



## Section 06: ASHRAE Std. 92.1-2004 Lighting Power Density Breadth

### 6.01: Purpose and Background

The purpose of ASHRAE Standard 90.1-2004 is to provide minimum requirements for the energy-efficient design of buildings. In the second technical assignment, an analysis was done on the lighting system to determine whether or not the Hauptman-Woodward Medical Research Institute was compliant with the standard. Since there are no provisions for a laboratory mixed-use building, the building area method was not used in the calculation of the total power density at HWI. Instead, the space-by-space method was utilized as prescribed in Section 9 of ASHRAE Std. 90.1-2004. Building area types were taken from Table 9.6.1 of the standard. For a complete breakdown of the lighting power density of each space at the Hauptman Woodward Institute, consult Appendix B-1.

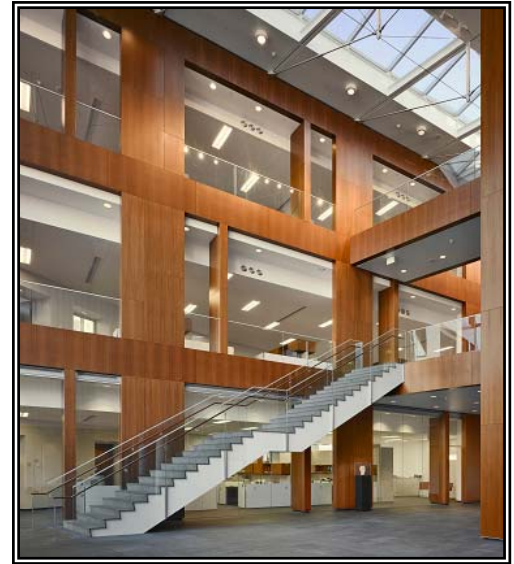


Figure XLIII: Atrium Task and Accent Lighting

### 6.02: Lighting System Redesign

After completing the power density calculations in the second technical assignment, it was determined that a majority of the spaces outside of the laboratory area did not comply with Standard 90.1-2004. There could be many reasons for this to be the case. First and foremost, the Standard has changed since the last revision in 1999, and could account for some discrepancies. In addition, many of the spaces within the Hauptman Woodward Institute have redundant lighting systems that provide architectural merit to the building. Upon inspection, each lighting system is switched independently, which allows for the building occupants to monitor the light output at any one time. Upon further inspection of Standard 92.1-2004, I discovered that there is a provision in section 9.6.3 that discusses the increase of the interior lighting power allowance. It states:



9.6.3 (a) An increase in the interior lighting power allowance is permitted for spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance, such as chandelier-type luminaires or sconces, or for highlighting exhibits, provided the additional lighting power shall not exceed 1.0 W/ft<sup>2</sup>. (Taken from ASHRAE Std 92.1-2004, Copyright ASHRAE)

After going through each space and applying this provision where appropriate, it appears that many spaces still do not pass the requirements of Standard 92.1-2004. The provision did help substantially in many areas, including the atrium, individual offices, seminar and classrooms, and other high-profile areas. The first step of the redesign is to determine how to reduce power consumption without sacrificing lighting quality. Since only a handful of spaces in the laboratory core were above the power allowance, I decided to keep those spaces as is, since there are no specific provisions for the work that is being done at HWI and there could be reasons why these areas have excess lighting requirements. However, in the South and West wings, there is plenty of room for improvement.

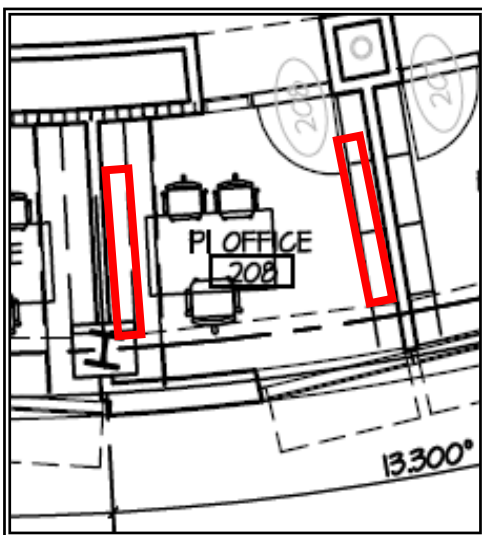


Figure XLIV: Typical Office Space (120

For example, a typical office at the Hauptman-Woodward Institute is approximately 120 square feet, and contains two indirect fixtures, as shown in Figure XLIV. Each fixture is equipped with 2x F39 T5 lamps which brings the total power density to the space to 1.3 W/ft<sup>2</sup>. If the lamps were replaced with 2x 28W T5 lamps designed to work in the same ballast, then the new power density of the space would be 1.07 W/ft<sup>2</sup> while only sacrificing 7% lumen output. This data is shown in the following, Table XLV.

	Lamp	Watts	Length	Lumens (25°C)	2 lamp Fixture
Original	39W T5	39W	45.2"	3100	78W
Retrofit	28W T5	28W	45.2"	2900	58W

Table XLV: Original and Redesign Lamp Choices for Office 208.



This change reflects all of the private office spaces, and has been adjusted accordingly. In addition to the office space, the second area of main concern was the Seminar and Lecture spaces. These spaces have very high lighting loads to do decorative fixtures, as shown in Figure XLVI. According to the initial ASHRAE 90.1 Analysis done in the second technical assignment, the larger lecture hall currently has a power density of 3.25 W/ft<sup>2</sup>. According to Standard 90.1-2004, the space is allotted 2.75 W/ft<sup>2</sup>, in accordance with the provisions for decorative lighting (+1.0 W/ft<sup>2</sup>) and visual display lighting (+0.35 W/ft<sup>2</sup>). Each fluorescent fixture is equipped with 2x F3239 T85 lamps, and pendant fixtures are fitted with 2x CF26W bulbs.

After researching the different bulb-type alternatives, it was not cost-effective to replace the bulbs with lower watt-bulbs due to the higher initial cost. The first cost of a typical 32W T8 lamp is approximately \$2.68. In comparison, an energy-saving 28W T8 lamp costs approximately \$11.65, as found on the Osram-Sylvania website. Since the building is already complete, I would recommend that the space be left untouched; however if the building still had been under construction, I would have recommended the removal of a handful of the pendant fixtures, as the remainder of them can achieve the same task while conserving energy.

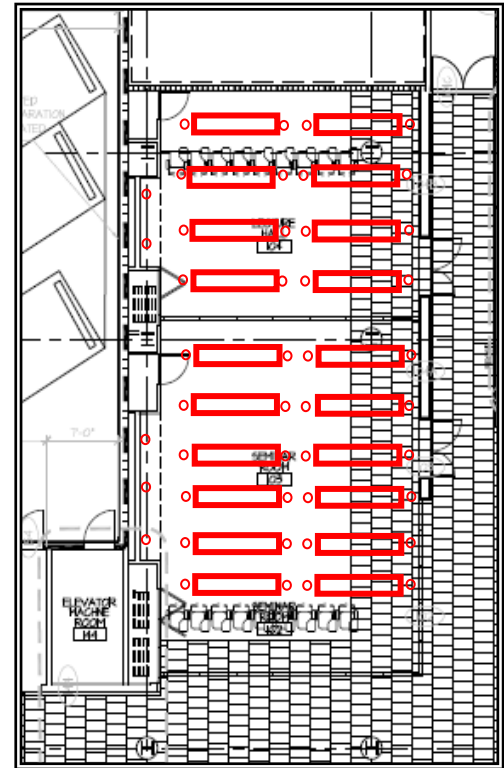


Figure XLVI: Seminar and Lecture

### 6.03: LPD Redesign Conclusions

After these major spaces were addressed, it was found that all were in compliance with the standard. The only exceptions were corridor and storage spaces, as shown in Appendix B-2.

A quick check of the total building power density shows that the building indeed has an acceptable amount of energy used for lighting. The total output is approximately 1.33 W/ft<sup>2</sup>, as compared to the original design of 1.46W/ft<sup>2</sup>, a reduction of approximately 9%. This reduction in energy will in turn reduce annual energy use and therefore reduce annual electric costs and emissions.



It is important to note that most of the wattage from building lighting will end up as sensible heat that will in turn be removed by the building mechanical system. We can estimate that 98% of the input wattage will result in heat that must be removed. Therefore, with a drop of 35,350 Btu/hr, the lighting redesign reduces the building cooling load by 2.97 tons, as shown in Table XLVII.

	W	LPD	Btu/hr
Original	108,040	1.46	368,653
Redesign	97,680	1.32	333,302
Difference			35,351
			<b>2.95 ton</b>

Table XLVII: Reduction in Cooling Load  
due to Lighting Redesign