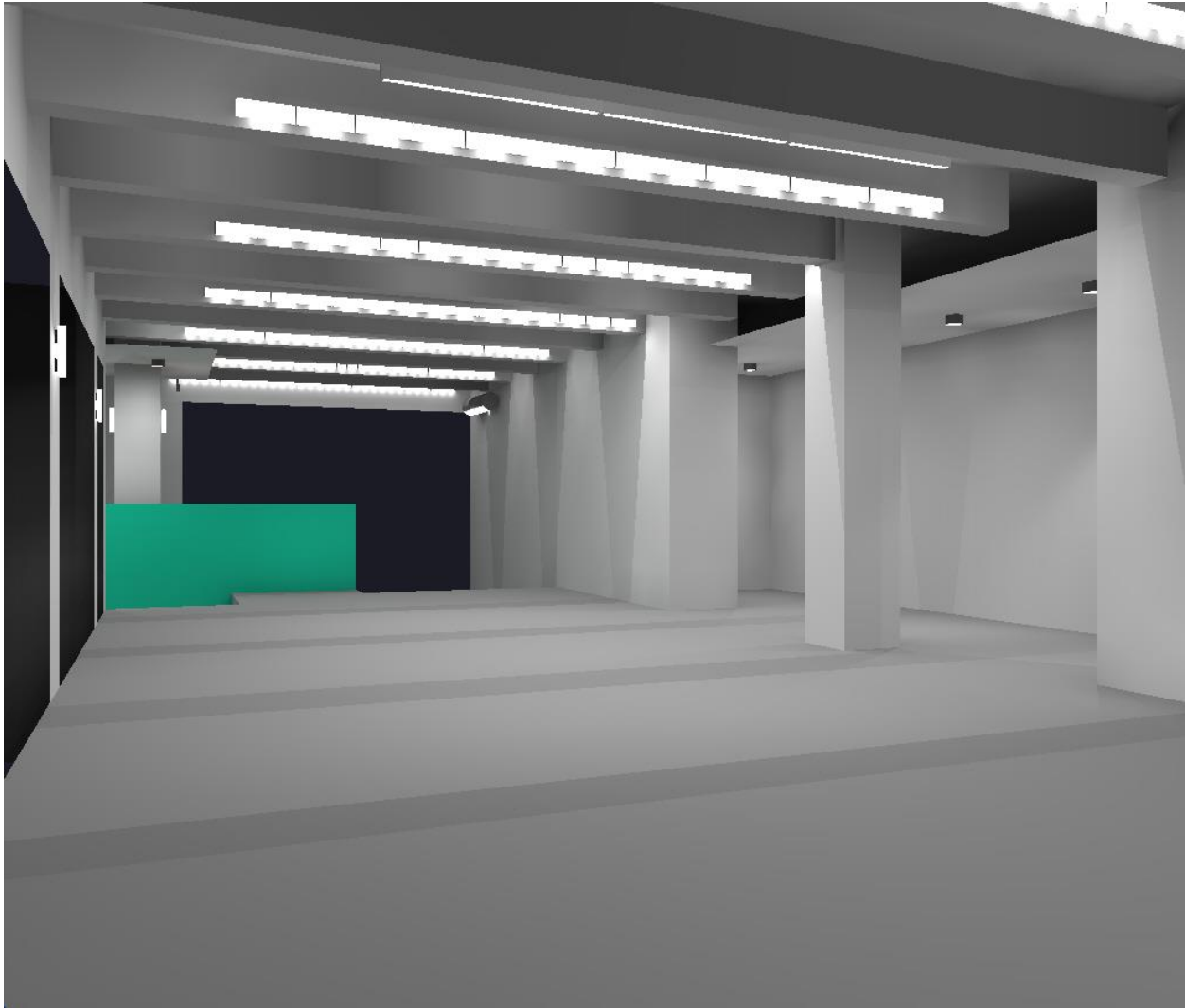


Figure 1.11 – AGI32 Raytrace rendering (looking from upper reception to the lower lobby direction)

2. Conference Room

2.1 Existing Condition

The large conference room is a rectangular shaped room on the first floor locates right next to the lobby. The conference room is separated from the reception area by a movable petition glass wall which can be removed and converts the first floor into a large open space. The conference room is also served as a multi-function work space if needed.

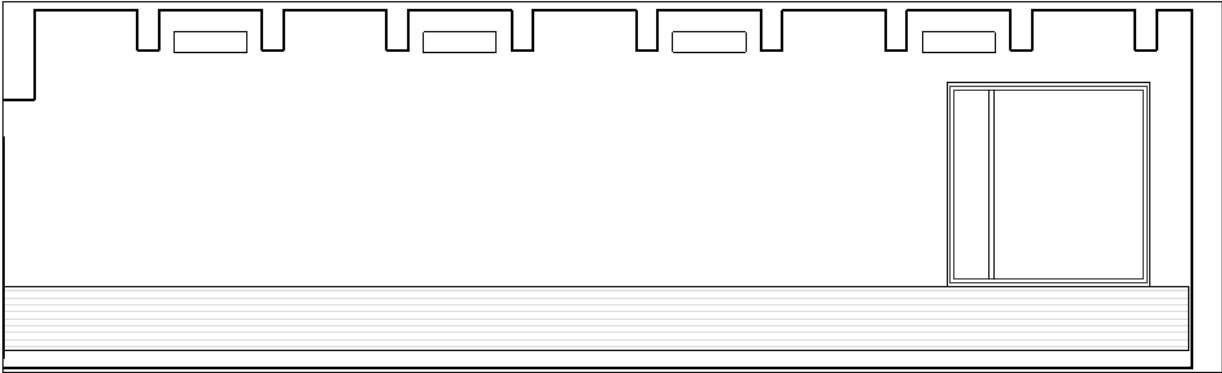


Figure 2.1-Section 1

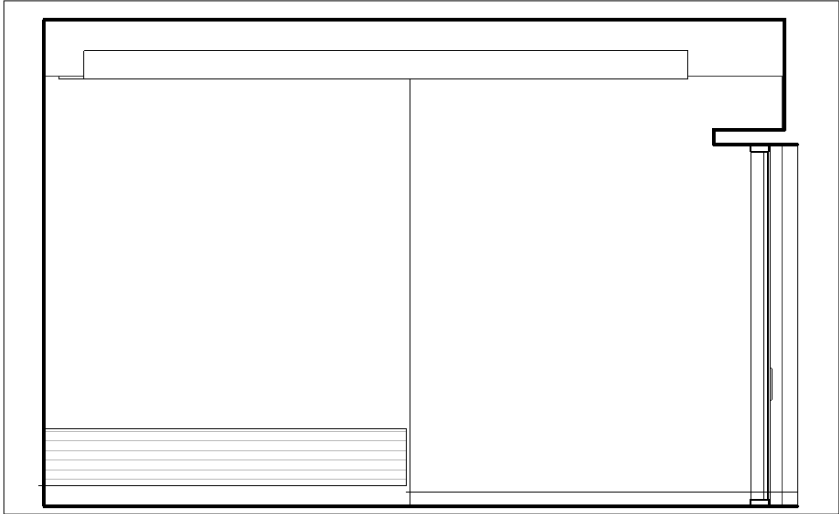


Figure 2.2-Section 2

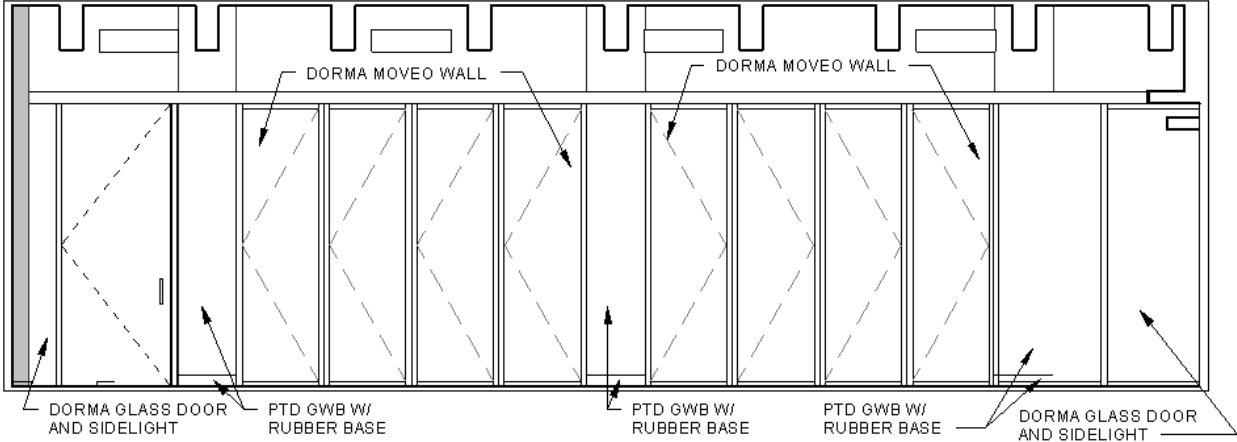


Figure 2.3-Section 3

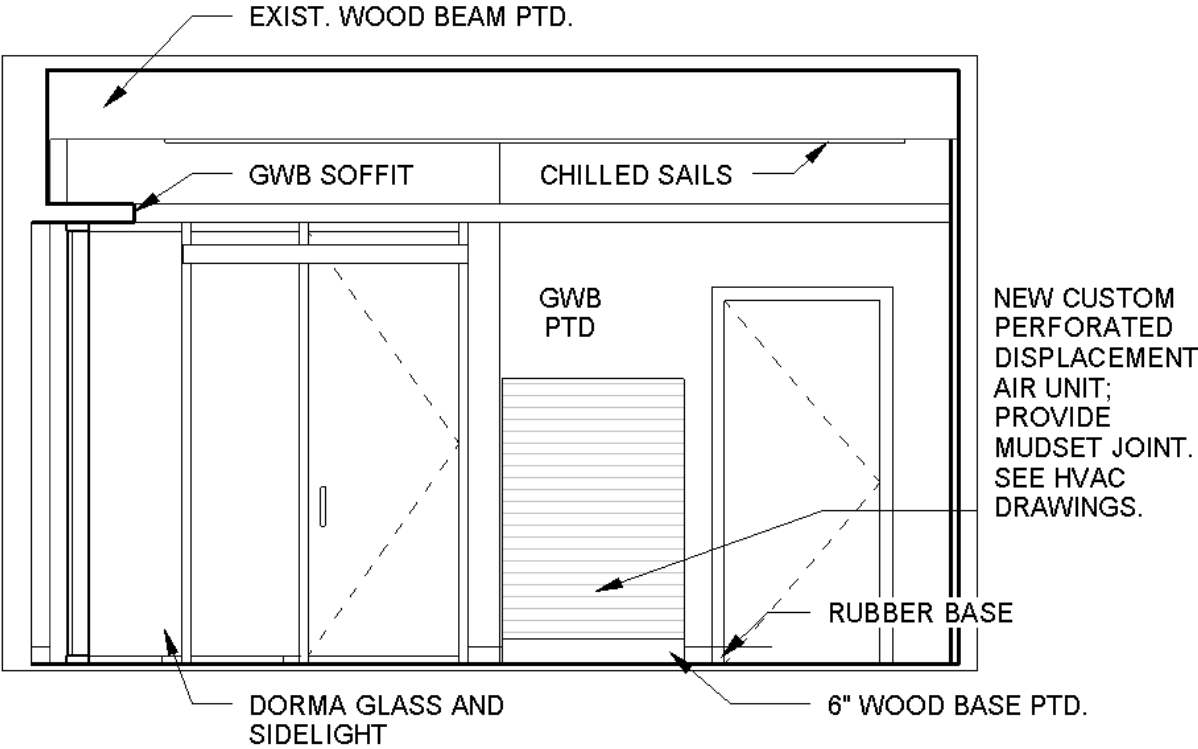


Figure 2.4-Section 4

Room Dimension

36' x 16' 8" x 8'-10 1/4" (L/W/H)

Room Finishing/Glazing

Table 2.1-Surface material

SURFACE	MATERIALS	FINISH	DESCRIPTION	REFLECTANCE
Floor	Carpet/Rubber	RBT-3/CPT-1	Dark color carpeting on 2-color rubber finish	0.3, 0.7
Wall	GWB/Glass	PT-1,2,4	5/8" GWB, 6" Mtl. framing furring wall/ Dorma Moveo moveable wall	0.94, 0.6
Ceiling	Timber, Acoustical Panel	PT-1	Exposed beams, acoustic panel	0.8

Existing Furnishing

The room has a long conferencing table in the center surrounded by 24 roller chairs. There are two doors accessible to the room and a projection screen on the southern side wall.

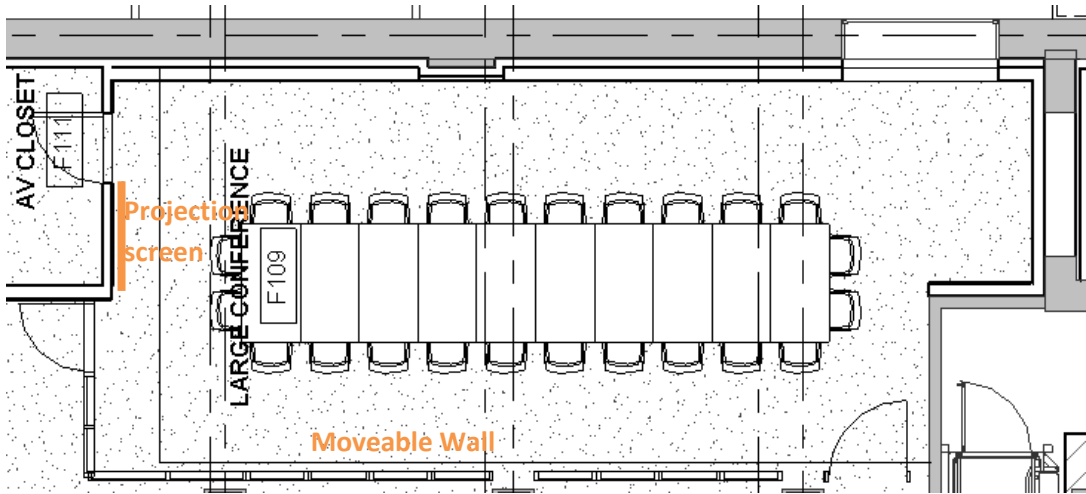


Figure 2.5-Conference room plan with furnishing

EXISTING LIGHTING

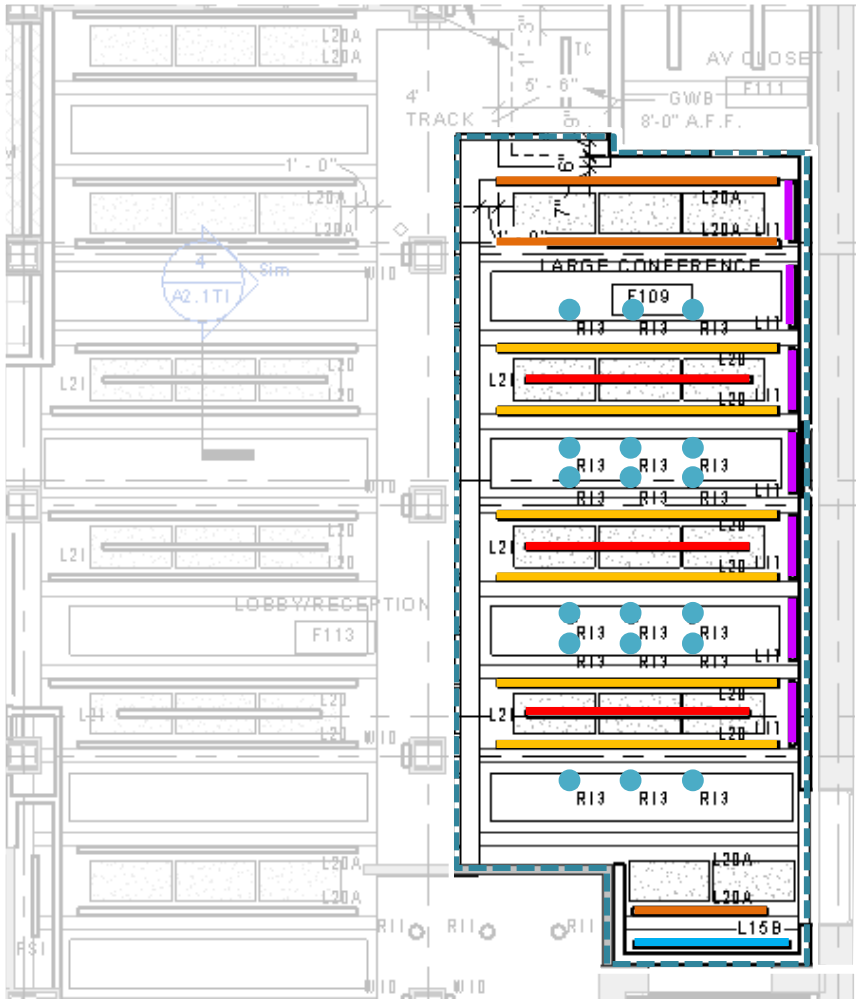


Figure 2.6 -Lighting plan

Table 2.2-Lighting schedule

Type	Quantity	Description	Manufacturer	Model	Lamp	Watt	Volts
L20	6	Surface-mounted continuous linear RGB-LED dimmable 125"x120' cove uplight with integral line-voltage driver	Color Kinetics PHILIPS	123-000018-01	RGB LED	13	120
L20A	3	Surface-mounted continuous linear white-LED dimmable 110"x110" cove uplight with integral line-voltage driver	Color Kinetics PHILIPS	523-000004-14/523-000005-06	2700K LED	6	120
L21	3	Pendant-mounted continuous linear white-LED dimmable downlight with flush frosted acrylic lens and narrow-profile extruded aluminum box housing	Lightolier PHILIPS	MICROSQUA RE MS-3-N-L-L-PC-12-J-U-A	3000K LED	38	277
L15B	1	Wall-surface-mounted horizontal continuous linear fluorescent dimmable one-lamp in cross-section T8 strip with narrow-profile housing, concealed behind architectural valance detail	Day-Brite PHILIPS	TN-1-32-277	3500K LED	32 or 25	277
L17	7	Surface-mounted continuous linear white-LED dimmable 10"x60" grazer with integral line-voltage driver, concealed in architectural detail	Color Kinetics PHILIPS	523-000065—08	2700K LED	12.5	277
R13	18	Recessed 1.75-in diameter white-LED dimmable downlight with diffuse parabolic reflector and flange, 25 degree beam spread, and 400-lumen output, integrated into chilled sail extensions	Lightolier PHILIPS	C2L-04-DL-30K-25-R-1 + C2L-DL-CCD-P	3000K LED	11	120

Light Loss Factor

All the lighting fixtures are LED products. Assumptions are made for LED LLF=0.7.

2.2 Design Criteria & Consideration

The large conference room is designed to be able to serve multiple purposes, such as meeting, AV, presentation, exhibition function. And by removing the moveable wall, the conference room and the upper lobby can form a joint large area for more potential usage. This particular characteristic of the space requires the lighting design to be able to change with different scenes or conditions. Therefore flexibility is a very important issue in lighting design as well as the control system to adjust the flexibility.

The main purpose of the space is conferencing, so both horizontal illuminance for writing/reading and vertical illuminance for face rendering are very critical in this space. In addition, due to the special usage of this space, multi-scene control devices shall be applied.

IES Handbook Ed.10 Illuminance Recommendations

Table 2.2-Illuminance criteria

Surface/Purpose	Eh	Ev	Avg:Min
Meeting	150	75	1.5:1
AV	30	30	
Front-screen projection		50	
Faces	300	400	1.5:1

ASHRAE 90.1 (2010) Requirements

Lighting Power Density = 1.23 W/sf

2.3 Lighting Evaluation

The same model is used for the lobby is made to evaluate the lighting design. And luminaire ies files are imported into the large conference room to run the calculation.

3. Open Office (3rd Floor)

3.1 Existing Condition

The open office on the third floor takes up most of the floor area. It's a narrow rectangular shaped area locates in the center of the floor space. This open office space is surrounded by private offices and labs, except on the building east side. The east side of the open office area is directly against the exterior wall which has three big windows with shading system. A small conference room with complete glass partition is on the west side of the office area right in front of the 3rd floor reception area. The private offices and labs are located along the outer side of the floor, most with glass front facing the open office area. And the cafeteria is by the reception area on the west side corner.

Room Dimension

102' x 33' 8"

Room Finishing/Glazing

Table 3.1-Surface material

SURFACE	MATERIALS	FINISH	REFLECTANCE
Floor	Rubber	RBT-1,2,3	0.3, 0.7
Wall	GWB Glass	PT-1,2,3,4	0.94, 0.5
Ceiling	Exposed timber beam, Acoustical panel	PT-1/AC T-1	0.8

Existing Furnishing

Two different types of cubicles are placed in the room center into two groups. See figure3.1 furnishing floor plan for detail layout. There are shelves on the on the stair wall and clothe racks on the other side of the small conference room across from the bathrooms.

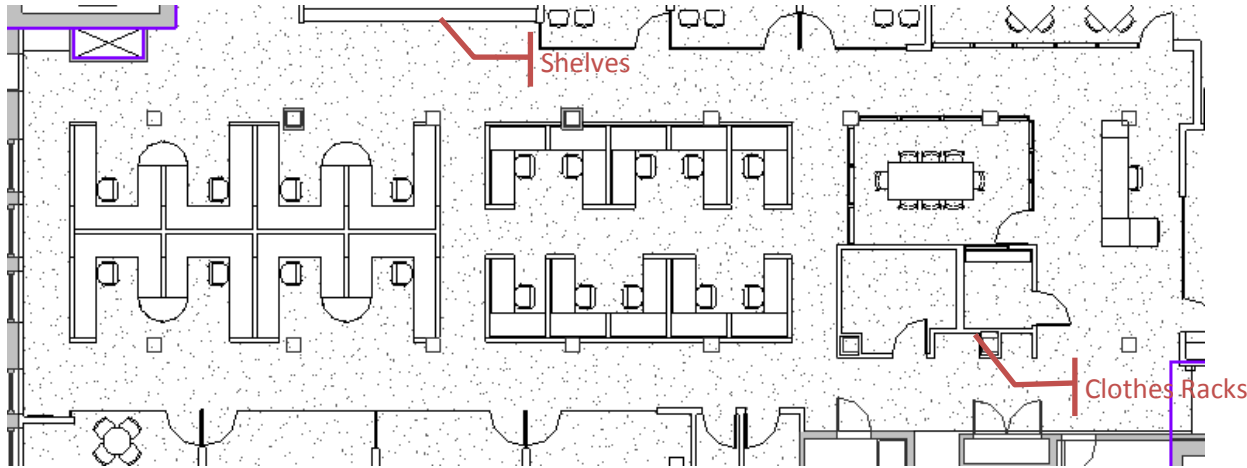


Figure 3.1-Existing furnishing plan

EXISTING LIGHTING

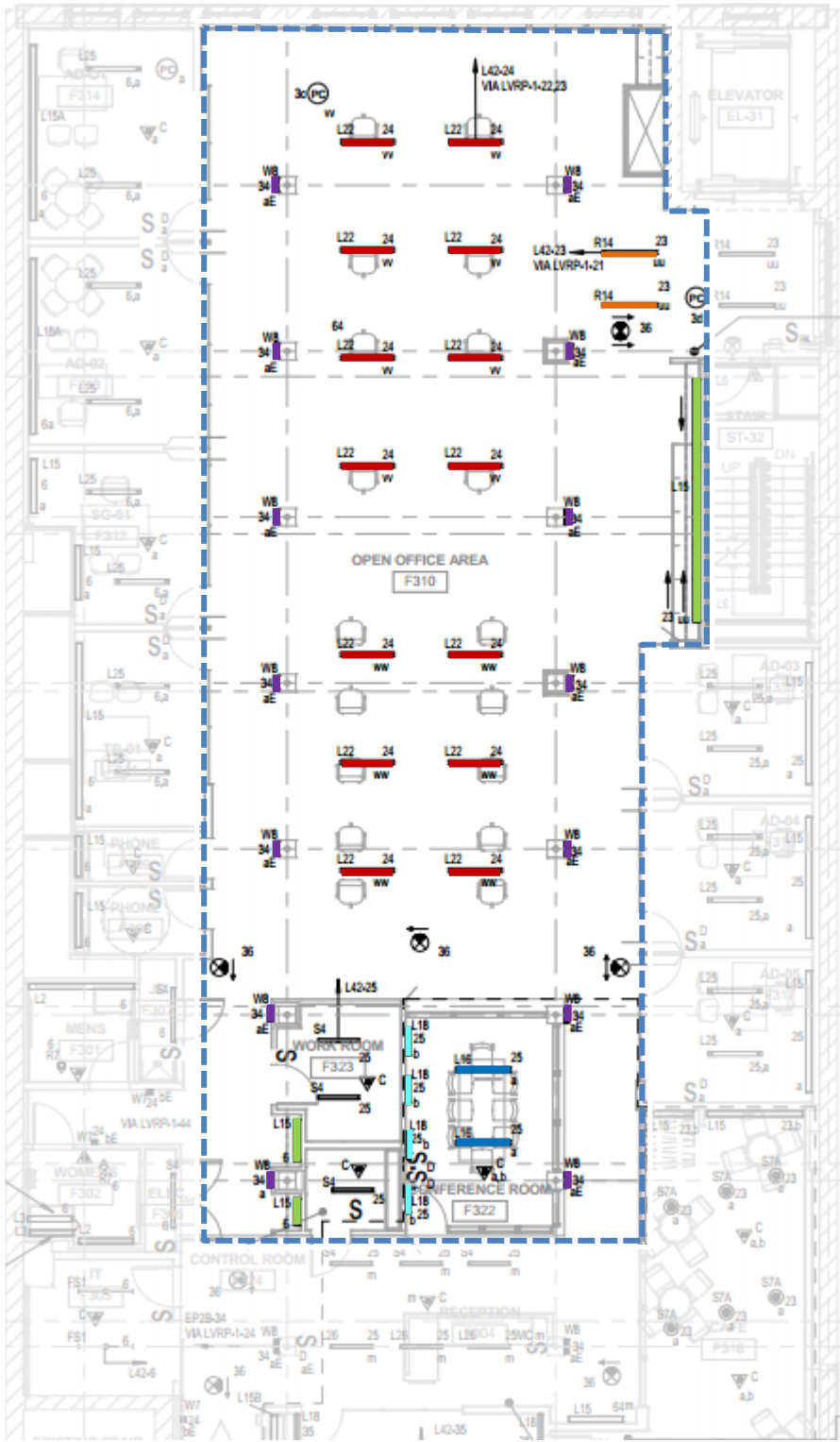


Figure 3.2-Existing lighting plan

Table 3.2-Lighting schedule

Type	Quantity	Description	Manufacturer	Model	Lamp	Watt	Volts
L22	14	Pendant-mounted linear fluorescent dimmable 2-lamp T5 direct-indirect fixture	Lightolier PHILIPS	AG-T-4-P-WH-DN-2-28-UNV-DA + AG-ER-24-W-W-UNV-DN + AG-AV-24-W + AGOG	T5 (2)	28	120/277
W8	14	Wall-surface-mounted white-LED non-dimmed direct-indirect wall-sconce in custom metal enclosure w/ curved solid metal shield and maximum 4-in depth	Terralux	L-04-B-04-30-12-[OPTIONS]-[2 UNITS] + 625-14"-W-[LED RETROFIT]-[VOLT]-[FINISH-MOD	3000K LED	13	120
L15	3	Wall-surface-mounted horizontal continuous linear fluorescent dimmable one-lamp in cross-section T8 strip w/ narrow-profile housing, concealed behind architectural valance detail	Bartco OSRAM SYLVANIA	MIT8-1T-[LENGTH]-UNV-DIMMING	T8	32/25	277
L16	2	Pendant-mounted continuous linear white-LED dimmable downlight w/ texture frosted lens, perforated housing and sculpted end-caps	Ledalite PHILIPS	1201-LAB-Q-[UPPER POTICS]-[LENGTH]-[WIRING]-2-E-[FINISH]	3500K LED	38	277
L18	4	Surface-mounted continuous linear white-LED dimmable 125"X120" cove uplight w/ integral line-voltage driver, concealed in architectural detail	Color Kinetics PHILIPS	523-000050-17	2700K LED	12.5	277
R14	4	Recessed 4-in-wide linear fluorescent dimmable one-lamp T5 downlight w/ flush frosted acrylic lens, 4ft unit, integrated into chilled sail extensions	Lightolier PHILIPS	CT3-F-L-A-S-4-U-2-[OPTION]	T5	28	277

3.2 Design Criteria & Consideration

The open office is a work space. So uniformity is one of the most important issues that will affect the lighting performance. Also, energy is a very important factor of a good lighting design. As for a company like Fraunhofer that dedicates into energy saving building technology, it is especially crucial to present a very environmentally friendly lighting/control system. Smart lighting system with dimmable luminaires and automatic control system need to be used. The control system should be able to automatically adjust light level according to vacancy status and daylighting condition as well as automatically shut lights off when necessary according to codes.

IES Handbook Ed. 10th Illuminance Recommendation

Table 3.3-Illuminance criteria

Surface/Purpose	Eh	Ev	Avg:Min
Work plane (computer)	150	50	1.5:1

AHSRAE 90.1 (2010) Requirement

Lighting Power Density Allowance = 0.98 W/sf

Control Requirement:

- Automatic shutoff control device is required to shut off building lighting in all spaces
- Automatic control device is required to manually turns light on or automatically turns light on to 50%
- Multi-level control is required to have at least one control step between 30% and 70% of full lighting power in addition to all off
- Potential auto daylighting control for primary sidelighted areas is required if the combined primary sidelighted area in the space is equal or exceeds 250sf
- Additional lighting control for special purposes and multi-scene control will be needed if applicable

3.3 Lighting Evaluation

The existing lighting design for the open office is simple yet efficient. The linear pendant light fixtures are uniformly placed above the working area according to the layout of the seats. The luminaires are direct-indirect fixtures which will provide the space a more evenly distributed lighting environment without causing too much direct glare. The luminaires house dimmable fluorescent lamps that allow the fixture dim and adjust the light level accordingly. Wall surface-mounted direct-indirect wall sconces are placed on every column in the office facing out from the actual working area. Those light not only provide illuminance to the walk paths around the cubicle space but also create more depth of light in the space.

Wall surface-mounted linear lights are placed where cabinet and shelves locate. Those luminaires serve as special functional light as needed in particular areas.

The clear conference room used two other types of fixtures to lighting up the room. Pendant LED light fixtures are used as ambient light. And cove lighting is used on the one side that is not a clear glass wall to help providing the space a little more reflectance and distinguish it out from the outer office area.

4. Façade—west

4.1 Existing Condition

The project is a renovation project of a 100-year old historical building of six-story, three-bay loft brick structure with classical revival-style detailing. The Fort Point Channel district is marked by an exceptional degree of visual uniformity. Fraunhofer Building, one of the buildings in the Fort Point Channel area, is not an exception of a loft structure built in 1913 by the Boston Wharf Company, and represent an unusually coherent and well-preserved collection of late 19th and early 20th century lofts that reflect a critical period of social, economic, and physical development in the City and the region. The loft buildings are generally masonry, with simple volumes and flat roofs. Buildings are elegantly proportioned, with classically inspired details concentrated at entrances and cornices. And the structure is left unchanged in this project to conserve the significant continuity throughout the District in terms of massing, scale, and style. In this project, the majority of the structure has been left almost unchanged, especially the façade. Besides the new entrance is more modernized after the renovation, almost the entire of the building façade remain exactly the same as it is about 100 years ago. The façade is mainly made of red bricks with mainly two window types taking up the façade wall.

Building Dimension

75' x 61' 8" (Height x Width), 6 story, two front entrances

Building Façade Finishing/Glazing

Table 4.1-Surface material

SURFACE	MATERIALS	DESCRIPTION	REFLECTANCE
Ext. Wall	Bricks, masonry window	Salvaged existing red color bricks	0.26

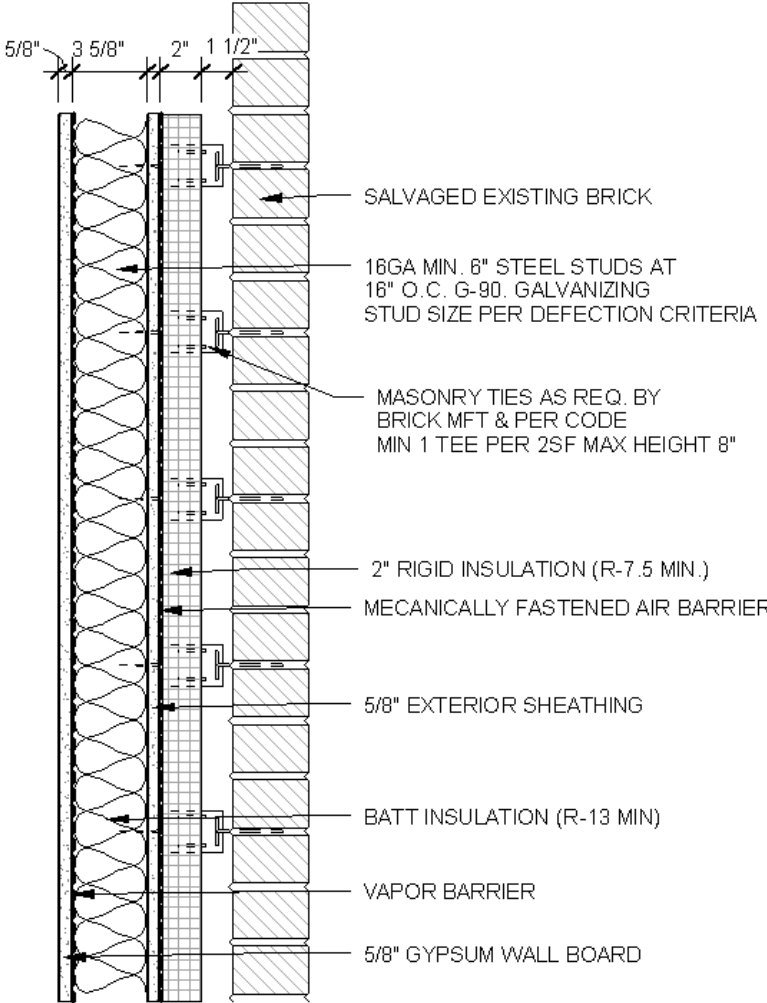


Figure 4.1-Exterior wall section



Figure 4.2-West elevation

EXISTING LIGHTING

The building is not employed any special exterior lighting fixtures for the façade. The author is not able to provide existing lighting condition summary for this area (surface).

4.2 Design Criteria & Consideration

Façade being an important part of architectural lighting design is usually for the reason that it plays a big role in advertising the architectural features of the building by highlighting the beauty of the structure and/or façade, and also improving the company image. In this project, the hundred-year old building façade was preserved almost entirely. The lighting design should help emphasizing the massing and proportion of the building structure. At the same time, the lighting design shall bear the idea in mind that the company is dedicates in researching energy saving building technology products. So eco-friendly fixtures and design concept should also be a primary consideration.

IES Illuminance Recommendations

Façade with reflection < 0.5 and low activity: $E_v = 40$ lux

ASHRAE 90.1 (2010) Requirements

- **Building entrances and exits:** main entries = 20W/linear-ft of door width
- **Façade:** 0.1W/sf for each illuminated wall or surface or 2.5 W/linear ft for each illuminated wall or surface length

4.3 Lighting Evaluation

No existing lighting design for the building façade, therefore no evaluation can be provided at this point.

