Appendix O : Architectural Lighting Report

STATE OF WYOMING

JOINT LEGISLATIVE AND EXECUTIVE TASK FORCE

DEPARTMENT OF ADMINISTRATION & INFORMATION
CONSTRUCTION MANAGEMENT

WYOMING STATE CAPITOL
REHABILITATION & RESTORATION

LEVEL I /LEVEL II

ARCHITECTURAL LIGHTING REPORT

PREPARED BY

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FOR

HDR

IN ASSOCIATION WITH

PDP
Preservation Design Partnership, LLC

AND

PLAN ARCHITECTS

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CONTENTS – Architectural Lighting

This documents the assessment, research, findings, and strategies on architectural lighting for the Wyoming State Capitol Restoration/Renovation. This report was developed under the leadership of HDR Inc. and Preservation Design Partnership. Archival support from Wyoming State Archives was instrumental in the historical lighting review.

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O_Architectural Lighting Report_Final

O.01 Existing Conditions

The following is a report of existing lighting conditions at the Wyoming State Capitol. It also includes likely lighting conditions at key period[s] in the Capitol's past and design guidelines and strategies for the restored, renovated, and, if necessary, new architectural lighting of the Capitol.

The effort for this report commenced with a week-long site visit commencing April 7, 2013. Materials used for the development of this report included project construction and specification documentation of prior work at the Capitol since its Phase 1 completion in 1888, historic photographs, and other documents related to the history of the Wyoming Capitol and to lighting criteria and techniques. Much of the historical documentation was made available by the Wyoming State Archives. Reference to extant Phase 3 lighting equipment is variously cited as 1916 (date of order/manufacture) to 1918 (date of completion) depending on context.

The over arching premise of this report is to guide a comprehensive restoration of this National Historic Landmark. This will set the stage for developing lighting recommendations that, at least in part, respond to a historical sense of architecture, space, and light. To this end, it is necessary to have an understanding of existing lighting conditions, historical lighting conditions (original and/or key modernizations or expansions), present–day lighting criteria and infrastructure givens which can be used in the development of recommended lighting strategies for future work at the Capitol.

Existing lighting conditions are comprised of two major categories, daylighting and man-made lighting. Additionally, since architectural surfaces play a significant role in spatial brightness perceptions and in the distribution of light, an overview of the lighting characteristics of existing architectural surfaces is worth noting.

O.01.01 Terms of Reference

Many of the terms encountered here are commonly understood. Several, however, may have different meanings to different readers and are, therefore, defined here in the context of this report. Definitions of many terms can also be found in *Appendix O1*.

Conventions

Lighting and dimensional metrics are reported throughout in US Customary. Many lighting references today use SI or metric units. *Table O.1* offers a list of conventions typically used in the States as well as SI equivalents. A more complete glossary of lighting terms is in *Appendix O1*.

Historical Context

For purposes of this report, the origins of the Capitol date to 1888. Architectural daylighting techniques and man-made lighting techniques of the late 19th century will to play a role now, as they did then, in the development of lighting for the restoration, renovation, and, if necessary, new work at the Capitol.

Daylighting

Architectural lighting enhances the perception of architectural space, allows for functional occupancy, and is integrated mechanically into the architecture. Many times, architectural lighting provides some sense of place by lighting the envelope of a space. When done carefully, architectural lighting offers a near–subliminal backdrop against which visual tasks occur – tasks such as facial recognition, text recognition, and other 2D and 3D object and graphic recognition, while simultaneously clarifying and enhancing architectural surfaces, forms, and space. Many historic structures originally used daylight as a primary source of architectural lighting. Façade (windows) and overhead (skylights/lanterns [aka laylights]) fenestration historically provided sufficient light to accommodate many of the functions in the Capitol during daylight hours. Due to cost, maintenance, and a general reverence for conserving resources, man-made lighting was typically reserved for darker-day, later-day and nighttime functions.

Man-made Lighting

For most lighting projects undertaken currently, man-made lighting is solid state (LED) and/or fluorescent electric lighting. However, in the historical context at the Capitol, man-made lighting consisted primarily of filament (incandescent) lamps. The decreasing cost of electricity, greater availability of inexpensive lamps and low labor cost to install and replace lamps fueled architectural integration of electric light, particularly in the period from 1910 to 1960. Man-made lighting was carefully integrated at the Capitol to functional and aesthetic effect during all three construction phases as evidenced by plans, specifications, and photographs. This lighting allowed the branches of Wyoming government to conduct business into the night.

O.01.02 Existing Interior Lighting Conditions

This discussion on existing conditions is based on the author's site visit to survey the facility with and without other project team members. A photographic record was made relating to lighting conditions and effects and to lighting equipment. A cursory record was made of light levels (illuminances) during daytime and nighttime hours to assess the existing daylighting and electric lighting conditions. Some lamping information was recorded to assist with later resolutions involving scale, size, and potential lamping (for purposes of light output, distribution, and energy use).

A fair amount of the existing lighting equipment in public areas is historical. Further, it appears that a reasonable cache of original plans and specifications are available concerning specific lighting details and equipment. This is significant and fortuitous for restoration and re–creation.

Overview

Most interior areas of the Capitol were surveyed. Detailed study was reserved for spaces of historical significance and where lighting effects and equipment offer some semblance of historic quality or where public access is encouraged. So, for example, typical office spaces, committee rooms, and lounges were not reviewed in detail. Lighting in many of these areas is of the typical mid-to-late-twentieth century variety of ceiling suspended wraparound lensed fluorescent luminaires and ceiling-recessed flat-lensed fluorescent luminaires. This lighting is neither historically significant nor current practice.

Table O.1. Conventions[1]

Metric	US Customary
Color Temperature[a]	K (Kelvin)
Illuminance	footcandle (fc)
Lighting Power Density (LPD)	watts/ft^2
Luminance	candelas per square foot (cd/ft^2)
Power	watts (W)
Temperature - Thermal	°F (Fahrenheit)

Footnotes

[a] Used in lighting as the temperature metric of heat necessary to achieve visible radiation from "black body radiators" such as a block of iron.

Daylighting

In this era of seemingly abundant electric light where uses relate less to time of day, fenestration at the Capitol has been reduced to being little more than a souce of exterior views. Reintroducing the skylights at the chambers in recent years was a significant positive step. The stair light wells were apparently, and unfortunately, covered in the 1970s work.

Man-made Lighting

Electric light is used throughout the Capitol to provide both decorative and functional light. Some of it dates to the Phase 3 work completed in 1918. Fluorescent light, clearly from the period of the last major work of the 1970s, is the primary electric light source. In the extant historic decorative luminaires, compact fluorescent lamps (CFLs) have replaced the earlier tungsten filament lamp type. With the exception of these CFLs, the fluorescent lighting exhibits color temperature (whiteness) and color rendering properties that are considered less than desirable for both an historic landmark and class A office space today.

O.01.03 Architectural Finishes

Visual perception and performance results from luminance (brightness) contrast and/or chromatic (color) contrast – the interaction of light with surface finishes and textures. Therefore, architectural finishes play a major role in contributing to visual and subjective perceptions, task performance, and lighting efficiency. Architectural finishes also serve to establish the extent and degree of visual detail intended in the original design and provide visual cues about the likely period of architecture and interiors. Many of the modern finishes and materials in the Capitol now are relatively monochromatic and efficiently pale.

O.01.04 Space-by-space

Key lighting parameters, including light levels and light sources found in prominent spaces today, and brief assessments are outlined in tabular form on pages O.3 through O.6. For this review, the interior of the Capitol is divided into the following areas: House, Senate, Governor's Suite, Rotunda and Public Circulation, Supreme Court Conference Room, and Other Areas.

House of Representatives

The House of Representatives is in the east wing of the Capitol on Floors 2 and 3. The lighting in this Chamber is quite serviceable for legislative functions. However, the upper perimeter of the room has a dingy appearance, perhaps exacerbated by the harsh and directional light from modern downlights. The distribution of the downlighting diminishes the historical character. In contrast, daylight is consistent with the historical character. It also provides an impression of brightness, imparting of a wonderful glow of the stained glass lantern, but contributes less to the task light at desks.

A recently-installed system of opal "greenhouse" protective diffusing panels just above the backside of the stained glass lantern acts as dust covers and accommodates periodic cleaning from a movable catwalk-like platform while reducing risk of damage to the stained glass. The protective covering above the stained glass may diffuse daylight too well. This combined with the skylight and stained glass transmission properties and the unfinished nature of the interstitial attic, modulates daylight too aggressively. At night, a series of ceramic metal halide PAR-lamp trackheads arranged on tracks mounted just below the skylight backlight the lantern, but little functional light is provided. *Figure O.1* illustrates night and daytime lighting conditions of the House lantern.

Table O.2 outlines existing lighting conditions in the House Chamber. *Lighting Attributes* identifies quantitative and qualitative aspects; *Luminaires* identifies types and features of luminaires and lamps found; and *Assessment* summarizes key findings. Photographs illustrate lighting effects and equipment in various spaces.

Chamber chandeliers are extremely difficult to access for cleaning and relamping. Currently, scaffolding or a rolling ladder brought in through the basement is used on roughly a 2-year cycle for group relamping and cleaning.

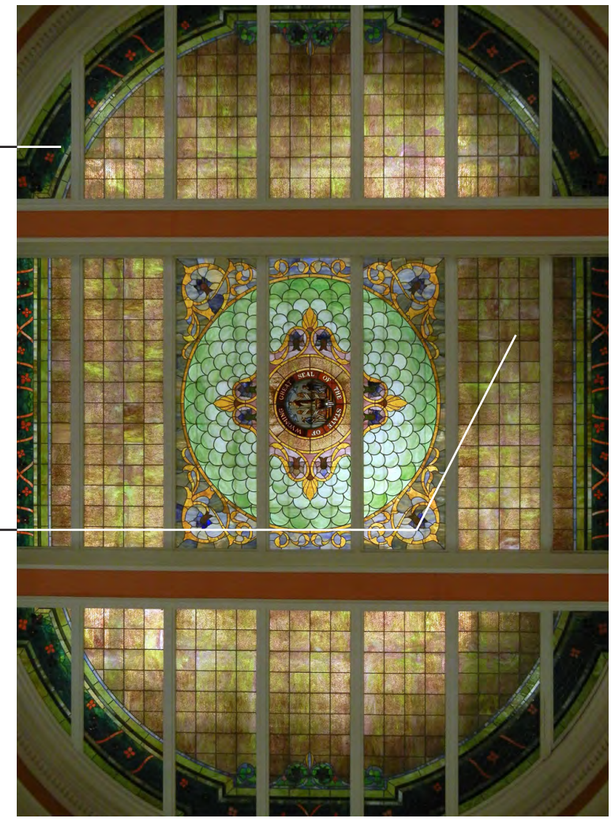
Significant historical lighting remains in place in public areas of the House of Representative dating to 1918 and can be attributed to the Beardslee Chandelier Manufacturing Company (Beardslee) based on historic specifications, plans, and photographs. Period detailing on most of the historic luminaires is intact.

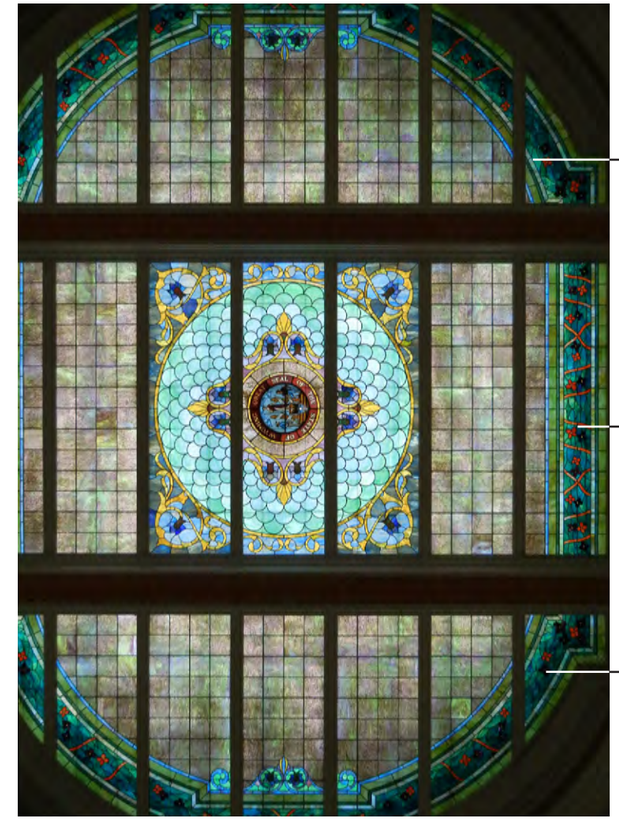
Senate

The Senate Chamber is in the west wing of the Capitol on Floors 2 and 3. The lighting in the Senate Chamber is very similar to that found in the House and is quite serviceable for legislative functions. Unlike the House,

Edge aberrations in light levels, sometimes considered appropriate for museum-quality presentation of art and artifacts, detract from the contribution of the lantern to the overall architectural composition.

Aiming, lamp beam spread and coverage, or burnouts appear to contribute to curious bright and dark patterns.





Edge aberrations in light levels are evident but less obvious than at night.

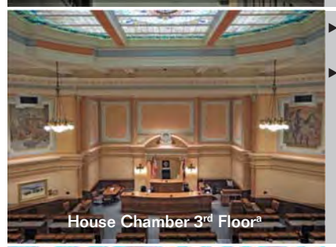
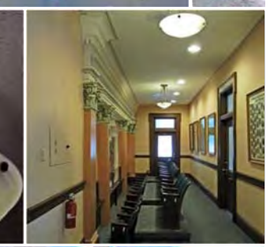
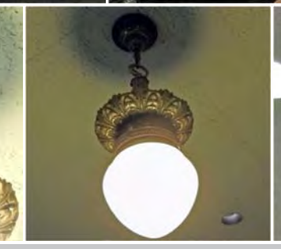
Coloration and detail are vibrant and clear where daylight access is unimpeded.

The catwalk may contribute to some marginal edge aberrations in light levels.

Figure O.1. House Chamber Lantern – Nighttime Electric Accent Lighting (left) and Daytime Daylighting (right)

The historic stained glass lantern is electrically lighted for nighttime effect (left) with a museum-like presentation. Little functional light is provided by this approach. Daylighting of the historic stained glass lantern (right) provides some basic-to-moderate functional light depending on season, time-of-day, and sky conditions. During the day, the lantern is more fully illuminated and contributes to the chamber's historic architectural composition and character. The maintenance platform is "parked" at the east end above the lantern and does not appear to cause shadowing.

TABLE O.2. LIGHTING CONDITIONS AND ASSESSMENTS: HOUSE OF REPRESENTATIVES PUBLIC AREAS

Space	Lighting Attributes	Luminaires	Assessment		Figures numbered from far left to right:
 House Chamber 2nd Floor[a]	▶ 10 to 18 fc on circulation floor ▶ Chamber illuminances ▷ daylighting only (representative) • 2 to 4 fc @desks, 8 a.m. cloudy • 10 to 16 fc @desks, 10:30 a.m. ptly cloudy ▷ electric ambient lighting only (representative) • 25 to 60 fc @desks, max ambient scene • 105 to 130 fc @dais w/17 fc vertical ▷ electric task lighting only (representative) • 50 fc @desks	▶ Historic incandescent decorative luminaires ▷ retrofitted with non-dim CFLs ▷ very good condition for age (ca. 1918) ▷ CFLs create more diffuse, flat appearance ▶ Circulation downlights retrofitted w/non-dim CFLs ▶ Modern quartz halogen downlights and accents ▷ 400W T4 minican lamps; 100W PAR38 lamps ▷ dimmable ▶ Modern fluorescent tasklights ▷ T2 linear lamps, non-dim, locally switched	▶ Illuminances satisfactory for typical legislative functions ▷ brightnesses flat and uninspiring; upper area dingy ▶ Downlight and accent strategy arguable ▷ obvious and distracting modern intrusion ▶ Tasklights create reflected glare ▷ polished stone desk top is unforgiving ▶ Lantern/skylight electric light strategy arguable ▷ provides aesthetic glow w/o functional light to chamber ▶ Preset controls provide some functional range ▷ existing "Interim" scene excludes downlights	  	**O.2, O.3, O.4, O.5**
 House Chamber 3rd Floor[a]	▶ 5 to 12 fc on circulation floor ▷ daylight estimated to contribute 1 to 2 fc ▶ 9 to 36 fc on stair treads ▷ daylight estimated to contribute 1 to 25 fc	▶ Historic incandescent decorative luminaires ▷ retrofitted with non-dim CFL lamps ▷ very good condition for age (ca. 1918) ▷ CFLs create more diffuse, flat appearance ▶ Circulation downlights retrofitted w/non-dim CFLs	▶ Illuminances satisfactory ▷ brightnesses very flat and uninspiring ▶ Downlight strategy arguable ▷ obvious and distracting modern intrusion	  	**O.6, O.7, O.8, O.9**
 House Chamber Laylight/Skylight[b]	▶ No illuminance measurements made ▶ Fluorescent linear work lights ▷ basic maintenance lighting ▶ Metal halide nighttime lantern fill ▷ lantern backlighting for aesthetic effect ▶ Full top glazing skylight over lantern ▷ introduces daylight ▶ Translucent polycarbonate lantern dust cover ▷ facilitates cleaning while reducing damage risk	▶ Fluorescent linear work lights ▷ bare striplights • independently switched on/off locally ▶ Metal halide fill lights ▷ strategically placed/aimed trackheads • ceramic metal halide PAR30/PAR38 • switched on/off via house preset system ▶ Glazing and polycarb skylight/lantern system ▷ transmittance greatly limits daylight availability ▷ diffusion further diminishes daylight and dazzle	▶ Illuminances satisfactory for day time maintenance ▶ Fluorescent striplight strategy arguable ▷ not placed consistently around perimeter ▷ no lamp protection provided ▷ not tied to vacancy sensors ▶ Metal halide strategy arguable ▷ provides aesthetic glow w/o functional light to chamber ▶ Glazing and polycarbonate selections might yield $\tau^c < 0.05$ ▷ with stained glass total τ^c might be < 0.007 ▶ Dark walls/voids and structure diminish effect of daylighting	 	**O.10, O.11, O.12**
 House Lobby 2nd Floor[d]	▶ 6 to 8 fc on circulation floor (all lights energized) ▶ 35 to 58 fc on desk ▶ No daylight access ▶ 3rd Floor Lobby serves as circulation ▷ 3 to 4 fc on circulation floor	▶ Historic incandescent decorative luminaires ▷ retrofitted with non-dim CFL lamps ▷ very good condition for age (ca. 1918) ▷ CFLs create more diffuse, flat appearance ▷ 3rd floor luminaire exhibits substitute globe ▶ Circulation downlights retrofitted w/non-dim CFLs ▶ Modern fluorescent tasklights ▷ T2 linear lamps, non-dim, locally switched	▶ Illuminances satisfactory for typical legislative functions ▷ brightnesses flat and uninspiring; upper area dingy ▶ Downlight and accent strategy arguable ▷ obvious and distracting modern intrusion ▶ Tasklights create reflected glare ▷ polished stone desk top is unforgiving	  	**O.13, O.14, O.15, O.16**
 House Historic Luminaires	▶ Medium screwbase sockets ▶ Diffuse light ▶ Not dimmable	▶ Historic equipment appears to date to 1918 ▷ quality opal glass diffusers some diffuser breakage and replacements (e.g., ahistoric diffuser in right middle image) ▷ cast or spun heavy gauge bronze and brass some components bent or out of plumb (e.g., left front cast arm in image at left) ▷ finishes appear stable and original ▷ most extant luminaires in very good condition ▶ Chamber chandeliers difficult to access	▶ Significant historic lighting in public areas ▷ original chandeliers/period detailing intact ▷ original pendants/period detailing intact ▷ original wall brackets/period detailing intact ▷ many appear to be in or near original locations ▷ some suspensions have been modified ▷ illuminances satisfactory ▷ brightnesses flat and uninspiring ▶ Some possible gas-pipe remnants ▶ Maintenance and preservation are apparent priorities	  	**O.17, O.18, O.19, O.20**

Footnotes
General - Most whole-room images are without flash. All images are enhanced for better clarity and reproduction and do not represent exact actual illuminated appearances.
[a] Photos and assessment on April 12, 2013, early-morning, partly cloudy to cloudy.
[b] Photos and assessment notes made on April 8, 2013, mid-morning, cloudy.
[c] τ is the symbol for transmittance.
[d] Photos and assessment notes made on April 12, 2013, mid-morning, cloudy, no daylight accessiblity.

the Senate presents a somewhat brighter, more lively appearance, perhaps attributable to the lantern configuration, the chamber finishes, and the 4-side-illuminated-gallery layout. The lighting distribution of the downlighting detracts from historic character. Daylight is consistent with the historic character. It provides an impression of brightness by imparting a wonderful glow to the stained glass lantern, but contributes less to task lights at desks.

A recently-installed system of opal "greenhouse" protective diffusing panels just above the backside of the stained glass lantern acts as dust covers and accommodates periodic cleaning from a movable catwalk-like platform while reducing risk of damage to the stained glass. Similar to the situation in the House, the protective covering above the stained glass may diffuse daylight too well. This combined with the skylight transmission properties, the stained glass transmission properties, and the unfinished nature of the interstitial attic, modulates daylight too aggressively. At night, a series of ceramic metal halide PAR-lamp trackheads on tracks mounted just below the skylight backlight the lantern, but, little functional light is provided. *Figure 0.21* illustrates night and daytime lighting conditions of the Senate lantern. The movable catwalk mechanism can only be parked in such a way that creates significant shadowing on the lantern.

Table O.3 outlines existing lighting conditions in the Senate. Similar to the House, the Senate Chamber chandeliers are extremely difficult to access for cleaning and relamping. Significant lighting dating to 1918 remains in place in public areas of the Senate and can be attributed to Beardslee based on historic specifications, plans, and photographs. Period detailing on most of the historic luminaires is intact.

Governor's Suite

The Governor's Suite is in the east wing on the south side of Floor 1. Although a few historic luminaires exist in the Governor's Suite, most lighting consists of 2 foot by 4 foot and 4 foot by 4 foot lensed and paracube louver recessed luminaires likely from the 1970s. The light levels in most areas are appropriate to task lighting, but are somewhat high for ambient (general) lighting for typical administrative and conferencing functions. In current practice, a low-to-moderate level of ambient lighting is supplemented with desk-mounted task lighting. The glare, institutional color-of-light, modern form-factors, lower ceiling heights, and acoustical tile ceilings neither befit the status of the office nor are historically sympathetic.

Table O.4 outlines existing lighting conditions in the Governor's Suite. Of the six historic luminaires in the suite, the two pendants in the ceremonial conference room most closely match the 1916 Chandelier Order[2] list from Beardslee (chandelier order) for a 9-socket, art glass chandeliers finished in brushed antique bronze (BAB) in "Gov. Private" space. These may be in or near original locations, but with shortened suspension lengths. Four other apparently historic luminaires currently in the suite are also likely Beardslee ca. 1918. Two of these are pendants similar (but likely originally 5-socket) to the 1916 Beardslee order for 4-socket, art glass chandeliers finished in BAB in "Gov. Business" space (of which four were originally purchased, so two are missing). Two others cannot be attributed to the 1918-Governor's Suite, but may perhaps be attributed to the 1916 Beardslee chandelier order for the rest of the building or to the 1937 work. Without original shop drawings and historic photographs of each space, certain attribution cannot be made. The three nickel-finished luminaires identified in the 1916 Beardslee chandelier order for the governor's toilet and the ante toilet are either missing or hidden above modern ceilings.

Governor's Portraits Gallery

To the east of the Rotunda on the 1st floor, a wide hall provides access to the Governor's Private Office and the Attorney General's Suite. This space, once grander with its original high ceilings and more ornate detailing, houses portraits of various Wyoming governors and an oversized bust of Lincoln. Light levels on the circulation path are serviceable. Perimeter recessed adjustable accents likely from the 1970s use 200W PAR56 incandescent lamps, and create ahistoric patterns of light. Aiming these lights on the artwork significantly overlights them, putting the artwork at risk of premature degradation unless they are rotated frequently. The downlights, intended for max wattage of 300W, are modern intrusions and are now prone to premature lamp failure.

During review of the gallery, the ceiling was accessed to determine if any decorative painting, details, and/or historic lighting remnants remained. *Figures O.51 and O.52* in *Table O.4* show some results. A similar access was made available in an adjacent room, 124. Further analysis by others will determine the period to which these findings belong.

Table O.4 outlines existing lighting conditions in the Governor's Portraits Gallery. Two historic surface-mount luminaires may be retrofits of the 1916 Beardslee chandelier order listing a 1-socket, Alba shade finished in bronze (green relief) for "First Floor Additional 14' Corridors" (where 14' is believed to describe ceiling height).

Rotunda and Circulation

The Rotunda and adjacent circulation are located on Floors 1, 2, and 3. Lighting here consists of a collection of historic luminaires as well as 4-foot-square surface-mounted lensed fluorescent luminaires, recessed downlights, trackhead accents, and electrically-lighted laylights likely from the 1970s work. The dome is backlit with daylighting and supplemental electric lighting. Light levels for circulation are appropriate with the exception of the north service stairs which in some instances fall below 1 fc and have a very dim appearance. Artworks, like the Governor's Portraits Gallery are over lighted unless art is rotated frequently.

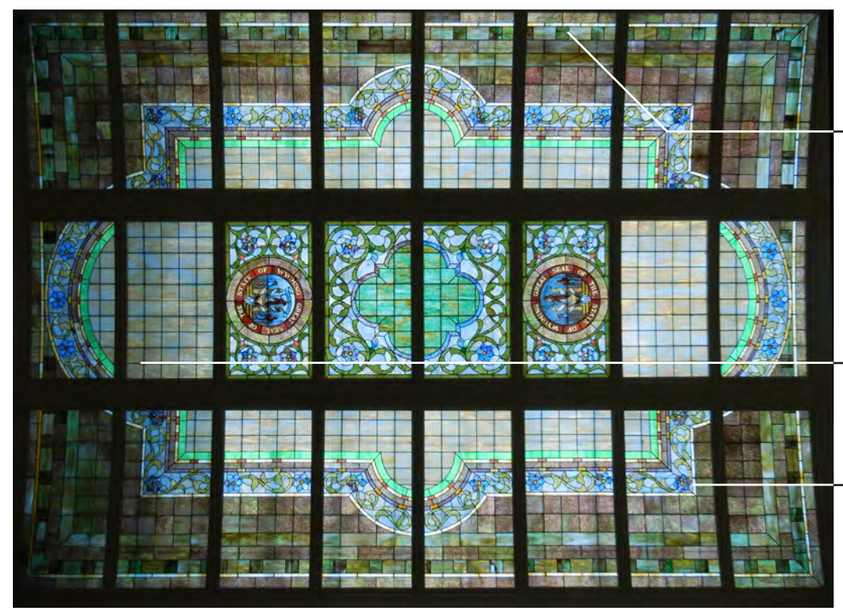
Table 0.4 outlines existing conditions in the Rotunda and Circulation areas. A number of historic luminaires appear in or near original locations and are well-preserved. Several shades exhibit damage and some have been replaced with modern acrylic ones.

Other Historic Luminaires

Aiming, lamp beam spread and coverage, or burnouts appear to contribute to curious bright and dark patterns.

The catwalk and maintenance platform create serious shadowing.

Edge aberrations in light levels, sometimes considered appropriate for museum-quality presentation of art and artifacts, detract from the contribution of the lantern to the overall architectural composition.



Edge aberrations in light levels are the shadowing from the maintenance platform, the lantern is consistently illuminated.

Even in daylight, the catwalk and maintenance platform cast serious shadows. Proximity of 1902 structure and the asymmetric layout of lantern-to-skylight compounds this.

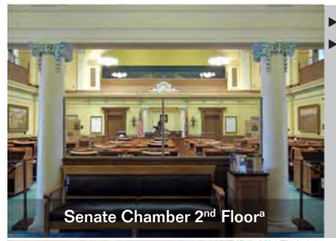
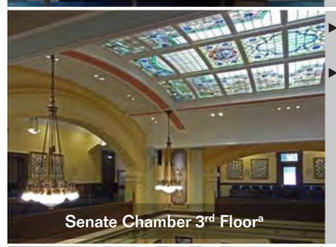
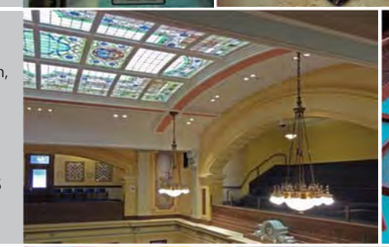
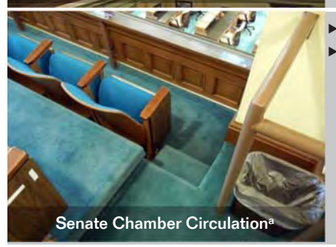
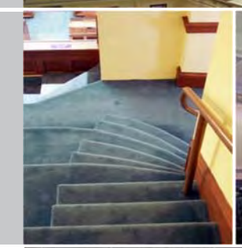
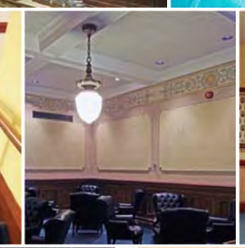
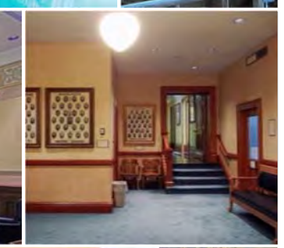
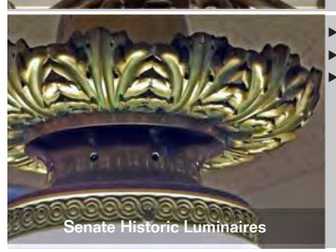
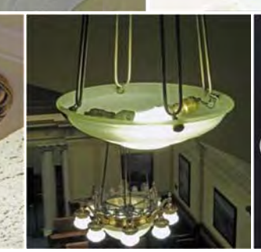
Color and detail are vibrant and clear throughout (except in the vicinity of the maintenance platform).

Figure O.21. Senate Chamber Lantern – Nighttime Electric Accent Lighting (top) and Daytime Daylighting (bottom)

The historic stained glass lantern is electrically lighted for nighttime effect as a museum-like presentation. Little functional light is available from this approach. Daylighting of the historic stained glass lantern provides some basic-to-moderate functional light depending on season, time-of-day, and sky conditions. During the day, the lantern is more fully illuminated thus contributing to the Chamber's historic architectural character. Day or night, shadowing is acute near the catwalk and the maintenance platform ("parked" at east end).

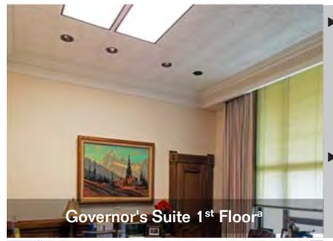
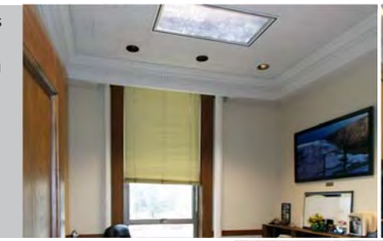
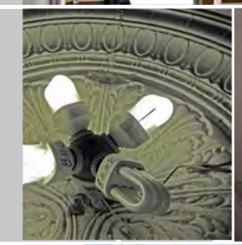
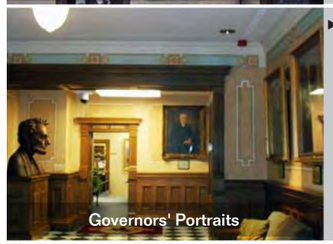
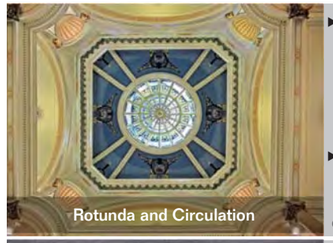
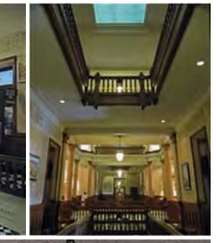
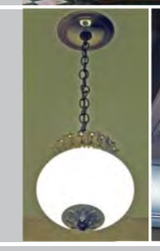
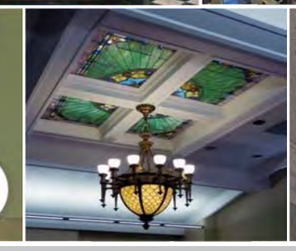
NORTH WEST
AS VIEWED FROM FLOOR

TABLE O.3. LIGHTING CONDITIONS AND ASSESSMENTS: SENATE PUBLIC AREAS

Space	Lighting Attributes	Luminaires	Assessment		
 Senate Chamber 2nd Floor[a]	▶ 7 to 16 fc on circulation floor ▶ Chamber illuminances ▷ daylighting only (representative) • 4 to 8 fc @desks, 3 p.m. cloudy ▷ electric ambient lighting only (representative) • 33 to 46 fc @desks, max ambient scene • 55 to 85 fc @dais w/13 fc vertical ▷ electric task lighting only (representative) • 50 fc @desks (presumed same as House)	▶ Historic incandescent decorative luminaires ▷ retrofitted with non-dim CFL lamps ▷ very good condition for age (ca. 1918) ▷ CFLs create more diffuse, flat appearance ▶ Circulation downlights retrofitted w/non-dim CFLs ▶ Modern quartz halogen downlights and accents ▷ 400W T4 minican lamps; 100W PAR38 lamps ▷ dimmable ▶ Modern fluorescent tasklights ▷ T2 linear lamps, non-dim, locally switched	▶ Illuminances satisfactory for typical legislative functions ▷ brightnesses somewhat better than those in House ▶ Downlight and accent strategy arguable ▷ obvious and distracting modern intrusion ▶ Tasklights create reflected glare ▷ polished stone desk top is unforgiving ▶ Lantern/skylight supplemental electric light strategy arguable ▷ provides aesthetic glow w/o functional light to chamber ▶ Preset controls provide some functional range ▷ existing "Interim" scene excludes downlights	   	Figures numbered from far left to right: **O.22, O.23, O.24, O.25**
 Senate Chamber 3rd Floor[a]	▶ 5 to 13 fc on circulation floor ▷ daylight estimated to contribute 1 to 2 fc ▶ 4 to 11 fc on gallery areas ▷ daylight estimated to contribute 1 to 2 fc	▶ Historic incandescent decorative luminaires ▷ retrofitted with non-dim CFL lamps ▷ very good condition for age (ca. 1918) ▷ CFLs create more diffuse, flat appearance ▶ Circulation downlights retrofitted w/non-dim CFLs	▶ Illuminances satisfactory ▷ brightnesses appear greater than those in House (perhaps due to lantern make-up, skylight configuration, livelier gallery areas/architecture, better highlighting of mural panels) ▶ Downlight strategy arguable ▷ obvious and distracting modern intrusion ▶ Glazing and polycarbonate selections might yield $\tau^b < 0.05$ ▷ with stained glass total τ^b might be < 0.007	  	**O.26, O.27, O.28, O.29**
 Senate Chamber Circulation[a]	▶ See notes above on illuminances in circulation ▶ 2 to 15 fc on stair treads	▶ Historic incandescent decorative luminaires ▷ retrofitted with non-dim CFL lamps ▷ very good condition for age (ca. 1918) ▷ CFLs create more diffuse, flat appearance ▶ Circulation downlights retrofitted w/non-dim CFLs	▶ Illuminances satisfactory for typical legislative functions ▶ Downlight and accent strategy arguable ▷ obvious and distracting modern intrusion ▶ Senate lobby has sterile appearance ▷ table lights and artworks improve House Lobby	  	**O.30, O.31, O.32, O.33**
 Senate Historic Chandeliers	▶ Medium screwbase sockets ▶ Diffuse light ▶ Not dimmable	▶ Equipment appears to date to 1918 ▷ quality opal glass diffusers some diffuser breakage and replacements ▷ cast or spun heavy gauge bronze and brass some components bent or out of plumb ▷ finishes appear stable and original ▷ extant luminaires in very good condition ▶ 4 CFLs in central bowl; 1 CFL in each small globe ▶ Chandeliers difficult to access	▶ Significant historic lighting in public areas ▷ original chandeliers/period detailing intact ▷ many appear to be in or near original locations ▷ illuminances satisfactory ▷ brightnesses flat and uninspiring ▶ Maintenance and preservation are apparent priorities	  	**O.34, O.35, O.36, O.37**
 Senate Historic Luminaires	▶ Medium screwbase sockets ▶ Diffuse light ▶ Not dimmable	▶ Equipment appears to date to 1918 ▷ quality opal glass diffusers some diffuser breakage and replacements (e.g., ahistoric diffuser in 3rd floor lobby) ▷ cast or spun heavy gauge bronze and brass some components bent or out of plumb ▷ finishes appear stable and original • OEM[c] "Bronze (Green Relief)" still evident ▷ most luminaires in very good condition	▶ Significant historic lighting in public areas ▷ original chamber chandeliers/period detailing intact ▷ original pendants/period detailing intact ▷ original chamber wall brackets/period detailing intact ▷ many appear to be in or near original locations ▷ some suspensions have been modified ▷ illuminances satisfactory ▷ brightnesses flat and uninspiring ▶ Maintenance and preservation are apparent priorities	  	**O.38, O.39, O.40, O.41**

Footnotes
General - Most whole-room images are without flash. All images are enhanced for better clarity and reproduction and do not represent exact actual illuminated appearances.
[a] Most photos and assessments on April 9, 2013, mid-to-late-afternoon, cloudy (snow).
[b] τ is the symbol for transmittance.
[c] Original Equipment Manufacturer (Beardslee).

TABLE O.4. LIGHTING CONDITIONS AND ASSESSMENTS: OTHER INTERIOR AREAS

Space	Lighting Attributes	Luminaires	Assessment		
 Governor's Suite 1st Floor[a]	▶ Typical illuminances (in all rooms but 100, 132) ▷ daylighting only (representative) window treatment deployed (as found) • 2 to 10 fc @desks, early p.m. partly cloudy ▷ electric ambient lighting only (representative) • 30 to 55 fc @desks, all lights energized ▶ Typical electric ambient illuminances in 100, 132 • 75 to 85 fc @desks	▶ Historic incandescent decorative luminaires ▷ several remain - see below ▶ 1970s recessed fluorescent luminaires ▷ 2 ft by 4 ft • lensed multi-lamp versions • paracube louvered multi-lamp versions ▷ 4 ft by 4 ft • lensed multi-lamp versions ▶ 1970s recessed downlights in select areas ▷ most retrofitted with non-dim CFL lamps	▶ Illuminances satisfactory for typical administrative functions ▷ brightnesses uninspiring; color-of-light unflattering ▶ Fluorescent luminaires are visually/physically overwhelming ▷ visually disconnected from historic context ▷ lensed versions are glary ▷ paracube louvered versions create cave impressions ▶ Downlights are obvious and distracting modern intrusion ▷ unable to compete with 2x4 and 4x4 fluorescents	  	Figures numbered from far left to right: **O.42, O.43, O.44, O.45**
 Governor's Suite Historic Luminaires	▶ Medium screwbase sockets ▶ Diffuse light ▶ Not dimmable	▶ Equipment appears to date to 1918 ▷ quality art glass diffusers ▷ cast or spun heavy gage bronze and brass ▷ stamped or formed heavy gauge ▷ finishes appear stable and original ▷ most extant luminaires in very good condition	▶ Several historic luminaires (of unknown origin w/in capitol) ▷ apparently original chandeliers/period detailing intact (left middle luminaire can be attributed to Beardslee 1916 BOM) ▷ apparently original pendants/period detailing intact ▷ original locations within capitol cannot be confirmed ▷ overall suspensions likely have been modified ▶ Maintenance and preservation are apparent priorities	  	**O.46, O.47, O.48, O.49**
 Governors' Portraits	▶ No illuminance measurements made	▶ Fluorescent lensed surface mount ▷ 1970s-era lighting ▷ at entries to Attorney General's and Governor's ▶ Historic articulated glass pendants with CFLs ▶ Recessed adjustable accents in vicinity of portraits ▷ 1970s-era black Alzak reflectors ▷ Rated for 300W PAR56 lamps • de-lamped to 200W PAR56 • very short life • too intense for sensitive artwork	▶ Illuminances satisfactory for circulation ▶ Fluorescent surface-mount and accent strategy arguable ▷ obvious and distracting modern intrusions ▷ intense accents accelerate sensitive artwork degradation ▶ Potential historic decorative painting scheme uncovered ▷ dropped ceiling may hide decorative paint and gas pipe (see images to right; far right pipe in far right image appears to be black iron gas pipe)	 	**O.50, O.51, O.52**
 Rotunda and Circulation	▶ 1st floor illuminances (electric light only) ▷ 8 to 9 fc on rotunda floor ▷ 29 to 40 fc on desks ▷ 2 to 3 fc on north and south vestibule floors ▷ 8 to 20 fc general circulation ▷ 11 fc at east elevator threshold ▶ 2nd floor illuminances (electric light only) ▷ 3 to 4 fc on general circulation ▷ 50 to 140 fc on artworks continued below	▶ Historic incandescent decorative luminaires ▷ retrofitted with non-dim CFL lamps ▷ very good condition for age (ca. 1918) ▷ CFLs create more diffuse, flat appearance ▷ some globes are broken or modern substitutes ▶ Fluorescent lensed recessed 2x4 and 4x4 units ▶ 1970s recessed downlights in select areas ▷ most retrofitted with non-dim CFL lamps ▶ Track monopoint accents in vicinity of artworks ▷ too intense for sensitive artworks	▶ Illuminances satisfactory for circulation ▷ brightnesses uninspiring; color-of-light unflattering ▶ Fluorescent 2x4s and 4x4s and accent strategy arguable ▷ obvious and distracting modern intrusions ▷ intense accents accelerate sensitive artwork degradation ▶ Faux skylights/laylights at 3rd floor over each stair well ▷ 1970s or 1980s mercury or metal halide backlighting	  	**O.53, O.54, O.55, O.56**
 Other Historic Luminaires	Rotunda and Circulation (continued) ▶ 3rd floor illuminances (electric light only) ▷ 7 to 41 fc on general circulation ▶ North Service Stairs illuminances (electric light only) ▷ 0.7 to 3 fc on general circulation Other Historic Luminaires ▶ Medium screwbase sockets ▶ Diffuse light ▶ Not dimmable	▶ Equipment appears to date to 1918 ▷ quality opal glass diffusers some diffuser breakage and replacements ▷ cast or spun heavy gauge bronze and brass some components bent or out of plumb ▷ finishes appear stable and original ▷ most luminaires in very good condition	▶ Significant historic lighting in public areas ▷ original chandeliers/period detailing intact ▷ original pendants/period detailing intact ▷ many appear to be in or near original locations ▷ some overall suspensions have been modified ▷ illuminances satisfactory ▷ brightnesses flat and uninspiring ▶ Maintenance and preservation are apparent priorities	  	**O.57, O.58, O.59, O.60**

Footnotes
General - Most whole-room images are without flash. All images are enhanced for better clarity and reproduction and do not represent exact actual illuminated appearances.
[a] Photos and assessments made throughout the week of April 7, 2013. Most sky conditions partly cloudy to cloudy.

The north circulation stairs, the Assistant Secretary of State's office, and the Supreme Court Conference Room are lit with what appear to be original historic luminaires from the 1916 Beardslee chandelier order. *Table O.4* outlines their characteristics.

Gas Bracket

A plaque bearing a gas wall bracket hangs in the Auditor's Suite along the north wall of the office in proximity to the rotunda (Room 117). This is an interesting curiosity [*See Figure O.64*]. Perhaps this is remnant from the original building's gas lighting system. *See O.02.02 Historical Lighting Conditions | Phase 1 - 1888*.

O.01.05 Existing Exterior Lighting Conditions

At night, exterior site lighting is concentrated at the front (south) entry plaza on 24th Street, at the west entrance porch, and at the north entry plaza. Lighting along the sidewalks adjacent to Carey Avenue and Central Avenue is provided by street lighting. Lighting along 24th Street is provided by street lighting at intersections with Capitol Avenue, Carey Avenue, and Central Avenue. A drop-off zone is illuminated by multi-globe postlights reminiscent of the 1920s. The west entrance path from Carey to the steps is unlighted. Some sculptures on site are illuminated, some more completely than others. The Phase 1 south facade and the rotunda and dome are illuminated. [*See Figure O.62*]. At the south entrance plaza and steps, light levels are relatively consistent at 2 fc. Shadowing at the entry doors results from the geometry/placement of the acorn postlight standards on the stairs and the porch structure layout. Most of the lighting is clear metal halide with strong blue content, but little orange/red content. Building materials and skin tones are not flattered by this lighting. Although the floodlighting approach minimizes the number of fixtures, the facade detailing loses much of its dimensionality and character. Some of the facade lighting is mounted on dedicated poles which detract from the south plaza entry sequence during the day [*See bottom image in Figure O.62*].

The statues of Esther Hobart Morris and Chief Washakie are softly illuminated. Their bronze-toned finish combined with the bluish color of the clear metal halide causes these sculptures to recede into darkness. The statues Spirit of Wyoming at the west lawn and the Bison on the east lawn appear to be illuminated with clear metal halide. The replica of the Liberty Bell at Carey and Capitol and the Spanish American War memorial at Central and Capitol do not appear to be illuminated at night. A "W" logo at the northwest corner defined by 25th Street is illuminated. A calf sculpture on the southwest lawn honoring former Governor Hansen is not illuminated. The state flag and the US flag do not appear to be flown at night and are not illuminated.

O.01.06 Existing Lighting Controls

Lighting control throughout the building is by local manual switches; several time clocks and contactors (mostly located in the attic) are used to automatically control selected lighting at the building's exterior, stairs, rotunda and dome; lighting in both chambers is controlled by ETC Unison dimming panels located in the attic with scene select control stations located in the chambers. Downlights in each chamber are dimmable while all other lighting is non-dim (on/off). Presets offer "maximum" light, a reduced setting, and a "historic" scene where only the historic luminaires are energized.

O.01.07 Existing Emergency and Egress Lighting

Emergency lighting throughout the building is provided by the use of battery-powered fixtures and exit signs; an approximately 5kW UPS inverter system located in the attic provides emergency power to selected lighting in the two chambers via transfer relays at the dimming panels. (There is no emergency power service in the building.)

O.01.08 Existing Maintenance

The quality of the state of the 1918 historic luminaires is testament to their original quality of manufacture and to the ongoing careful maintenance of this equipment. Many historic luminaires appear intact and operable. All luminaires are group relamped. Cleaning takes place at time of relamping.

O.01.09 Endnotes

[1] Gary Steffy, Architectural Lighting Design, Third Edition (New York: John Wiley & Sons, Inc. 2008), p. 5.

[2] Beardslee Chandelier Manufacturing Company Chandelier Order (Chicago: Beardslee, October 19, 1916). [*See Appendix O2 for full contents of Chandelier Order*.]

Figure O.62. Facade Lighting

Clear metal halide washes the Phase 1 south facade and the rotunda and dome (top). The wash effect flattens detailing and the color rendering of the clear metal halide does not enhance the appearance of the building materials. The bottom image illustrates the facade lighting posts (①) visible during the day at the south entry plaza.

O.02 Historical Conditions

Each of the Capitol's three major construction phases was illuminated with the man-made lighting technology and fixture styling of the day, though daylight also played a prominent role. Gas light, and to some extent electric light, were commonly installed in commercial, institutional, and monumental buildings by the 1880s. These light sources allowed for commerce and deliberations to take place from early morning to late evening regardless of sky conditions. The following discussion briefly addresses the various states of lighting over the early history of the Capitol. This will be used as background in developing lighting concepts and luminaire designs. Conjecture on original lighting techniques in specific spaces is noted where little or no Capitol-specific documentation exists.

O.02.01 Historical Lighting Background

Although Edison's electric lamp was nearly a decade old by the completion of Phase 1 in 1888, the reliability of and comfort with gas use and perceived dangers of electricity remained pervasive. During the 1880s, many gasworks were engaged in stiff competition with electric plants. Establishments commonly switched from gas lighting to electric lighting and back again as stories were promoted on the safety and risks of one system over another. By the turn of the 20th century, combination lights were in vogue seemingly to mitigate cost spikes in one source and risks of another, including the failure of one system or the other. Ultimately, this competition likely drove down costs of each approach. This helped to fuel the use of more man-made lighting to achieve greater levels of light and expand the use of permanent architectural lighting into nearly all types of interior spaces and into exterior applications, including entries, walkways, roadways, and facades.

The geometry of the building and the extensive use of skylights/lanterns on each of the three phases made daylight a prominent, if not predominant, source. The narrow, elongated architecture of the Capitol with its long sides oriented to the north and south, high ceilings and tall windows, claimed to bear a "much greater percentage of glass surface than can be found in any other state or municipal building". This approach no doubt distributed daylight effectively throughout the office spaces.[1] In the circulation areas and Chambers, skylights/lanterns were used where windows could not be provided or where borrowed light was expected to be ineffective.

O.02.02 Historical Lighting Conditions | Phase 1 – 1888

Specifications dating to 1886 identify gas as the primary man-made method of interior lighting with provisions for the future addition of electric lighting.[2] Based on the bid citations in the Commissions Final Report, the large gas double cone reflector specified for the Supreme Court was procured and installed as was electric wiring for future electric lighting.[3] The left image of Figure #.63 illustrates a double cone reflector from E.P. Gleason's 1887 catalog.[4] The gas reflectors for the House and Senate would await funding approval for Phase 2.

Apparently gas wall brackets and/or pendants were used in the building . The specifications were clear about the need to "furnish in place gas pipe leading to all points marked ⊹ (see specific gas fixture specifications on file) on plans." No plans or more specific specifications have been found to date. The right-side image of *Figure O.63* illustrates then-commonly-available one-swing gas wall brackets. *Figure O.64* illustrates just such a gas fixture on a plaque in Room 117. The building may have been fitted with simple gas fixtures for its first few years of use, with the planned intention of specifying, purchasing, and installing more significant, in both decoration and light quality, combination fixtures in Phase 2.

Daylighting was a hallmark of the early Capitol. The 1886 specifications spell out the kinds of glass to be used for lower-level and attic windows ("double thick 'French sheet'"), 1st and 2nd floor windows ("French polished plate glass" – the highest clarity glass at the time), interior glass doors, windows and transoms ("double strength French sheet"), and skylights ("hammered glass one inch thick"). The rotunda dome lantern was "to be opal and rolled cathedral-stained glass, in different shades and Mosaic designs, set in lead sash, to have movable sections, worked with cords, for ventilation." The ceiling lights in the third-story halls illuminating the rotunda circulation light wells with daylight "will be white enamelled glass, set in wood sash, in small lights with movable sections and cords." In the specification section for outside doors, "all iron work exposed in the light shaft to be painted white." Clearly, all means were employed to maximize daylight.[5]

Exterior lighting, if any existed, and none is cited in the specifications or Commissioners' reports, would likely have been simple gas lanterns on postlights placed at a very few key positions, such as the front entry.

O.02.03 Historical Lighting Conditions | Phase 2 – 1890

The 1886 specifications identified gas double cone reflector lighting for the chambers matching that of the Supreme Court. However, it is unclear what, if any, lighting was installed during Phase 1 based on the reports made over the tenures of several Building Commissions. A Special Report of the Second Capitol Building Commission in 1889 states, "Among the first things of importance requiring attention are the piping of gas into the building; also the putting in of electric light wires, with latter should be done through a conduit pipe in the same trench with the gas main." At the same time, the commission indicated, "It will be a matter of considerable importance to obtain proper chandeliers or combination chandeliers and electroliers through-out the building which will be adapted to both gas and electric so that if it should become necessary at any time to change one system of light for the other the change could be made with comparatively little expense." The Brush-Swan Electric Light Company estimated "For suitable combination fixtures, arranged for both gas and electric light (or either) throughout the entire building, putting up and connecting ready for use with lamps shades + shade holders, the cost would be about $4,000.00."[6] It was common practice during this period to install combination electric and gas luminaires as explained above. The gas portion could also be used as emergency lighting.[7]

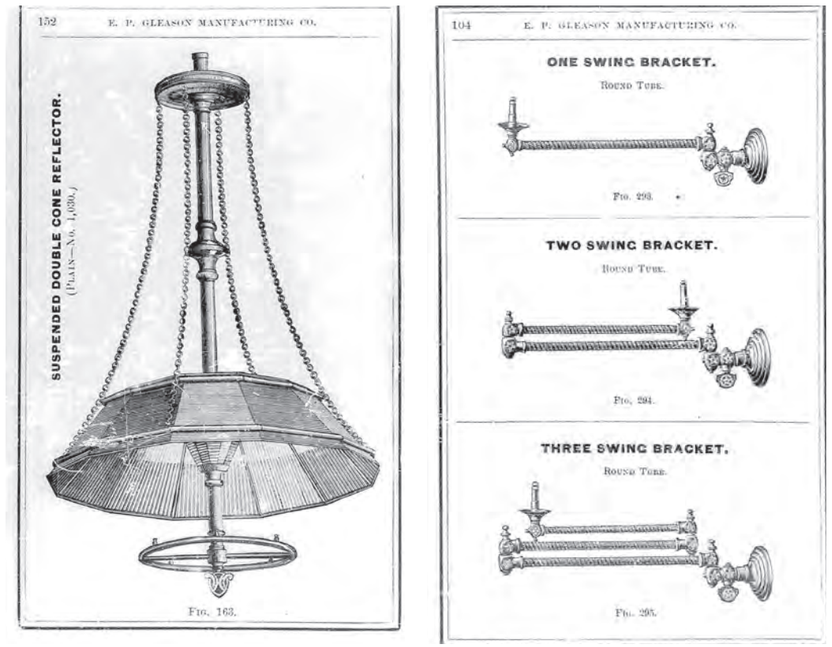


Figure O.63. Phase 1 -1888 Gas Lighting

Double cone gas reflectors are referenced in the Phase 1 specifications and bid schedules. An example from E.P. Gleason's 1887 catalog is shown here (left). The versions in the Wyoming Capitol were "5 feet 6 inches in diameter, containing 30 burners each, with shut-off at convenient points of access." These must have been quite bright. In the same Gleason catalog, wall brackets were available in various arrays (right). The top most variety is similar in scale and decoration to the bracket on a plaque in Room 117 (see Figure O.64 below).

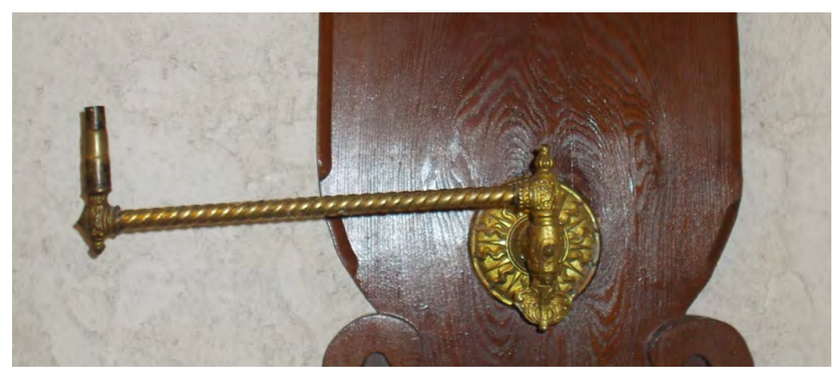


Figure O.64. Wall Bracket Plaque in Room 117

A plaque exhibiting a gas wall bracket can be found in Room 117. Perhaps this is a remnant from Phase 1.

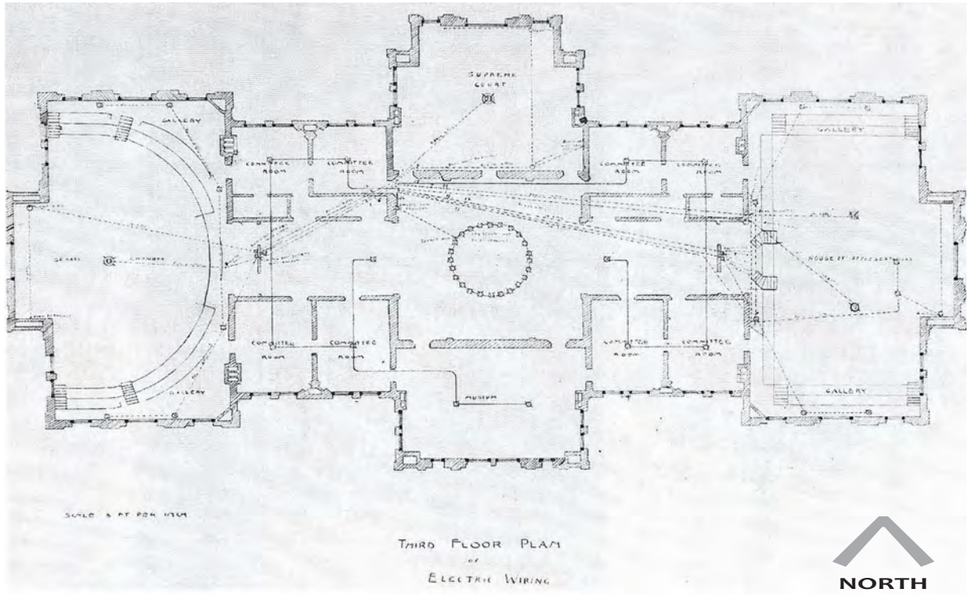


Figure O.65. ca. 1889 Electric Wiring (Lighting) Plan
Lighting is clearly indicated on this plan ,believed to be ca. 1889, and is apparently a combination gas and electric plan. The Supreme Court luminaire symbol shows "30" presumably corresponding to the number of burners cited in the 1886 specifications. The Senate is fitted with a 12-burner luminaire and the House with two 12-burner luminaires (corresponding to the number of gas burners shown in the combination gas/electric fixtures seen in Figure O.66). This plan may not have been completely implemented until 1896 or so or may not have even been drawn until that time – this is an undated drawing.

Figure O.66. Late 19th/Early 20th Century View of House of Representatives
The lighting equipment shown in this undated photograph are consistent with the plans and commission reports of the 1890 to 1896 time frame. The combination wall brackets and chandeliers are fitted with the number of gas burners cited on plans. Wall brackets appear to match those in Figure O.67 dated 1902. Chandeliers are multi-burner versions of the pendant fixture shown in Figure O.69 and O.70. This was a common means of increasing/decreasing light output and fixture scale while using a standard kit of parts.

In the 1890 report, the commissioners note, "At the present time there are no provisions for properly lighting the building. A few of the offices are temporarily connected with the electric light but the manner in which the connection is made is both unsightly and unsafe. The absence of gas in the building compels the State Geologist to use gasoline in his analytical work. This is a dangerous proceeding. He should be provided with gas at once." The commissioners also report that, "The work of introducing both electric light and gas should also precede the improvement of the grounds." It would seem, then, that the building may have been piped and wired during its Phase 1 construction but that neither electric or gas service was actually provided to the building.[8]

Electric wiring plans exist circa 1889. Many of these appear to be "as builts" or, perhaps, revisions with ink or pencil marks on top of blueline plans. A 3rd floor electric wiring plan, shown in *Figure O.65*, may be an original Phase 2 layout from the architect or engineer. Luminaire locations are clearly identified, including a ring of lights around the rotunda dome (and a note indicating "Skylights not to be rewired").

A list of lights was complied on December 6, 1891 and consisted of 19 rooms, including the Governor's Room, Chief Justice, and Rotunda. The 32 lights cost a grand total of US$22.50. There is no mention of what energy source was used. In fact, these could have been oil lamps. Further, the quantity of lights is inconsistent with what are believed to be 1889 plans. The plan in Figure O.65 has 32 lights alone, not counting the lights shown at the rotunda dome. Therefore the layout in *Figure O.65* must be a) an original Phase 2 "intended" plan that was left to installation and evolution from 1890 to 1914 or b) a plan developed and implemented after completion of Phase 2 in 1890, such as would have been necessary for the work in 1896 cited below and likely shown in *Figures O.66 through O.70*.

By 1894, the Biennial Report notes that funding might make possible "additional improvements in the interior of the building the most important of which would be to provide chandeliers appropriate to such a structure in the legislative halls and about the dome and hallways."[9] In 1896, the Office of the Board of Capitol Commissioners reported that "The interior improvements consisted in first providing a permanent and convenient system of lighting the Legislative Halls, offices and corridors of the building."[10]

Based on the commission reports, electricity was fed to the building at or prior to 1896. Indeed, *Figures O.71 and O.72* illustrate one method, if not the method, used to electrify the building for a period of time. An arc lamp is also in evidence at the south entry. Carbon arc lamps were relatively powerful lights using two carbon rods across which an electric current or arc was struck to produce light. Although this would no doubt have illuminated the entire south entry porch, stairs, and walkway, the glare would have been quite significant.

By 1906, the commission concluded that earlier attempts at electrifying the Capitol were inadequate and unsafe. Lightning apparently struck the building several times and nearly resulted in fires. The commission retained an "electric engineer" who drafted plans and specifications for complete rewiring which was apparently implemented by 1908. This included, finally, placing the wires underground, "thus improving the exterior appearance of the premises."[11, 12]

In 1908, the commission was exploring installation of "electric lamp posts at the south and west entrances of the grounds and at the west entrance of the building" expecting the appearance of the premises to be much improved.[13] In the 1910 report, the commission acknowledges that ornamental lights were installed and that the much needed rewiring of the building was complete.[14]

The commission reported in 1914 that "cluster lights" were purchased and installed for the "North side of the Capitol."[15] It is possible that this was a reference to the very kind of post lights that appear in *Figures O.73 and*

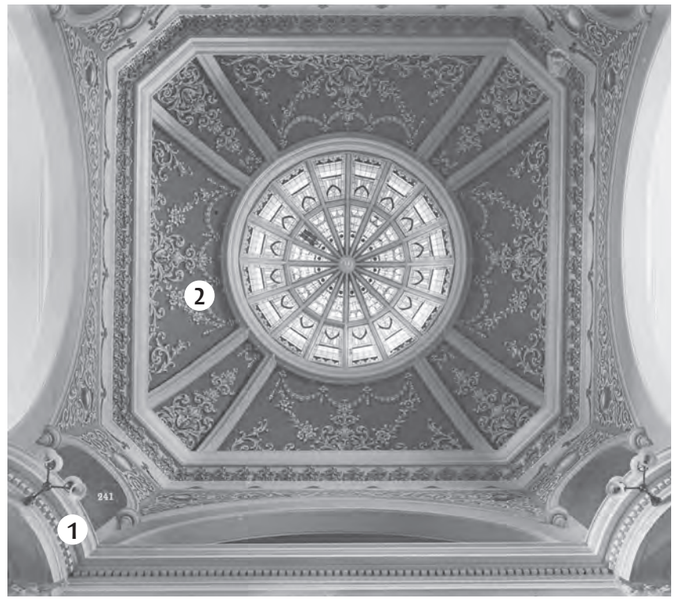


Figure O.67. 1902 View of Rotunda Dome
Combination wall brackets are shown on the rotunda 2nd floor fascia detailing (①). These are similar to versions seen in Figures O.66 and complement the pendants shown in Figures O.69 and O.70. Electric lamps ring the perimeter of the dome (② more clear in the close-up shown in Figure O.68).

Figure O.68. 1902 Electric Lamps
A common application for the then-new, more universal and utilitarian source, incandescent lamps, architectural detailing was outlined with lamps (②) consistently placed.

Figure O.69. 1902 Mineral Display on 3rd Floor
This combination luminaire (and another visible through the arch to the west side of the rotunda), likely served as the "standard" fixture for circulation and most work spaces.

Figure O.70. 1907 Margaret Knight, Deputy State Superintendent of Schools
This combination luminaire, a 4-arm version of the example shown in Figure O.69, in an office setting suggests the universal application of a standard approach to lighting throughout much of the capitol after Phase 2 completion. The dongle hanging from the central cluster body is a switch, presumably for the electric lights.

O.74 and may have been what was installed on the south and west exteriors in 1910. It is unclear whether the cluster postlights were first installed by the building commission or by the City of Cheyenne, but by about 1920, these lights were ubiquitous along Capitol Avenue.

Photographs from the building painting project of 1915-1916 and Governor Kendrick's inauguration of 1915 clearly show the lighting in place at the south entrance and walkway (*See Figures O.73, O.74, and O.76*). The sentry standards (mounted to fence piers) may have been used at the west and north site boundaries. The stair standards shown in *Figure O.76* were likely used on the west and north stairs. These standards were unusual for their clear glass globes which, while no doubt considered quite sophisticated as crystalline objects, were glary unless dimmed to just a nightlight glow – which could have been the case.

O.02.04 Historical Lighting Conditions | Phase 3 – 1918

Commission reports through 1914 warn of an impending space shortage in the Capitol. On March 27, 1915, the Wyoming State Leader of Cheyenne reported "The Capitol building commission has selected Architect William Dubois … to prepare plans and specifications for the $150,000 addition that is to be constructed to the state Capitol building this spring." By 1916, plans were well underway to purchase and install new lighting for the new east and west wings and the "old building" interior from Beardslee Chandelier Manufacturing Company of Chicago. As outlined in *Existing Conditions O.01.04 Space-by-space*, some original Beardslee luminaires exist today and are in remarkably good condition. *Appendix O2* is a copy of the lighting Chandelier Order from Beardslee to William DuBois, Architect, on October 19, 1916 (referenced throughout as the chandelier order). The submittal drawings referenced in the cover letter have not been found. A search of Beardslee catalogs of the era suggests the Beardslee part numbers shown in the chandelier order identify drawing numbers specific to the Capitol project. Historic photographs of the Capitol interior, the 1916 Beardslee chandelier order descriptions, plans with room numbers from the 1916 design work by DuBois, and extant luminaires provide a robust archive on the design, detailing, and quality of the Beardslee luminaires, most of which are American Classical Revival Style. Examples of many of the extant luminaires are shown in *Tables O.2, O.3, and O.4*.

Both the 1916 Beardslee chandelier order in *Appendix O2* and visual inspection on site in April 2013 provide additional finish and shade information. Office luminaires were finished in brushed antique brass. Those in corridors were finished in statuary bronze with green relief. Those in the House and Senate Chambers were finished in brushed antique bronze. Only toilet room luminaires were finished in nickel. Alba shades were used on a number of public-area luminaires. Alba was a brand name of opal glass shades made by Macbeth-Evans Glass Co. in Pittsburgh, known for now-considered classical shapes. At the time, these were no doubt considered a contemporary interpretation. Alba glass was considered quite durable and easy to maintain. Marketing materials of the day claimed, "It is semi-translucent, jade-like glass, only whiter and more transparent. The loss of light is less than half that of the globes usually used, and it give the light an even spread over the surface to be illuminated. It does not accumulate dirt, because it is perfectly smooth on both sides." Nearly all of the extant circulation fixtures were specified with Alba shades, many of which are intact today.

Although the fixture bodies no longer exist in various administrative and support spaces, such as offices, committee rooms, lavatories, and toilets, the 1916 Beardslee chandelier order can be matched to shades from the Beardslee Catalog No. 22, 1915. This catalog and that of the Macbeth-Evans Glass Company (Alba glass shades) for Ajax Lighting Equipment, ca. 1910 also illustrate several of the shades on extant luminaires. *Table O.5* lists many administrative spaces and missing luminaires, their shades, and finishes. *Figure O.77* is an excerpt from the 1915 Beardslee catalog illustrating many missing shades. *Table O.6* indicates the number of luminaire shades in both extant and missing luminaires in many public spaces. *Figure O.78* is an excerpt from the 1915 Beardslee catalog and the 1910 Macbeth-Evans Catalog illustrating extant shades. Cross-referencing *Tables O.5 and O.6* and *Figures O.77 and O.78* with the information in *Appendix O2* and the available

Figure O.71. 1902 Electrification and Exterior Lighting

The capitol building as it appeared twelve years after completion of Phase 2. Electric wiring and even an arc lamp are shown in this photograph. Figure O.72 more clearly delineates the electrical wiring to the building and the arc lamp at the south entrance. Contrary to original plans and ongoing commission report directives, electric wiring was apparently not placed in conduit below grade for some time. This made for an unsightly, if not unsafe, installation.

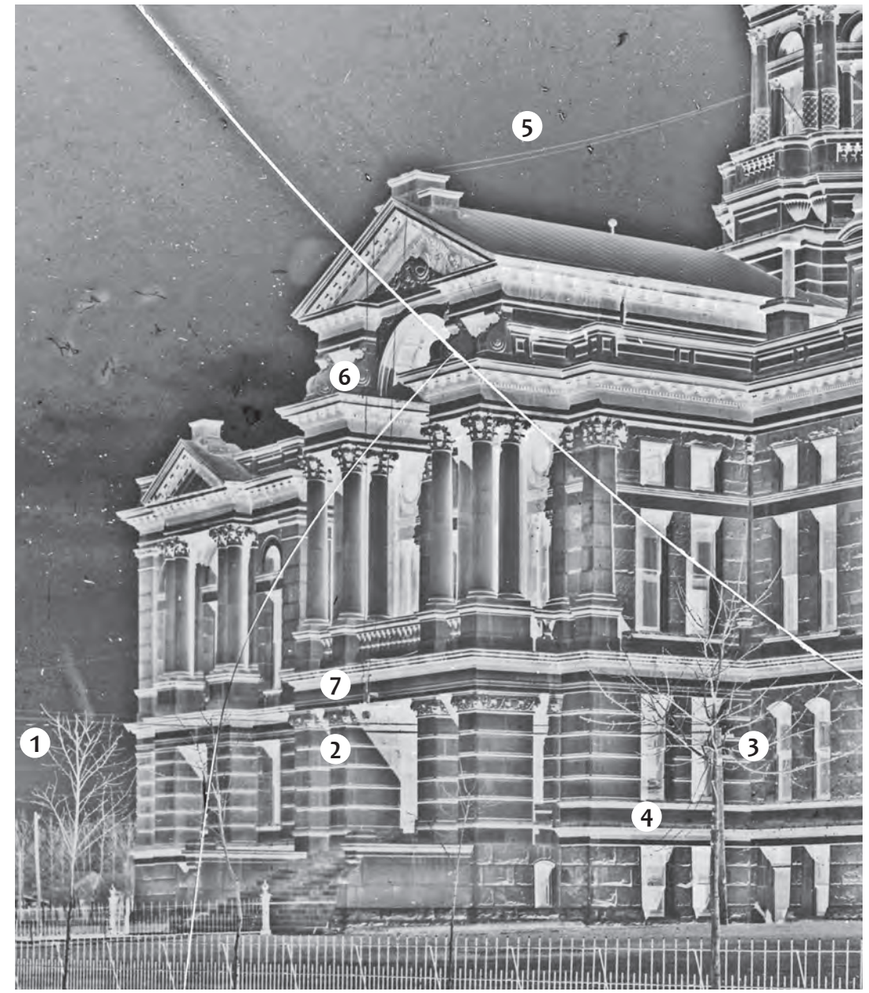


Figure O.72. 1902 Electrification (negative view for clarity of wiring detail)

The capitol building was electrified with wiring (seen just above ①) from a power source presumably off site to the south. Wiring flies past entrance (②), to a pole (③) behind a tree, then swags down to a basement-level window (④). Wiring exits the rotunda and swags to the south pediment (⑤), makes a vertical drop at the south portico (⑥), to the arc lamp (⑦).

Figure O.73. ca. 1915-1916 South Entrance

In 1914, The Capitol Building Commission reported installation of "cluster lights" on the north side of the capitol. This view of the south entrance believed ca. 1915-1916 shows cluster lights. Cluster lights in this form are seen in catalogs as early as 1903. Figure O.74 is a close-up view of the south entrance illustrating three different postlights in use at that time.

Figure O.74. ca. 1915-1916 South Entrance

The curb line drop-off area was illuminated with cluster postlights using opal globes and, likely, incandescent filament lamps. This appears to be a Union Metal postlight (*Figure O.75*). Gate standards define the site proper. Stair standards are shown more clearly in *Figure O.76*.

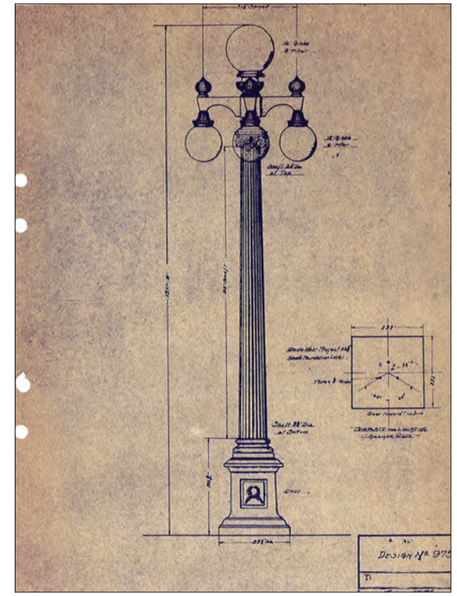


Figure O.75. ca. 1913 Union Metal Drawing

The cluster lights seen in *Figures O.73 and O.74* are believed to be this model from Union Metal's archives ca. 1913. The ornaments on top of the arms were, apparently, not ordered or were removed after installation. The wreath is a Union Metal mark.

Figure O.76. 1915 Kendrick Inauguration

The light standards on the stair plinths exhibit an unusual clear glass globe, through which can be seen an incandescent filament lamp.

Phase 3 plans offers a definitive understanding of the lighting of perhaps 70 percent of the building at its completion in 1918.

The analyses presented in *Figures O.77 and O.78* and *Tables O.5 and O.6* identifies some significant missing luminaires and/or different shades. For example, the luminaire shown in *Figure O.15/Table O.2* in the House Lobby may well be an extant luminaire body, but the shade does not match those on the 1916 Beardslee chandelier order and the Alba shades seen in the 1910 Macbeth-Evans Catalog. The current shade, an R. O. Marbo glass shade seen in a 1925 Edwin F. Guth catalog, matches those on several, though not all, similar luminaires in the rotunda, east wing and west wing and may have been replaced during later remodels. The shades in the circulation corridors in the House and Senate Chambers also do not match the 1916 Beardslee chandelier order and the Alba shades seen in the 1910 Macbeth-Evans Catalog. Although the luminaire bodies may be original, perhaps the shades were changed in subsequent remodels. The shades on the House Chamber wall brackets at the dais do not match the 1916 Beardslee chandelier order and the 1915 Beardslee Catalog and, after a survey of photographs, appear to have changed sometime after the 1950s. This is further evidence that the shades on the circulation corridors in the House and Senate Chambers were also changed at some point.

Of significant interest are the four missing rotunda "Old Building" luminaires matching the only extant version seen in *Figure O.57/Table O.4*. These four missing luminaires were likely replaced by the two 2x4 fluorescent lensed luminaires now occupying the NW, NE, SE, and SW corners of the rotunda's first floor.

Given this analysis, the six small shades on the chandelier in the Assistant Secretary of State's Office (*seen in Figure O.60/Table O.4*) are likely not original. Similarly, the small shades on the Supreme Court chandelier (*seen in Figure O.59/Table O.4*) and on the Governor's Suite art glass chandelier (*Figure O.48/Table O.4*) are suspect. Further, the styling and lack of citation on the 1916 Beardslee chandelier order, call into question the authenticity of the two indirect luminaires in the Governor's Suite (*one seen in Figure O.46/Table O.4*). The west and east balcony pendants respectively in the House and Senate Chambers (*seen in Figures O.40 and O.41/Table O.3*), and the north circulation stair pendants (*seen in Figure O.58/Table O.4*) cannot be corroborated with 1915 Beardslee or 1910 Alba catalogs and may also be later substitutes.

Perhaps most noteworthy is that a large chandelier was identified in the 1916 Beardslee chandelier order for the "Rotunda/Dome." This luminaire was identified as a 31-socket unit, using a total of 19 shades. No photos have been found of this installation. Of course, this luminaire is missing. There are some vague references to chandeliers in the vicinity of the dome in early building commission reports, so the 1916 effort may not have been the first.[16]

O.02.05 Historical Lighting Controls

There is no clear evidence on how lighting controls, if any, were implemented in Phase 1. At the time, gas lights would likely have been individually controlled by gas cocks or keys at each luminaire. Any electric lights could have been individually controlled by a switch at each luminaire, at the room entry (though unlikely), or at a central switch board.

Phase 2 lighting may have involved the local-switch-at-each-luminaire approach as shown in *Figure O.70* for electric lights and gas cocks for gas lights. Phase 2 plans appear to indicate centralized switch or circuit panels on each floor in each wing.

Phase 3 lighting plans indicate local switching within each area or room. This was, no doubt, a pleasant convenience from individually switching each and every luminaire at the beginning and end of work days. Any

Table O.5. Phase 3 | 1916 Beardslee Luminaire Status – Administrative Spaces

This summarizes many of the missing luminaires in administrative areas, their shades, and finishes reported in the 1916 Beardslee chandelier order (see Appendix O2) as well as the number of luminaires, lamps, and shades in respective spaces (room numbers in accordance with 1916 chandelier order and DuBois plans). In all of these spaces, the shades, seen in adjacent Figure O.77, would have been oriented downward, resulting in maximum light for work and corresponding glare (with exposed, visible lamps). No reference material has been found illustrating missing fixture bodies in these spaces.

Space | Shade Catalog No.		Luminaire Count	Lamps per Luminaire	Shades per Luminaire	Finish	OAS[a]
West Wing						
Office 101 | **B1202½**	1	6	4	4	Light BAB[b]	6' 6"
Office 104 | **B1202½**	1	1	2	2	Light BAB[b]	6' 6"
Office 107 | **B1213½**	3	1	1	1	Light BAB[b]	6' 0"
Lavatory 203 | **B1213½**	3	1	1	1	Nickel	3' 0"
Lavatory 204 | **B1213½**	3	1	1	1	Nickel	3' 0"
Office 207 | **B1202½**	1	1	2	2	Light BAB[b]	NR[c]
Office 208 | **B1202½**	1	1	2	2	Light BAB[b]	NR[c]
Office 209 | **B1202½**	1	1	2	2	Light BAB[b]	NR[c]
Committee Room 301 | **B1202½**	1	1	4	4	Light BAB[b]	4' 0"
Committee Room 302 | **B1202½**	1	2	3	3	Light BAB[b]	4' 0"
Committee Room 310 | **B1202½**	1	1	4	4	Light BAB[b]	4' 0"
Committee Room 311 | **B1202½**	1	2	3	3	Light BAB[b]	4' 0"
Committee Room 312 | **B1202½**	1	1	4	4	Light BAB[b]	4' 0"
East Wing						
Lavatory 222 | **B1201½**	2	1	1	1	Nickel	Wall bracket
Lavatory 223 | **B1201½**	2	1	1	1	Nickel	Wall bracket
Lavatory 228 | **B1201½**	2	1	1	1	Nickel	Wall bracket
Lavatory 229 | **B1201½**	2	1	1	1	Nickel	Wall bracket
Lavatory 233 | **B1213½**	3	1	1	1	Nickel	3' 0"
Lavatory 234 | **B1213½**	3	1	1	1	Nickel	3' 0"
Office 240 | **B1202½**	1	1	2	2	Light BAB[b]	NR[c]
Office 241 | **B1202½**	1	1	2	2	Light BAB[b]	NR[c]
Office 242 | **B1202½**	1	1	2	2	Light BAB[b]	NR[c]
Toilet 303 | **B1213½**	3	1	1	1	Nickel	3' 0"
Toilet 304 | **B1213½**	3	1	1	1	Nickel	3' 0"
Toilet 313 | **B1213½**	3	1	1	1	Nickel	3' 0"
Committee Room 314 | **B1202½**	1	1	2	2	Light BAB[b]	4' 0"
Committee Room 315 | **B1202½**	1	1	2	2	Light BAB[b]	4' 0"
Committee Room 316 | **B1202½**	1	1	2	2	Light BAB[b]	4' 0"
Toilet 317 | **B1213½**	3	1	1	1	Nickel	3' 0"
Committee Room 323 | **B1202½**	1	1	2	2	Light BAB[b]	4' 0"
Committee Room 324 | **B1202½**	1	2	2	2	Light BAB[b]	4' 0"
Committee Room 325 | **B1202½**	1	1	2	2	Light BAB[b]	4' 0"
Governor Ste Toilet | **B1213½**	3	1	1	1	Nickel	3' 0"
Governor Ste Toilet | **B1213½**	3	1	1	1	Nickel	3' 0"
Ante Toilet | **B1213½**	3	1	1	1	Nickel	3' 0"

Footnotes

[a] OverAll Suspension (presumed from ceiling to bottom of luminaire, but may have indicated overall length of chain or stem).

[b] Light Brushed Antique Brass.

[c] None Reported. Many of these were quite possibly surface-mounts - directly mounted to the ceiling.

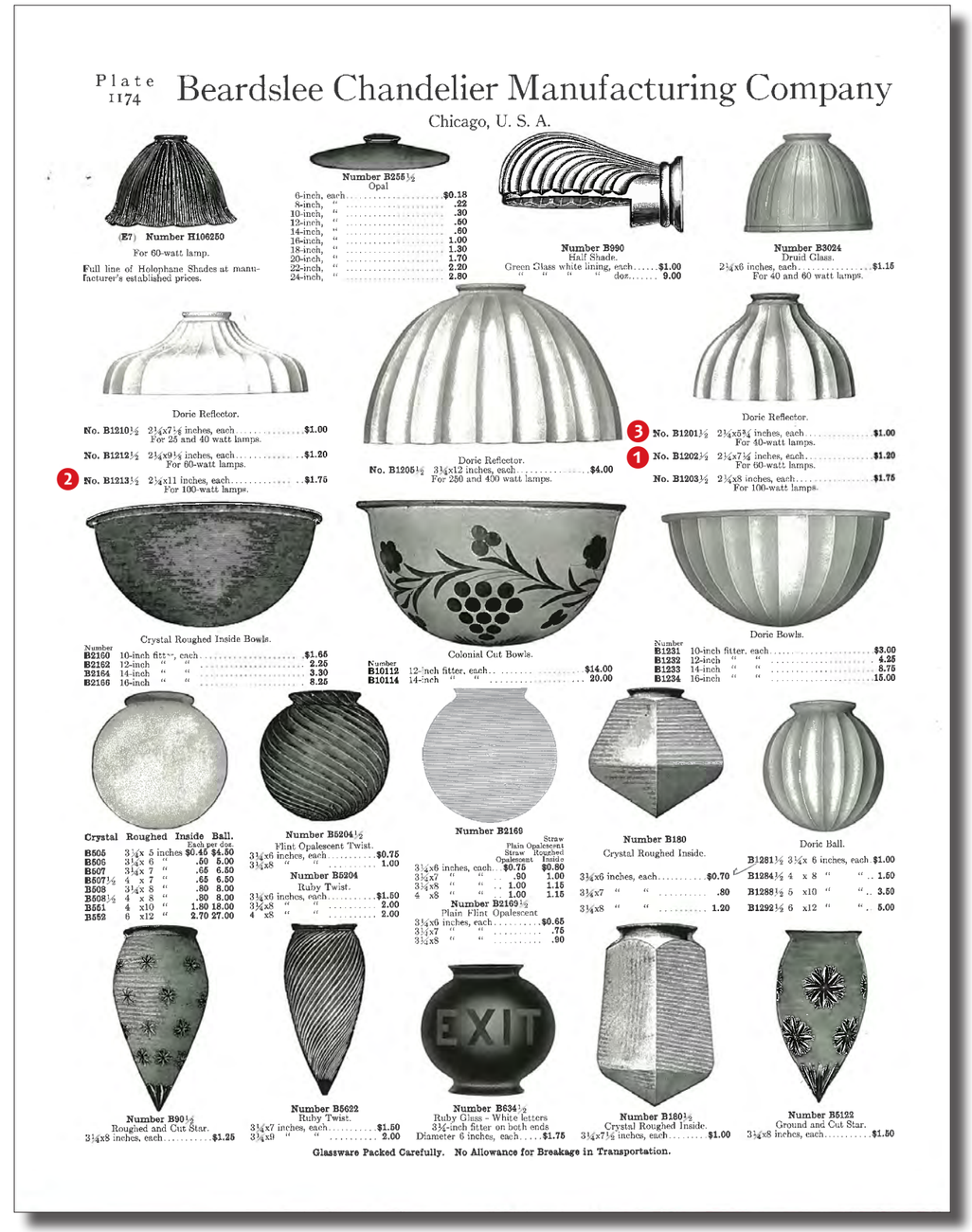


Figure O.77. 1915 Beardslee Catalog No. 22 Shade Plate 1174

This page, from a copy of the 1915 Beardslee Catalog, is used to identify the shades of missing luminaires in the capitol (see Table O.5).

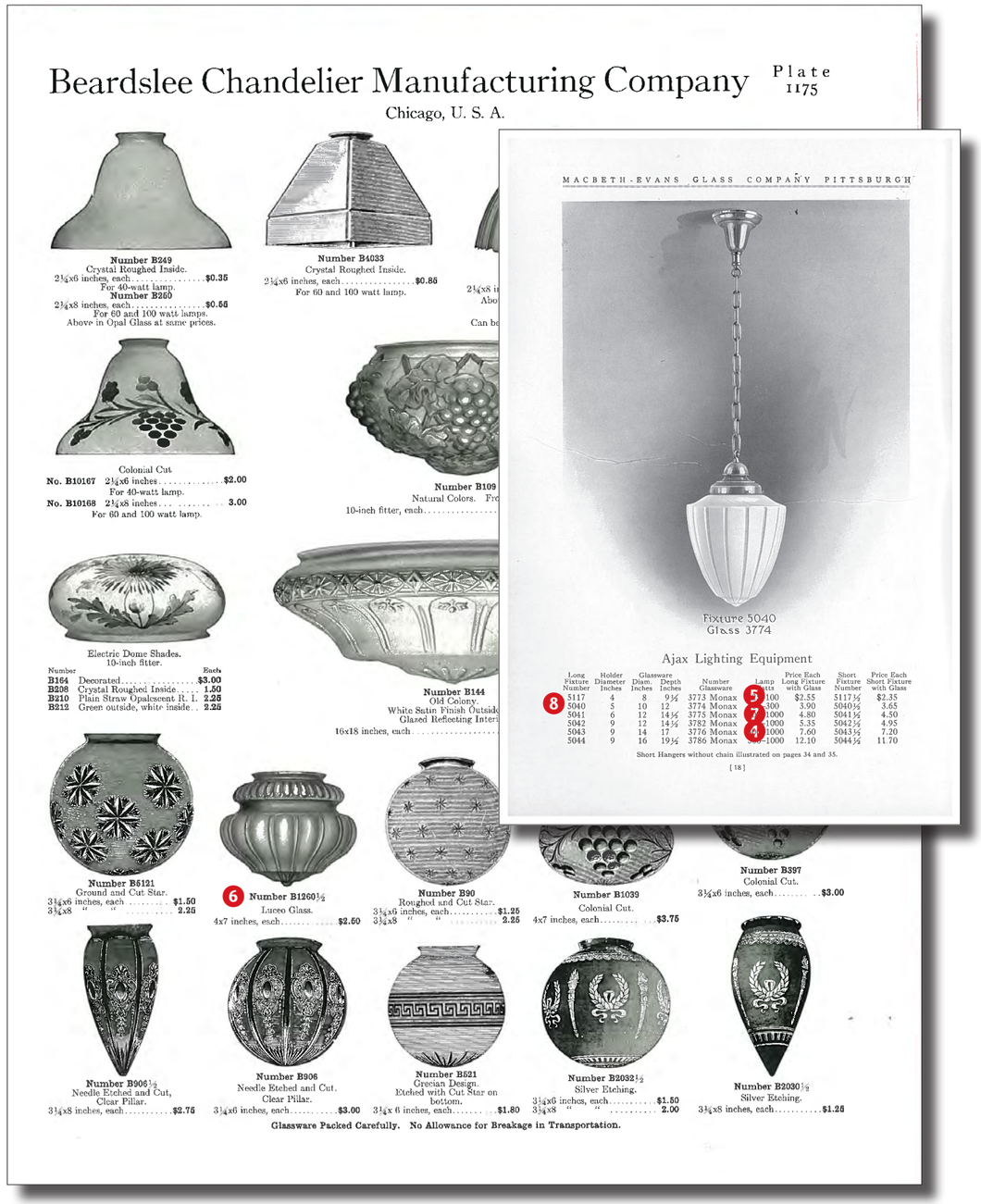


Figure O.78. 1915 Beardslee Catalog No. 22 Shade Plate 1175 and 1910 Macbeth-Evans Alba Shade Reference (inset)

The Beardslee Catalog page and the Macbeth-Evans Catalog page (inset) identifies/corroborates the shades on many extant pendants, surface mounts, chandeliers and wall brackets (see Table O.6).

TABLE O.6. PHASE 3 | 1916 BEARDSLEE LUMINAIRE STATUS – PUBLIC SPACES

This table indicates corroboration between many of the extant luminaires in public areas, their shades, and finishes with those in the 1916 Beardslee chandelier order (see Appendix O2) as well as indicating the number of luminaires, lamps, and shades in respective spaces (room numbers in accordance with 1916 chandelier order and DuBois plans). In all of these spaces, the shades, seen in adjacent Figure O.78 result in a moderate amount of diffuse, relatively uniform light while minimizing glare (no exposed, visible lamps).

Space | Shade Catalog No.		Luminaire Count	Lamps per Luminaire	Shades per Luminaire	Status	Finish	OAS[a]
West Wing							
Vestibule | **Alba 3776**	4	1	1	1	Field confirm	BZ Gr Relief[b]	NR[c]
Corridor 106 | **Alba 3776**	4	2	1	1	Luminaire missing	BZ Gr Relief[b]	NR[c]
Hall 206 | **Alba 3773**	5	3	1	1	Different shade[d]	BZ Gr Relief[b]	NR[c]
Senate Chamber 210 | **B1260**	6	2	2	2	Extant intact	Light BABZ[e]	Wall bracket
Hall 211 | **Alba 3773**	5	3	1	1	Different shade[d]	BZ Gr Relief[b]	NR[c]
Lobby 215 | **Alba 3773**	5	5	1	1	Extant intact	BZ Gr Relief[b]	NR[c]
Corridor 218 | **Alba 3776**	4	1	1	1	Different shade[d]	BZ Gr Relief[b]	4' 6"
Senate Chamber 307 | **B1260**	6	4	12 (4/8 - 2 ckts)	9 (1/**8**)	Extant intact	Light BABZ[e]	11' 0"
East Wing							
Corridor 226 | **Alba 3776**	4	1	1	1	Different shade[d]	BZ Gr Relief[b]	4' 6"
Lobby 232 | **Alba 3773**	5	5	1	1	Extant intact	BZ Gr Relief[b]	NR[c]
Hall 239 | **Alba 3773**	5	3	1	1	Different shade[d]	BZ Gr Relief[b]	NR[c]
House Chamber 243 | **B1260**	6	2	2	2	Different shade[d]	Light BABZ[e]	Wall bracket
Hall 244 | **Alba 3773**	5	3	1	1	Different shade[d]	BZ Gr Relief[b]	NR[c]
House Chamber 320 | **B1260**	6	4	12 (4/8 - 2 ckts)	9 (1/**8**)	Extant intact	Light BABZ[e]	10' 0"
First Floor Additional							
Corridors | **Alba 3776**	4	2	1	1	Field confirm	BZ Gr Relief[b]	6' 0"
Old Building							
Front Entrance | **Alba 3776**	4	1	1	1	Field confirm	BZ Gr Relief[b]	Clg Lt[f]
Entrance Lobby | **Alba 3773/3775**	5 7	1	5	4/1	Extant intact	BZ Gr Relief[b]	Clg Lt[f]
Rotunda | **Alba 3773/3775**	5 7	4	5	4/1	Luminaire missing	BZ Gr Relief[b]	Clg Lt[f]
Corridors | **Alba 3776**	4	3	1	1	Field confirm	BZ Gr Relief[b]	NR[c]
Corridors | **Alba 3773**	5	1	1	1	Field confirm	BZ Gr Relief[b]	Clg Lt[f]
Lobby and Rotunda | **Alba 3776**	4	6	1	1	Different shade[d]	BZ Gr Relief[b]	NR[c]
Rotunda Dome | **Alba 3773/3774/3776**	5 8 4	1	31	6/12/1	Luminaire missing	BZ Gr Relief[b]	NR[c]

Footnotes

[a] OverAll Suspension (presumed from ceiling to bottom of luminaire, but may have indicated overall length of chain or stem).

[b] Bronze Green Relief.

[c] None Reported. Many of these were quite possibly surface-mounts - directly mounted to the ceiling.

[d] Existing shade observed as different from 1916 Beardslee BOM specification. Luminaire body may also be different, but cannot be confirmed.

[e] Brushed Antique Bronze.

[f] Specifically identified on 1916 Beardslee BOM as "Ceil. Lt." and, therefore, believed to be mounted to celing surface.

"master control" of the whole building or areas of the building was likely achieved by) manually throwing breakers at the breaker panel.

O.02.06 Endnotes

[1] Final Report of the Capitol Building Commission (Cheyenne: Capitol Building Commission, State of Wyoming. 1888), p. 17.

[2] Specifications for the Erection and Completion of a Capitol Building for Wyoming Territory, to be Located in Cheyenne as Designed by D. W. Gibbs & Co., Architects, Toledo, Ohio (Toledo: Barkdull Brothers, 1886), p. 31.

[3] Final Report of the Capitol Building Commission Schedule (Cheyenne: Capitol Building Commission, State of Wyoming. 1888), p. 6.

[4] E.P. Gleason Mfg. Co. [catalog] (New York, 1887), pp. 104 and 152.

[5] Specifications for the Erection and Completion of a Capitol Building for Wyoming Territory, to be Located in Cheyenne as Designed by D. W. Gibbs & Co., Architects, Toledo, Ohio (Toledo: Barkdull Brothers, 1886), p. 27.

[6] Special Report of the Second Capitol Building Commission (Cheyenne: Capitol Building Commission, State of Wyoming, 1889), pp. 2, 3, Exhibit C.

[7] The Illumination of the Federal Building, Indianapolis, Ind. J.E. Woodwell. The Illuminating Engineer (New York:

[8] Report of the Capitol Commission (Cheyenne: Capitol Commission, State of Wyoming, 1890), p. 2.

[9] Bi-ennial Report of the Capitol Commission (Cheyenne: Capitol Commission, State of Wyoming, 1894), p. 1.

[10] Capitol Building Commission Report (Cheyenne: Office of the Board of Capitol Commissioners, State of Wyoming, 1896), pp. 1 and 3.

[11] Biennial Report of The Capitol Building Commission (Cheyenne: Capitol Building Commission, 1906), p. 7.

[12] Biennial Report of The Capitol Building Commission (Cheyenne: Capitol Building Commission, 1908), p. 8.

[13] Ibid.

[14] Biennial Report of The Capitol Building Commission (Cheyenne: Capitol Building Commission, 1910), p. 8.

[15] Biennial Report of The Capitol Building Commission (Cheyenne: Capitol Building Commission, 1914), pp. 2 and 6.

[16] Bi-ennial Report of the Capitol Commission (Cheyenne: Capitol Commission, State of Wyoming, 1894), p. 1.

O.03 Criteria

A review of lighting criteria, project givens, and present-day perspectives on architectural preservation/restoration will set some parameters for developing lighting strategies. Specific lighting criteria are introduced as design targets. Project givens include the physical siting, size, configuration, and intended programming of the architecture. Architectural preservation/restoration priorities related to lighting techniques and hardware will guide various issues.

O.03.01 Lighting Criteria

Key criteria related to the quantitative aspects and lighting effects are illuminance, glare, ultraviolet intensity, color rendering and color temperature, room surface finishes, controls, and patrol [surveillance] requirements. These are the primary criteria to be used in development and selection of electric lighting for the Capitol. Certainly, to the extent that sustainable, energy efficient lighting design and technologies can be implemented without adversely affecting functionality and historic character, they are considered. Modern lighting criteria espoused by the Illuminating Engineering Society (IES) are considered where these do not adversely affect historical lighting effects. Where conflicts arise, these are noted. The most recent lighting recommendations by the IES were published in 2011 and provide adjustment for the visual age of the majority of the observers using three groupings: visual ages <25 years; 25 – 65 years; >65 years. For purposes of the Capitol project, the majority of observers ages are assumed to be 25 – 65 years old. With younger observers there will more light than considered optimal to perform visual tasks. With older observers there will be less light than optimal which essentially means somewhat longer time periods may be needed to perform tasks. Safety and security, however, will not be diminished.

Lighting Criteria History

By 1886, lighting criteria had evolved somewhat from an earlier prescriptive for architects and builders, that is, liberally fenestrate. Windows, skylights, monitors, clerestories, transoms, and sidelights were de rigueur. By 1863, an illuminance metric (the footcandle) was proposed and adopted. At that time, man-made light was a precious commodity that made limited nightlife possible. By 1886, the competing interests of gas and electricity were driving the cost of light down. However, it would be another twenty years before the Illuminating Engineering Society would be founded and lighting criteria guidelines formalized.

It was not until the latter part of the nineteenth century, then, that illuminance criteria appeared in print. By 1906, these typically ranged from 0.25 to 3 and up to even 6 footcandles (fc) depending on the functional aspects of the interior space. Some early twentieth century scientific work concluded that darker colored spaces needed more light. By the 1920s, anecdotal evidence supported and was reported that the quality of the light—distribution of brightnesses–was as important as the quantity of light (aka illuminance, reported in fc). At about this same time, lighting intensity criteria began to rise by as much as 5 fc a decade through the 1970s. Energy issues and more prudent procedures for establishing industry–recognized criteria have resulted in a decrease in illuminance criteria for interior spaces and exterior areas over the past few decades.

Today, visible light intensity criteria are related to the intended functional and emotional (subjective) requirements of the light. Functional requirements are directly linked to the visual tasks at hand and ages of observers — older occupants and visitors perhaps requiring more light than younger ones. Subjective requirements are linked to the desired reaction of the occupants and visitors — responses to displays and to architectural settings. Functional and subjective requirements influence the other, and can be used to support or negate the other. For example, at the Capitol, a lighting approach for the rotunda that establishes an interpretive historical character might result in just a few footcandles of light on the rotunda floor while selectively enhancing the architecture and softly accentuating artworks. If security or code requirements were to demand from electric lighting as much as 10 or 15 footcandles uniformly throughout, then the rotunda would become the lighting-equivalent of a washed-out, modern-day waiting lobby. Functional and aesthetic rationale need to be assessed and priorities set for lighting.

Lighting for Art and Artifacts – 1888

For millennia, the display of artwork was made in daylit halls, courts, temples, cathedrals, castles and, more recently in museums and Capitols. Gas lighting and electric lighting were new tools for curators at the end of the nineteenth century. Displays of art and historic artifacts became increasingly acceptable and popular endeavors at the same time. Insufficient experience with the effects of lighting on art meant that no limiting lighting criteria were espoused for the sake of preserving art and artifacts. Typically, more light was considered better − for all to see the glory of the artwork or experience the detail and history of the artifact. Daylight was preferred for its intensity and color rendering, with gaslight and electric light supplementing on darker days and in the evenings.

Lighting for Art and Artifacts – 2013

For preservation-worthy objects, balancing light exposure and users' expectations can be a significant challenge. Exposure to light degrades most all types of artworks and interior finishes, with some more vulnerable than others. *Table O.7* identifies the three categories of light sensitivity for preservation-worthy objects and respective illuminance criteria. The degree and speed of degradation are related to the sensitivity of the materials and to total exposure time and the levels of visible light, UV (ultraviolet) and IR (infrared). Room ambient light alone may be too intense for more fugitive materials and finishes. Users have expectations of light in these settings to meet their needs for circulation, facial recognition, conversation, and, perhaps even casual reading depending on the type of space functions. This determines ambient light requirements. If artworks are to have some emphasis in order to contribute to a more visually interesting setting, there are recommended ratios of focal light levels to ambient light levels (2:1 art to background at a minimum and 3:1 or more preferable as an effect). All of this elevates light levels to values much higher than those found in museum settings typically where preservation/conservation of objects is paramount.

Table O.7. Preservation-worthy Objects Categories and Illuminance Criteria[1]

Category	Examples of Preservation-worthy Objects[a,b,c]	Criteria[d]
High Sensitivity	books, botanical specifimens, costumes, cotton, drawings, dyed leather, features, fugitive dyes, fur, gouache, insects, manuscripts, miniatures, paintings in distemper media, paper, prints, silk, skins, some minerals, some photographs, stamps, tapestries, textiles, wallpapers, watercolors, wool, and writing inks	5 fc
Low Sensitivity	bone, horn, ivory, lacquer, leather, oil paintings, some plastics, some photographs, tempera paintings, textiles with stable dyes, and wood finishes	20 fc
No Sensitivity	ceramics, enamel, glass, jewels, metal, most minerals, stone, and wood	100 fc

Footnotes

[a] Where any doubt exists, assign objects to categories of higher sensitivity to light with concomitant reduction in illuminance.

[b] Objects or artworks consisting of a variety of the exemplified materials should be categorized in the most sensitive category. Some objects, such as ceramics or metal, may exhibit fugitive finishes and should be assigned to the high-sensitivity-to-light category.

[c] Consult with conservator to establish light sensitivity categories for given objects.

[d] Values are maximum, maintained targets in footcandles, intended for application on artwork-dependent plane of interest (horizontal, vertical, or other).

In museums, visitors may be routed through several rooms of progressively darker settings with little or no daylight before viewing the most sensitive artworks in extremely low light − almost dark so that artworks illuminated with just 5 fc have a prominence and clarity acceptable to visitors. The Capitol does not offer such a transition sequence. However, occupancy sensors on short time delays (to extinguish lights quickly once visitors move on) can be used to further limit light exposure to only those periods when people are actually in the space to view the artworks. In addition, strict hours of display and light exposure as well as a regimen of rotating artworks into long-term dark storage or back to donors can help delay the effects of degradation over very long periods of time. These practices demand vigilant curatorial attention.

Where preservation-worthy materials are intended for long term and prominent display and where light levels cannot be limited to that of museums housing sensitive works, it is recommended that high quality facsimiles of the works be made for purposes of public display and that the originals be retired to secure, properly conditioned, dark storage. A successful example is the Civil War-era flag display in the Michigan Capitol rotunda, where, it was discovered during restoration of the Capitol in 1989, some flags had nearly disintegrated to dust after nearly 125 years of display. (http://www.hal.state.mi.us/mhc/museum/explore/museums/hismus/special/flags/flagsave.html) On the upper floors of the rotunda, selected portraits of Michigan governors are displayed. The portraits, original oil paintings, are currently

illuminated with historically-sympathetic picture lights fitted with UV filters (*see Figure O.79*).

Lighting for Function – 1888

Gaslight introduced the public to light levels of perhaps 2 or 3 fc near the source and average room illuminance of one–quarter fc. By 1906, lighting criteria was evolving and not yet codified by the industry.

The "1906 – 1915" column in *Tables O.8 and O.9* outlines illuminance criteria typical of the period. With electric light, people had the luxury of 2 or 3 fc average throughout an entire space, even in 1888. Based on the 1886 lighting specifications and bid information, it is possible that most of the public circulation spaces could have had one-quarter fc average of gaslight and, if electric lights were installed, perhaps more than 1 fc average on the floor plane. Under the 30-burner reflector specified in the Supreme Court, there may have been as much as 5 to 10 fc directly underneath the luminaire and certainly 1 to 2 fc average throughout the space.

By 1918, electric lighting was exclusively the man-made light of use in the Capitol. The "1906 – 1915" column in *Tables O.8, and O.9* outline illuminances likely achieved with the electric lighting system of the day.

Lighting – 2013

Even at the turn of the 20th century, papers on the psychological effects of lighting are part of the illuminating archives. Indeed, light was considered for more than just its contribution to functional reading and writing. Today, there are a number of criteria beyond "just illuminances on the floor or desk" that contribute to the overall perception by and performance of people. So, in addition to illuminance, a number of these other aspects are discussed here and are consideration appropriate and important to the overall character and function of the Capitol.

Lighting for Function – 2013

Table O.8 outlines typical industry illuminance (light level) criteria for interior situations. Criteria are dependent on a variety of factors and subject to various interpretations. The column on the far right identifies recommended illuminance targets for the task area. These are maintained values – that is, after some years of operation and the effects of dirt accumulation and lamp output degradation are accounted for, these are the illuminances that should be available and considered appropriate for task performance. For more historic and ceremonial settings, reducing values may be appropriate if task performance time is allowed to increase accordingly. However, egress code minimums should not be compromised.

Depending on interpretation by registered professionals and the authority having jurisdiction (AHJ), the code may require minimum light levels in occupied spaces greater than those necessary to address recommendations cited in *Table O.8*. The code minimum would take precedent over the recommended illuminances outlined here unless exceptions are granted. For example, IBC 2012, Section 1205.3 requires 10 fc throughout all occupied areas. This is well in excess of illuminances necessary for many tasks and applications and contributes to unnecessary energy use and a more vapid setting. It is proposed that the AHJ be requested to set aside this requirement.

Lighting for Comfort

The light levels recommended and discussed previously are sufficient for function − the performance of tasks such as walking, conversing, reading, and writing. However, subjective impressions, the unfolding of the monumental space to first-time visitors, facial recognition, and the historic architecture should also influence the lighting concept design. These are presented here as criteria aspects.

People's perception of space depends on luminance (brightness), contrasts and/or color contrasts, both of which are related to illuminance on various surfaces. This includes not only floor plane or work surface illuminance. Ceiling and/or wall surface brightnesses contribute significantly the sense of spaciousness, preference, and visual attraction, helping to guide people into and/or through spaces. *Figure O.79* is a clear example of where the overall lighting effect is about more than just light on the floor − of which there are 3 to 5 fc. Strategically positioned historical lighting helps brighten the architectural pilasters and brackets. In-floor uplights at the 2nd and 3rd floor balcony floors further accentuate these details, as well as brighten the ceiling panels and painting. Flag display and portrait lighting also contribute to the overall impression of brightness and define the unique character of the rotunda. Without all of this "other" lighting, the rotunda would feel much like a confined and relatively dark space, except for the bright dome which itself would be overly bright against the background of seeming darkness.

Facial recognition enhances impressions of safety and security. Uniform vertical light intensities – light falling onto vertical planes in space – of just a few footcandles can greatly improve facial recognition in low-light environments. Some lighting of wall and/or ceiling surfaces, or glowing wall brackets or chandeliers yield diffuse light that provides these uniform, yet soft vertical intensities.

Lighting of the architecture for people's experience can be overtly expressive with architectural details highlighted, or simply neutrally expressive with soft washes of light from brackets, chandeliers, and candelabras. In any case, haphazard brightness patterns introduce visual noise and should be avoided. Where the prime experience is intended to be that of drinking in the history of a place and its events, the architectural lighting should be overtly expressive. Where the prime experience is intended to be that of a diorama or where artifacts or art are on display, the architectural lighting should be neutrally expressive, with display lighting accentuating exhibits, art, and artifacts in some planned hierarchy. Even so, given the history and monumentality of the Capitol's architecture, it should be lighted in a way that allows visitors to appreciate the style and craftsmanship of the period of construction and the earth's materials used to create this fine example of a state's seat of government.

Figure O.79. 1879 Michigan Capitol Flag Displays and Governors' Portraits

The image on the left is a fish-eye view of the rotunda with the displays of replica flags. Historic flags are kept in dark storage. The image on the right is a more conventional view of the rotunda with better depiction of the UV-filtered picture lights used to illuminate portraits in a historically-sympathetic manner (commercially-available picture lights can be found in the literature at the turn of the 20th century). Picture lights have the benefit of always fixing the light onto the same location on the artwork without relying on re-aiming (or misaiming) by maintenance or curatorial personnel, as readily happens with adjustable art accent lights.

Visitors' and occupants' expectations of "the normal" should also be considered here. The architectural apertures that originally admitted daylight at the Capitol should be reopened, where architecture and function permit. The variable sky conditions filtered through laylights introduce welcome patterns of varying light intensity.

Glare

Glare is light concentrated in too small an area that is visible from normal viewing positions or is an overwhelming amount of light over a large area. Glare can be a direct phenomena or an indirect (reflected) phenomena. Glare is considered problematic when it interferes with important viewing or in casual situations where the glare could be easily eliminated without resorting to turning off lights or delamping lights (e.g., as in man-made situations where accent lights are mis-aimed and proper re-aiming can mitigate the glare). Shielding glare

Table O.8. Interior Illuminance Criteria[1]

Typical Application/Function[a,b] Discussion	1906 - 1915[c]	2013 IES[d]	Recommended[d]
Chambers Average recommended for audio visual/Average recommended for continuous-concentrated reading-writing primarily screen display work at desk from task lighting/Average recommended for general (ambient) background	NA/10 fc/4 fc[e]	3 fc/30 fc/20 fc	3 fc/30 fc/20 fc
Committee/Hearing Rooms Average recommended focal lighting at committee's table for media events (vertical)/Average recommended for audio visual/Average recommended at committee's table/Average recommended for general (ambient) background	NA/NA/2 fc[e]	50 fc/3 fc/30 fc/10 fc	50 fc/3 fc/30 fc/10 fc
Conference Rooms Average recommended for audio visual/Average recommended at conference table/Average recommended for general (ambient) background	NA/NA/NA/2 fc[e]	3 fc/30 fc/10 fc	3 fc/30 fc/10 fc
Corridors/Circulation Average recommended for general (ambient) background	1 fc[e]	5 fc	5 fc
Egress Minimum code-required on defined egress paths	NA	1 fc min IBC 2012	1 fc min IBC 2012
Elevator Thresholds Minimum code-required on corridor-side of thresholds (demands modern lighting intrusion)	NA	10 fc min ASME A17-1-2010	10 fc min ASME A17-1-2010
Galleries Average recommended for general (ambient) background	2 fc[e]	10 fc	10 fc[f]
Lounges Average recommended for general (ambient) background	NA	4 fc	4 fc
Lunch Room/Break Room Average recommended for general (ambient) background	NA	10 fc	10 fc
Offices - Ceremonial Average recommended focal lighting at presider's position for media events(vertical)/Average recommended for continuous-concentrated reading-writing primarily screen display work at desk from task lighting/Average recommended for general (ambient) background	NA	50fc/30 fc/10 fc	50fc/30 fc/10 fc
Offices - Work (primarily screen display viewing) Average recommended for continuous-concentrated reading-writing primarily screen display work at desk from task lighting/Average recommended for general (ambient) background	5 fc/2 fc[e]	30 fc/10 fc	30 fc/10 fc
Public Reception Average recommended at desk/Average recommended for general (ambient) background	NA	15 fc/5 fc	15 fc/5 fc
Rotunda Average recommended for general (ambient) background/Minimum required on floor plane of defined egress path	1 fc[e]	10 fc day/5 fc night 1 fc min IBC 2012	10 fc day/ 5 fc night[g] 1 fc min IBC 2012
Stairs Average recommended for treads/Minimum required on treads	NA	5 fc 1 fc min IBC 2012	5 fc 1 fc min IBC 2012
Working Reception Average recommended for continuous-concentrated reading-writing primarily screen display work at desk from task lighting/Average recommended for general (ambient) background	NA	30 fc/10 fc	30 fc/10 fc

Footnotes

[a] The Lighting Handbook Tenth Edition uses an illuminance recommendation system based on Categories A through Y. A representative sampling of applications/functions are cited here as examples. The complete list of applications, functions, and tasks cited in the reference will be used in the development of lighting recommendations for the capitol.[2]

[b] For general circulation, targets are intended to apply to ground or floor plane. For work spaces, targets are intended to apply to the plane of the task or work surface (usually horizontal). For specific tasks, targets are intended to apply to horizontal work surface on which task is located. Reference cites definitive tasks and more expansive list.[2]

[c] The Illuminating Engineering Society of North America was not founded until 1906 and did not establish consensus criteria until sometime later. NA = not available. Values cited here are based on early 20th century references for illumination levels in buildings of the time, which, given that these were published projects in prestigious journals, were likely considered good-to-best.[3,4,5,6,7]

[d] Unless otherwise noted, values are intended as average, maintained targets achieved on the task area. Assuming visual ages of majority of occupants/users are between 25 and 65 years. Values interpreted from The Lighting Handbook Tenth Edition: Reference and Application (New York: Illuminating Engineering Society, 2011)

[e] Electric light only.

[f] For purposes of legislators maintaining visual attention on tasks, Gallery lighting could be as little as one-fifth Chamber background lighting, or 4 fc. For live and video surveillance and to better balance Chamber brightnesses for legislators, Gallery lighting should be about one-third to one-half Chamber background lighting, or 7 to 10 fc. IES criteria for courtroom galleries is 10 fc.

[g] All illuminance recommendations include effects of daylight and electric light. It is presumed that the daylight contribution in the rotunda during the day will provide at least 5 fc of illumination. As such, the electric lighting system need only provide for the nighttime recommendations and comprise half of the daytime recommendation.

TABLE O.9. EXTERIOR ILLUMINANCE CRITERIA[1]

Typical Application/Function[a,b] Discussion	1906 - 1915[c]	2013 IES[d]	Recommended[d]
Exit Discharge (exterior exit thresholds) Minimum code-required on grade exterior-side of exit thresholds (3-foot extension by width of threshold considered extent of exit discharge)	NA	1 fc min IBC 2012 0.5 fc min @curfew[e]	1 fc min IBC 2012 0.5 fc min @curfew[e]
Exterior Ramps, Stairs, and Landings Average recommended on grade for defined path of travel (need not be entire surface) treads and landing surfaces	NA	0.4 fc 0.2 fc @curfew[f]	0.4 fc 0.2 fc @curfew[f]
Facade Maximum recommended for accenting on features and/or unique details (should be no more than 15% to 20% of overall facade area)/Average recommended for facade fields (general areas of entire or portions of entire facade). Set back levels at curfew (e.g. 11 p.m.).	NA	15 fc/5 fc 8 fc/3 fc @curfew[f]	15 fc/5 fc 8 fc/3 fc @curfew[f]
Pedestrian Paths Average recommended on grade of defined path area	NA	0.2 fc 0.1 fc @curfew[f]	0.2 fc 0.1 fc @curfew[f]
Plazas Average recommended on grade of defined plaza area	NA	0.4 fc 0.2 fc @curfew[f]	0.4 fc 0.2 fc @curfew[f]

Footnotes

[a] The Lighting Handbook Tenth Edition bases illuminance recommendations on Categories A through Y. A representative sampling of applications/functions are cited here as examples. The complete list of applications, functions, and tasks cited in the reference will be used in the development of lighting recommendations for the capitol.[2]

[b] For general circulation, targets are intended to apply to ground or floor plane. For work spaces, targets are intended to apply to the plane of the task or work surface (usually horizontal). For specific tasks, targets are intended to apply to horizontal work surface on which task is located. Reference cites definitive tasks and more expansive list.[2]

[c] The Illuminating Engineering Society of North America was not founded until 1906 and did not establish consensus criteria until sometime later. NA = not available. Values cited here are based on early 20th century references for illumination levels in buildings of the time, which, given that these were published projects in prestigious journals, were likely considered good-to-best.[3,4,5,6,7]

[d] Unless otherwise noted, values are intended as average, maintained targets achieved on the task area. Presuming visual ages of majority of occupants/users are between 25 and 65 years. Values interpreted from The Lighting Handbook Tenth Edition: Reference and Application (New York: Illuminating Engineering Society, 2011)

[e] After curfew, use motion sensors to sense occupancy and increase illuminances to pre-curfew code minimum.

[f] After curfew, consider motion sensors to sense occupancy and increase illuminances to pre-curfew recommendations.

sources is typically most convenient and most effective. Light-toned, matte-finish room surfaces help reduce the potential for direct glare from electric sources and/or daylighting by reducing the severe contrast that results with darker surfaces. However, only where supported by historic documentation and/or evidence should finishes be light–toned and matte.

Where historic finishes are richer and darker, attention should be given to purposely lighting these darker surfaces to avoid harsh contrast differences. This may be done with historic wall brackets or strategically spaced and placed pendants, for example.

Ultraviolet Radiation Effect on Art, Furnishings, and Finishes

Ultraviolet (UV) is deleterious to many materials. In museum settings, UV is typically limited to 75 microwatts per lumen (µW/lm) or less.[8] This can be achieved either by source selection, light intensity, and/or filtration. Important and/or priceless art and artifacts and their intended display locations should be identified in order to develop appropriate lighting resolutions. Alternatively, consideration might be given to rotating materials to limit exposure to light.

Fugitive surface finishes will fade or crack under light exposure. Historical decorative finishes should be specified with UV-inhibiting treatment. With the exception of museum lighting instruments that accommodate UV-reduction filters, most luminaires using modern halogen and fluorescent lamps, even when used in historical refurbishments, exhibit some amount of UV radiation. This is particularly pronounced with open-top luminaires such as the chambers' chandeliers. Many LED lamps, on the other hand, present no UV.

Color Rendering and Color Temperature

Gas flames exhibited color rendering and color temperature characteristics unappreciated today. Color rendering is a rating of how well a given light source renders color compared to daylight or laboratory-standard electric light. Depending on the quality of gas, the pressure of the gas, and the type of gas burner, gas flames can render gold, yellow, orange, and red tones quite well. Indeed, the flame sources can actually enhance the visual warmth of these colors. On the other hand, flame sources render greens, blues, and purples quite poorly. Carbon filament incandescent lamps (the electric lamps from 1879 through about 1910) were, essentially, an electric candle. These sources – gas flame and carbon filament – resulted in low light levels. Low illuminances, say of a few footcandles and less, result in even poorer color discrimination, compounding the low color rendering of blues and greens of gas flame and carbon filament sources. Perhaps the colorful interiors of the late nineteenth and early twentieth centuries were meant to make up for this deficiency.

Most light sources today exhibit high color rendering. Efficient light sources should have a color rendering index (CRI) of at least 85 and preferably 90+, with 100 being best (epitomized by halogen incandescent lamps or clear–sky/sunny daylight). However, these light sources, if used in high-light-intensity situations, will illuminate overly colorful settings to a point that these environments will be considered gaudy. So, lamp color rendering, light intensity, and surface finishes should all be coordinated to establish a reasonably historical character in the restored environment.

Color temperature is an expression of the whiteness of the light produced by a light source (reported in Kelvin, with 0K as black – the "source" emitting no visible light). The yellow light of candle and some gas flames has a color temperature of about 2000K. More efficient gas jets might produce flames of color temperature of somewhat whiter light at 2500K. Carbon filament lamps of 1890 probably exhibited a color temperature of 2200K. Early tungsten filament lamps, unavailable until 1907, probably

exhibited a color temperature of 2500K. Today's halogen incandescent lamps have a whiteness of 2800 to 2900K. For interior lighting where historical character is important, light source color temperatures should not exceed 3000K (today's typical warm white fluorescent lamps). This might necessitate straw or peach filters on certain present–day white light sources. In order to prevent the light from being too cool or institutional.

It is worth noting that recent research into very low light intensities and people's visibility and perceived brightness indicates that cooler toned sources (at least 3000K and preferably 5100K) have benefit.[9, 10] As such, 3000K might be considered a compromise for most historic interior and exterior lighting situations. Higher color temperatures appear quite institutional and annoyingly sterile.

Finishes

Lighter finishes limit harsh luminance ratios and assist in the efficient distribution of light. However, only where supported by historic documentation and/or evidence should finishes be light–toned and matte.

Sustainability

Using the earth's resources wisely is appropriate and crucial to any institution's public relations. Minimizing the amount of spent material put back into the earth is equally important. Judiciously using light and employing lighting methods and technologies that maximize system life, minimize the number of lamps and ballasts, and maximize efficiency are recommended for enhanced sustainability. Daylighting, if not adversely affecting cooling requirements and not adversely affecting view/glare situations, should be considered throughout for some component of the lighting. While registered interior historic buildings and registered historic landmark buildings are exempt from the ASHRAE/IESNA 90.1 Energy Standard, efforts should be made to use the most efficient lamps available without sacrificing historical appearances and effects. Based on previous experience, the lighting power density (LPD) might approach 2.5W/sf building-wide for conventional lamping and perhaps as low as 2.0W/sf building-wide for LED lamping in historic settings. Some spaces, particularly the Chambers and the Rotunda where backlighted laylights use many high-powered luminaires to overcome the very low transmittances inherent in the historic stained glass, might exhibit connected loads approaching 7.5W/sf for conventional lamping or perhaps as low as 6.0W/sf for LED lamping, though seldom would the entire load be used during daytime hours when solar loads are greatest. Daylighting and automated controls responding to occupancy and daylighting may yield an energy-use-equivalent of 1.5W/sf for conventional lamping or perhaps as low as 1.3W/sf for LED lamping. Even less is possible given the potential for "historic lighting" tour preset scenes when the legislature is not in session and the flexibility of a whole-building dimming control system.

Maintenance

Lighting maintenance is crucial to the efficient and effective performance of daylighting and man-made lighting. Spot and group relamping are appropriate techniques. Spot relamping is done when, on regularly-scheduled tours, lamps are observed to be expired and replaced within a limited time frame, such as a day. Group relamping is done when it appears a group of lamps are at or near the end of their rated life, such as when a multiple number of lamps in the same vicinity are observed to be expired over a relatively short period of time, perhaps a week or two. During the relamping efforts, luminaires should be checked for wear and should be cleaned in accordance with manufacturers instructions. Where very long-life lamps are used, such as LEDs, cleaning may need to occur on annual or biannual cycles as lamps may last a good number of years and the resulting dirt build-up would yield a significant reduction in light output.

Particularly in historic properties, special procedures will be necessary to maintain lighting equipment in difficult to access areas. Every effort should be made to best accommodate maintenance, from OSHA-compliant catwalks to personnel lifts to chandelier winches. While use of long-life LED lamps offers promise of less-frequent service, maintenance access to lamps and power supplies and for purposes of cleaning is necessary. Access to some exterior lighting will be best served by periodically employing riggers or taking advantage of scaffolding erected for other work.

Controls

Automated lighting controls can best tune the lighting installation for a variety of use situations for the entire building or for discrete components, such as chambers, offices, committee rooms, and public circulation. Historical scenes for day and night can be set for public areas during tour hours or for clean-up, work, nightlight, and all-on-panic preset scenes. Automation is the only method for achieving best operational efficiencies – minimizing energy use and maximizing in-service power supply and lamp life. Automation achieves professional and consistent preset scenes for typical uses and allows for variable scenes advantageous for overnight security. Lighting should be zoned and dimmed in such a way to accommodate these various scene setups on a whole-building preset control system. Control stations of no more than 2-buttons can be made available to the public and employees with readily accessible, but limited, functionality – providing an "on" setting where lights are energized to a predetermined dimmed set point for the function at hand, such as circulation, and an "off" setting where lights are extinguished on a slow fade to allow timely exit from the area. Scene access can be limited by time of day. Access to a more complete array of scenes, such as "panic" to turn all lights to full bright or to energize all occupancy sensors, is limited to appropriately-cleared staff and authorities at security stations or through coded access from smart phone or computer (requiring secure Internet connections).

Automated controls should be capable of taking input signals from occupancy sensors in public areas and vacancy sensors in employee areas. Exterior lighting and some components of interior circulation lighting can then be dimmed after established curfews for nightlighting or distant live-surveillance patrol lighting, but which come to full-bright when motion is sensed in the local vicinity.

Egress

Where possible and practical, architectural lighting equipment will be powered by generator(s) capable of powering the lighting and types of lighting loads involved and without the use of luminaire-integrated battery packs which cannot be accommodated in most historic luminaire bodies. This will minimize the intrusion of modern auxiliary lighting hardware mounted on or recessed into walls and/or ceilings. Egress lighting will be coordinated by the Design Team to meet code and practice requirements.

Security

Off–hours patrol lighting should not contribute to the artwork/surface-finish exposure limits cited previously. This can be achieved with dimmed, timed, and/or motion–sensed lighting set to as little as one-twentieth of typical settings. Lighting related to the security of the facility should be addressed in conjunction with a security specialist. Current camera and detection technologies require little to no light for remote surveillance and detection. As indicated in the discussion on controls, secure control stations on-site or remote-access coded control can be made available with whole-building lighting control systems with dimming and various input capabilities.

Security for visitors

Facial recognition and discerning people movements can enhance the sense of security for visitors and assist live or remote surveillance. Lighting of surroundings can also enhance the sense of security. Security lighting for visitors should not exceed the artwork/surface-finish exposure limits cited previously. Although vertical illuminances help with facial recognition and discerning people movements, glare and over lighting must be avoided. Lighting related to the security of visitors should be addressed in conjunction with a security specialist.

O.03.02 Lighting Givens

A primary goal of the project is to restore the Capitol's architectural configurations, finishes, and furnishings, including lighting hardware, and settings to some point in its past. Although the issue of architectural preservation is, in its purest, disengaged from the functional requirements of the space, the architectural envelope must ultimately support the intended functional aspects of the spaces and inhabitants. The lighting design challenge is bridging any schism between the restoration lighting results and the functional program lighting issues. This assignment involves such lighting techniques as task lighting, to illuminate the task area, whether it be table, rostrum, desk, or circulation path floor; ambient lighting, some background light reminiscent of historical conditions; and accent lighting, to feature, architectural details and surfaces, special wall finishes or murals, and artworks. These three "layers" of light and how they are balanced are the key to functional spaces within the context and appearance

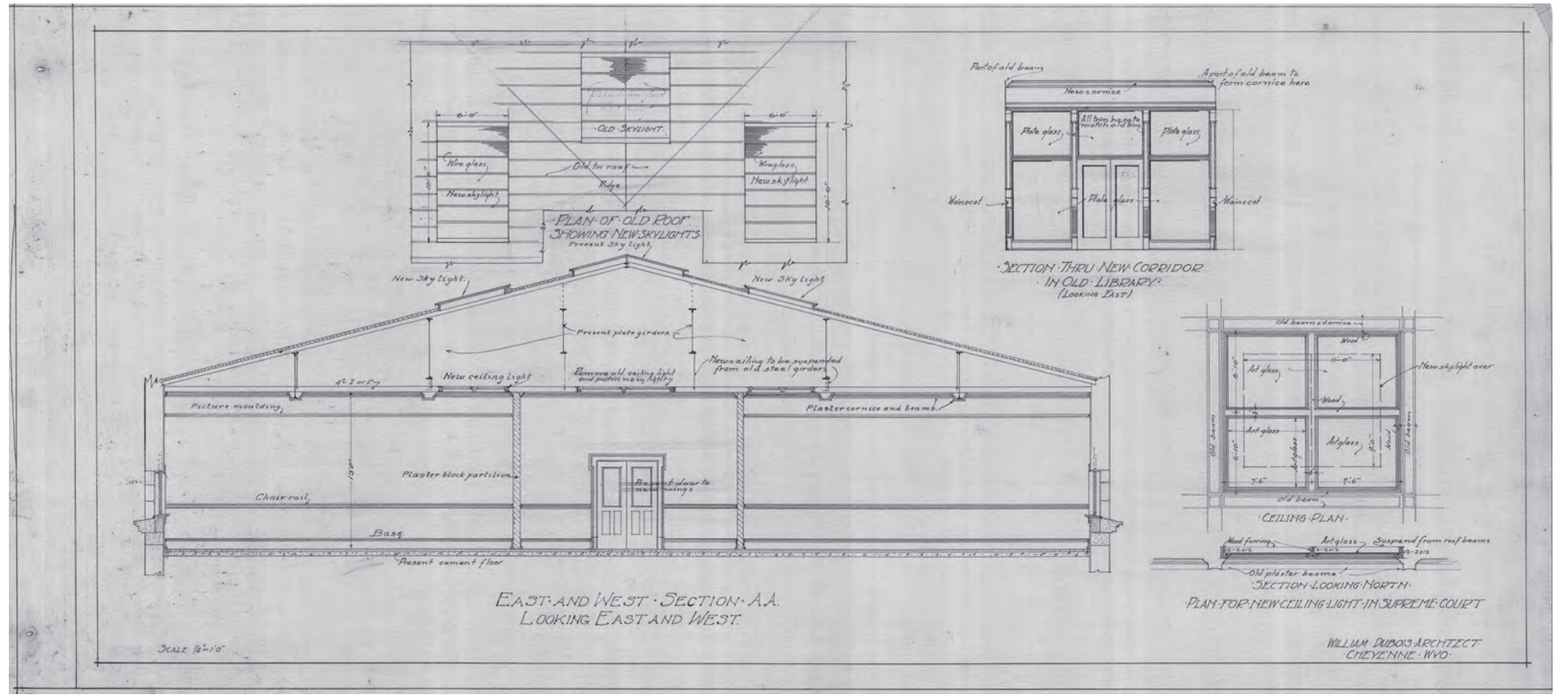


Figure O.80. ca. 1916 Details for Skylights/Laylights at 3rd Floor

This drawing, believed to be from the 1916 design package by William DuBois for the Phase 3 work at the capitol, illustrates the sections and plan views of the skylight/laylight details proposed for the 3rd Floor areas of what had been east- and west-most Phase 2 spaces. Also see Figure O.81.

of period architecture. Although man-made lighting must be used to accommodate dark-day and night functions, fenestration – apertures allowing daylight – is an important contributor to the overall lighting scheme. The building, both now and in its past, though perhaps more so in its past, is configured with a significant amount of fenestration daylighting potential. These daylighting opportunities need to be tapped to their fullest for authenticity, energy-effectiveness, occupants' benefits, and to avoid the institutional intrusion of full-force, modern electric lighting required when daylight is subverted.

Skylights/Laylights

Skylights/laylights are potential light sources in the chambers; rotunda dome; east and west rotunda circulation stairs light wells; and east- and west-wing 3rd floor circulation; some 1918-era offices (*Figures O.80 and O.81*); and Supreme Court. Examples of state projects where skylights have been reopened are the Virginia Capitol, the Michigan Capitol, the Ohio Statehouse, and the Ohio Courts. These skylight/laylight assemblies now offer the temporal qualities and the day-time electricity savings of daylight. Daylight intensities will depend on the skylight configurations, the skylight transmittances, the laylight configurations, the laylight transmittances, and the plenum configurations and finishes. Sufficient daylight intensities are even available from skylights/laylights exhibiting total transmittances as low as 15 percent. Control of this daylight potential will be crucial to developing comfortable, yet historically sympathetic laylights. The relatively deep plenums between the laylights and skylights offer great opportunity for the integration of supplemental electric light on darker days or to daylight in evening hours. Though it is common to throttle skylight and laylight transmissions too low and/or too diffuse, as exemplified by many museums and the current chamber skylights/laylights, to address degradation effects, avoid glare, and establish a "consistently neutral (dim) daylight quality," this reduces the available ambient light for much of the day and limits the experiential qualities of time-of-day, seasonal, and varying sky conditions. Careful study with the architects and mechanical engineers can yield an approach that better balances historical accuracy ("leave all the daylight in") with artwork conservation ("keep all or much of the daylight out") and user experience ("want variable effects and relative intensities of daylight"). This may demand automated daylight controls to respond to the extremes of daylighting.

Windows, Transoms, Sidelights and Door Lites

Windows along the exterior perimeter of many spaces will continue to play a dominant role in the restored architecture. The daylight will need to be mitigated to comfortable intensities for visitors and occupants, and to acceptable intensities for exhibits or restored finishes and furnishings. Automated systems help to minimize the "set it and forget it" mentality that typically results in little if any daylight contributing to the overall ambient lighting. Automation can also be used at night to benefit security and limit unwanted surveillance of work areas.

Transoms, sidelights, and door lites contribute to at least a sense of daylight, if not to actual illuminances. Impressions of brightness as well as the perceptions of variability of daylight result from these techniques.

Historical details

1918 and perhaps even 1890 luminaire locations should be considered a given lighting opportunity in the restoration. However, architectural reconfigurations of corridors and interior walls may prevent this approach.

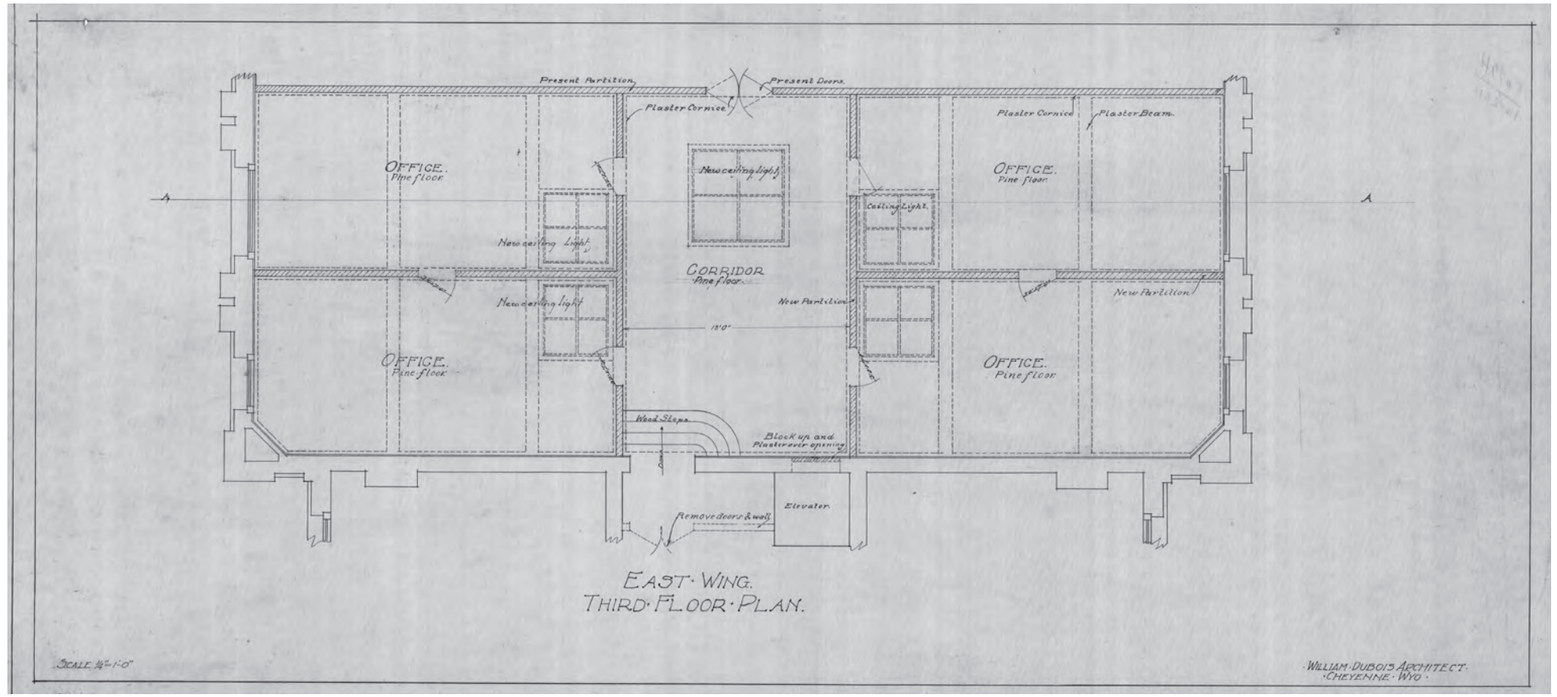


Figure O.81. ca. 1916 Plans for Skylights/Laylights at 3rd Floor

This drawing, believed to be from the 1916 design package by William DuBois for the Phase 3 work at the capitol, illustrates the intended ceiling plan layout of the skylights/laylights proposed for the 3rd Floor areas of what had previously been the east- and west-most Phase 2 spaces. Also see Figure O.80.

Also, in some, perhaps many, situations, in order to approach, if not achieve, modern-day lighting criteria, it is likely that more luminaires will be necessary. Their arrangements should be made in symmetric and historically-sympathetic patterns.

Skylights/laylights are opportunities for incorporating electric lighting to supplement daylight. Other details, including mouldings and coves may also offer opportunity for introducing historically-sympathetic lighting effects.

Media Lighting

Video conferencing and video recording/broadcast lighting can be highly disruptive − both to the occupants and the historic fabric of the architecture. Most of the newer camera technologies, even HD, are now capable of recording in relatively low-light conditions. For special events normally held in ceremonial spaces, discreet lighting can be integrated into the architecture to work in conjunction with the historic lighting to provide some nominal focal accenting. These spaces and/or any special lighting needs should be identified in advance of final lighting design. This may involve interior and/or exterior situations and may call for dedicated power receptacles and data feeds to accommodate various media outlets.

Seasonal and Event Lighting

Seasonal lighting and lighting and projection for events may demand power receptacles, control, and data feeds at key positions. Loads and locations must be identified if these aspects are to be accommodated in the design. Though lighting design is not directly affected, the electrical and architectural (and perhaps landscape architectural) disciplines are affected and details may be required to accommodate such lighting discreetly.

O.03.03 Endnotes

[1] The Lighting Handbook Tenth Edition: Reference and Application (New York: Illuminating Engineering Society, 2011), pp. 21.4 and 21.12.

[2] Ibid, p. 4.33 and application chapters.

[3] C.E. Knox, Illumination of the Engineering Societies Building, New York (New York: Illuminating Engineering Society, Vol. I, No. 7, 1906), pp. 445-480.

[4] Louis Bell, L.B. Marks, and W. D'A. Ryan, The Illumination of the Building of The Boston Edison Electric Illuminating Company, of Boston (New York: Illuminating Engineering Society, Vol. I, No. 7, 1906), pp. 603-632.

[5] Hermann Bohle, *Electrical Photometry and Illumination* (London: Charles Griffin & Company, Limited, 1912), pp. 162-171.

[6] W.E. Chapman, Artificial Lighting of Typical Offices in State, War, and Navy Department Building (New York: Illuminating Engineering Society, Vol. 10, No. 8, 1915), pp. 651-658.

[7] M. Luckiesh, *The Lighting Art* (New York: McGraw–Hill Book Company, Inc., 1917), p. 205.

[8] The Lighting Handbook Tenth Edition: Reference and Application (New York: Illuminating Engineering Society, 2011), p. 21.5.

[9] S. M. Berman, "Energy Efficiency Consequences of Scotopic Sensitivity," *Journal of the Illuminating Engineering Society*, 1992, no. 1: 3-14.

[10] S. M. Berman, et. al., "Spectral Determinants of Steady-State Pupil Size with Full Field of View," *Journal of the Illuminating Engineering Society*, 1992, no. 2: 3-13.

O.04 Lighting Strategies

The Wyoming Capitol has been at the forefront of lighting technologies and industry practice at various points in time. In its early years, daylight contributed significantly in setting the primary scene for the occupants. It was an early adopter of electric light. Over this past hundred-plus years, American society's desire for ever more light at ever lower costs led to ever-more-brightly, uniformly downlit spaces by the 1970s. Now, however, societal desires to preserve architectural treasures and specifically houses of democracy leads to a wonderful opportunity at the Capitol – restore it while embellishing its practical and functional use as the seat of the state's government.

The following design strategies are intended to offer guidance for interpretive historical lighting meeting modern-day expectations of function, efficiency, and sustainability all while preserving historic character.

These strategies are based on a period of significance of 1918, from which a compelling number of luminaires and lighting techniques remain intact today at the Capitol. These are initial ideas that may evolve or perhaps change significantly over the design phase and with input from the state and other project disciplines.

O.04.01 Priorities and Criteria

Priorities help establish criteria which, in turn, help establish design strategies. Here, although restoring the Capitol's original glory is a priority, functional restoration trumps decorative or museum-quality restoration. For example, where restoration of 1918 lighting might result in a visually aesthetic and authentic appearance, if light levels and/or control capabilities do not satisfactorily address the intended functions of spaces or areas, then the restoration effort is not entirely successful. Similarly, if control systems are not sufficiently tunable to energize or dim or extinguish electric lights according to use and/or daylight contributions, then the restoration effort misses operational and sustainability opportunities. Historically sympathetic yet functionally appropriate lighting will allow the Wyoming Capitol to operate and grow within the context of a historic setting. The lighting strategies outlined below are based on this priority of functional restoration.

O.04.02 Interior Lighting Strategies

Daylight and electric light should complement each other as originally intended and designed at the Capitol. Most fenestration apertures are proposed to be restored. Means of daylight control are necessary, but work best when automated. Electric light should respond to daylight and occupancy to reduce energy use. A whole-building lighting control system is recommended.

Occupancy and vacancy sensors are proposed to be used throughout, pending coordination with security system operation. In offices, vacancy sensors will automatically switch lighting OFF after a programmable period of vacancy, such as 10 minutes, but require manual switching to on when an occupant re-enters. Occupancy sensors will dim lighting in areas of sensitive artworks, such as the Governors' Portraits Gallery, or of low-occupancy, such as the north stairs after a period of vacancy, such as 5 minutes (in situations where code requires otherwise, the code will prevail).

Pending coordination with security requirements, lighting control keypads are proposed throughout the Capitol for control of lighting. In public areas, keypads can be locked-out during normal business hours. In offices and meeting rooms, keypads might be fitted with three lighting buttons – NORMAL, DIM, and OFF – and three shade overrides – OPEN, CLOSE, and RAISE/LOWER – for example. Hardwired and wireless control systems should be reviewed since both offer distinct advantages/disadvantages.

Lighting Techniques/Effects

The lighting techniques and effects contribute greatly to setting the scene or time period. Soft and relatively diffuse light patterns are reminiscent of the 1918 era. Accenting, though not in great evidence in historic photographs or plans of the Capitol, was done softly at the time with wall brackets and picture lights. Illuminated coves were known to be used at the time, though not evident in the Capitol, for overall soft-glowing ceilings. Task lights were used where more focused and intense work occurred. These lighting techniques/effects are considered appropriate to the extent that they complement the historic finishes and architecture.

Luminaires

A remarkable stock of extant luminaires remain from the 1918 Phase 3 project, all of which appear to correlate with the original 1916 Beardslee Chandelier Order. These extant luminaires are proposed to be restored and used as patterns for replications to fit-out the Capitol with a Beardslee 1918-era family of lighting equipment. These luminaires provide diffuse and relatively low-glare lighting. Additionally, the 1915 Beardslee catalog offers a wide range of compatible luminaires from the period for use in areas where no historic luminaires remain and where the 1918 originals used exposed lamps, such as in offices and toilet rooms. This should be a resource for recreating historic luminaires. All lighting equipment should be UL/NRTL listed and labeled.

Lamping

What arguably might be considered the "best" light source today is the light emitting diode (LED). Indeed, we are in an era of significant change, even upheaval, in the lighting industry. LEDs are doing to lighting what electric incandescent lamps did to gas lighting in the late 19th century. LEDs promise to be much longer lived (typically 35,000 to 100,000 hours) than other options. They have the capability (when so developed) to emit light of a color that is nearly identical to that of incandescent. Many LEDs produce no UV or IR and therefore are better suited for lighting artworks, delicate fabrics, and interior finishes. Most LEDs use no mercury, unlike fluorescent and high intensity discharge (HID) lamps. LEDs may offer some marginal energy reductions over conventional lamps in such a historic landmark, however, the greater potential benefit is that of promised in-service longevity. Most LED power supplies are rated to 20,000 hours. Most LED lamp modules are rated to between 25,000 and 100,000 hours, significantly better than 10,000 to 15,000 hours from CFL lamping – the conventional lamps for historic luminaires. LEDs are the suggested lamp technology of choice for the Capitol.

House Chamber

The lighting work recommended for the House Chamber, based on daylight and electric light strategies employed in Phase 3/1918 (*see Figure O.82*), is outlined below, with a visual vocabulary of various luminaires and techniques in *Table O.10*.

Restore 2nd floor west gallery pendants
- rewire for new lamping, UL/NRTL-list and label
- replace/repair all metal and glass work to original intent
- refinish to original intent
- use warm-white, high-color-rendering LED lamps

Re-create 2nd floor north/east/south circulation pendants
- introduce period re-creations to approximate originals

Restore 2nd floor chamber wall brackets
- rewire for new lamping, UL/NRTL-list and label
- replace/repair all metal and glass work to original intent
- refinish to original intent
- use warm-white, high-color-rendering LED lamps

Re-create 2nd floor chamber dais task lights
- introduce period re-creations to approximate originals (see inset)

Provide individual period desk task lights
- re-introduce task lights at each desk with dimmable LEDs

Restore skylight/laylight
- higher transmittance skylight glazing
- higher transmittance laylight protector
- automated shading
- tunable-white-and-color LED floodlight backlighting
- maintain clear volume with 1-foot-plus border
- paint-out all interstitial materials matte white
- re-design traveling catwalk to eliminate system shadowing
- accommodate chandelier lifts without affecting daylight

Restore chamber chandeliers
- rewire for new lamping, UL/NRTL-list and label
- replace/repair all metal and glass work to original intent
- refinish to original intent
- use warm-white, high-color-rendering LED lamps
- introduce LED uplighting on top of bowl to illuminate ceiling
- place on lifts for periodic cleaning/maintenance

Introduce period picture lights
- introduce period LED picture lights to provide perimeter brightness

Restore 3rd floor gallery pendants
- rewire for new lamping, UL/NRTL-list and label
- replace/repair all metal and glass work to original intent
- refinish to original intent
- use warm-white, high-color-rendering LED lamps

Introduce gallery steplights
- place miniature LED steplights in risers or step cheeks

Introduce gallery-ledge uplighting
- place miniature linear LED uplight channels on ledge in front of galleries to illuminate perimeter ceiling

Provide preset scene control
- re-introduce preset controls

The House Chamber is proposed to be restored without relying on many, if any, downlights. These are from a modern era (post-1940) and are an obvious intrusion both for the view/aesthetic of the hardware and for the lighting effects they create. The cumulative effects of introducing uplighting on the four restored chandeliers, LED backlight floodlighting of the laylight, and the gallery-ledge uplights will brighten the room considerably and may obviate the need for task lighting at representative's desks. Additionally, restored gallery lighting and the introduction of recreated period picture lights on key artworks will contribute to improved overall brightness impressions.

A preset control system is proposed to be provided with access at key positions for staff operation. Station lock-out functions will be employed to prevent inadvertent scene change during sessions or events. Functionality should include video input to allow laylight backlight to playback daytime-like conditions during night sessions. Many control systems also accommodate control from smartphone or other WI-FI capable devices using secure connection. Preset scenes might include SESSION, BREAK, HISTORIC, and OFF. If audiovisual presentations are programmed, then an AV scene should also be included. In addition to dimming electric lights, this would also deploy the skylight shading system.

Senate Chamber

Similar to the recommendations for the House Chamber, those for the Senate Chamber are based on daylight and electric light strategies employed in Phase 3/1918 (*see Figure O.96*). The Senate Chamber lighting strategies are outlined below, with a visual vocabulary of various luminaires and techniques in *Table O.11*.

Unlike the House Chamber, the wall brackets at the dais in the Senate, appear to have original glass globes which are consistent with the 1916 Beardslee chandelier order.

Restore 2nd floor east gallery pendants
- rewire for new lamping, UL/NRTL-list and label
- replace/repair all metal and glass work to original intent
- refinish to original intent
- use warm-white, high-color-rendering LED lamps

Re-create 2nd floor north/west/south gallery pendants
- introduce period re-creations to approximate originals

Restore 2nd floor chamber wall brackets
- rewire for new lamping, UL/NRTL-list and label
- replace/repair all metal and glass work to original intent
- refinish to original intent
- use warm-white, high-color-rendering LED lamps

Re-create 2nd floor chamber dais task lights
- introduce period re-creations to approximate originals

Provide individual period desk task lights
- re-introduce period task lights at each desk with dimmable LEDs

Restore skylight/laylight
- higher transmittance skylight glazing
- higher transmittance laylight protector
- automated shading
- tunable-white-and-color LED floodlight backlighting
- maintain clear volume with 1-foot-plus border
- paint-out all interstitial materials matte white
- re-design traveling catwalk to eliminate system shadowing
- accommodate chandelier lifts without affecting daylight

Restore chamber chandeliers
- rewire for new lamping, UL/NRTL-list and label
- replace/repair all metal and glass work to original intent
- refinish to original intent
- use warm-white, high-color-rendering LED lamps
- introduce LED uplighting on top of bowl to illuminate ceiling
- place on lifts for periodic cleaning/maintenance

Introduce period picture lights
- introduce period LED picture lights to provide perimeter brightness

Restore 3rd floor gallery pendants
- rewire for new lamping, UL/NRTL-list and label
- replace/repair all metal and glass work to original intent
- refinish to original intent
- use warm-white, high-color-rendering LED lamps

Introduce gallery steplights
- place miniature LED steplights in risers or step cheeks

Introduce gallery-ledge uplighting
- place miniature linear LED uplight channels on ledge in front of galleries to illuminate perimeter ceiling

Provide preset scene control
- re-introduce preset controls

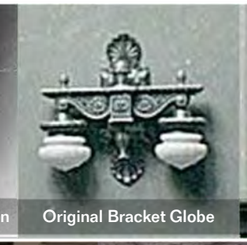
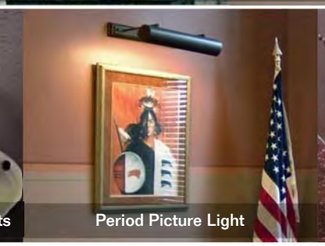
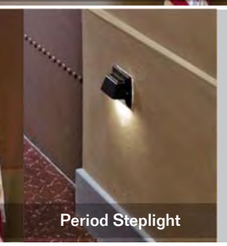
The Senate Chamber is proposed to be restored without relying on many, if any downlights. Downlights are from a modern era (post-1940) and are an obvious intrusion both for the view/aesthetic of the hardware and for the lighting effects they create. The cumulative effects of introducing uplighting on the four restored chandeliers, LED backlight floodlighting of the laylight, and the gallery-ledge uplights will brighten the room considerably and may obviate the need for task lighting at senator's desks. Additionally, restored gallery lighting and the introduction of recreated period picture lights on key artworks will contribute to improved overall brightness impressions.

Like the House, a preset control system is proposed to be provided with access at key positions for staff operation. Station lock-out functions will be employed to prevent inadvertent scene change during sessions or events. Functionality should include video input to allow laylight backlight to playback daytime-like conditions during night sessions. Many control systems also accommodate control from smartphone or other WI-FI capable devices using secure connection. Preset scenes might include SESSION, BREAK, HISTORIC, and OFF. If audiovisual presentations are

Figure O.82. ca. 1918 House Chamber | Basis for Recommended Lighting Work

The salient components of lighting work recommended to achieve an overall functional, aesthetic, and historically-sympathetic restoration for the House Chamber are based on Phase 3/1918 and outlined in the accompanying text on House Chamber.

Table O.10. Recommended Lighting Vocabulary: House of Representatives Public Areas

Area	Proposed Strategies	Proposed Lighting Vocabulary	
 House Chamber 2nd Floor	▶ Restore/replicate/recreate new historic luminaires ▷ Use historic photos, 1916 fixture order, and historic catalogs as basis ▷ Recreate missing ▷ Add new as needed to meet lighting criteria ▶ Introduce period task lights at desks ▶ Introduce period picture lights at key artworks ▶ Use dimmable incandescent-color LED lamping ▶ No modern downlights	 Original Globe for Circulation  Original Bracket Globe  Original Dais Task Light  Period Picture Light  Period Task Light	Figures numbered from far left to right: **Figures O.83, O.84, O.85, O.86, O.87, O.88.**
 House Chamber 3rd Floor	▶ Restore/replicate/recreate new historic luminaires ▷ Use historic photos, 1916 fixture order, and historic catalogs as basis ▷ Recreate missing ▷ Add new as needed to meet lighting criteria ▷ Add modern discreet uplight to chandeliers ▶ Introduce period picture lights at key artworks ▶ Introduce period or modern steplights pending design of gallery steps ▶ Introduce modern discreet uplight into balcony ledges to brighten ceiling ▶ Use dimmable incandescent-color LED lamping ▶ No modern downlights	 Original Chandeliers  Original Pendants  Period Picture Light  Period Steplight	**O.89, O.90, O.91, O.92, O.93, O.94**
 House Chamber Laylight/Skylight	▶ Restore laylight lantern for more functional electric light and daylight ▷ Redesign upper-most skylight glazing to higher transmittance ▷ Redesign lantern protective layer to near-clear higher transmittance ▷ Redesign maintenance access to eliminate shadowing ▶ Introduce automated shading system ▷ Control daylight glare and night spill light ▶ Introduce tunable LED floodlights at perimeter of interstitial space ▷ Contribute functional light to chamber for night sessions ▷ Photocell control to respond to daylighting ▷ Replay dynamics and whiteness of daylighting at night for sessions		**O.95**

programmed, then an AV scene should also be included. In addition to dimming electric lights, this would also deploy the skylight shading system.

Governor's Suite

Lighting strategies for the Governor's Suite are outlined below. A visual vocabulary of various proposed luminaires and techniques is shown in *Table O.12*.

The few extant historic luminaires that exist in the Governor's Suite are proposed to be restored and replicated and new historic luminaires re-created from the 1915 Beardslee catalog and 1916 chandelier order as necessary to fit-out the suite. Final luminaire types and selections will depend on space configuration and function. For example, the extant historic luminaires seen in *Figure O.108* are proposed to be restored with globes matching the 5-inch diameter versions outlined in Beardslee correspondence of September 6, 1917, with consideration given to matching the originally-intended straw opalescent glass. Two of these extant/restored luminaires could be used in the Ceremonial Conference Room. Two replicas could be used in the Executive Conference Room. Similarly, the historic luminaires seen in *Figure O.109* are proposed to be restored. Two of these extant/restored luminaires could be used in the Governor's office. Replicas could be used in the Lieutenant Governor's office. In typical offices in the suite, simple historic chain-suspended bowls similar to the Beardslee Doric bowl (*see Figure O.110*) are proposed. At low-ceiling circulation areas and in toilet rooms, a small surface-mount luminaire using a miniature Beardslee Doric bowl is proposed.

Pending final historic luminaire layouts and lamping efficiencies, consideration should be given to a task light at each desk. Pending furniture styles, period task light re-creations could be appropriate.

Where notable artwork is displayed, recreated period picture lights are proposed. This lighting has ergonomic benefit by contributing to the overall brightness of an area, limiting the cave effect. Illuminated art also acts as a periodic respite to the close visual focus on paper work or computer displays. Picture lights were the only way to feature artworks in the early 20th century.

In spaces such as the Ceremonial Conference Room or the Executive Conference Room where additional lighting may be appropriate to meet periodic space functionality needs or to address media or focal lighting of key dignitary positions, very discreet arrays of pinhole and slot LED downlights/accents are proposed (*see Figure O.128*).

Automated shade control for the suite will optimize daylight use and limit nighttime spill light as well as offer some nighttime security.

Governors' Portraits Gallery

Extant historic luminaires are proposed to be restored and replicated as necessary to provide general illumination of the gallery. Period picture light re-creations are proposed to be used to illuminate the portraits. Occupancy sensors can be used to dim portrait lights to very low levels when the space

is unoccupied during normal business hours. A visual vocabulary of various proposed luminaires and techniques is shown in *Table O.12*.

Rotunda and Circulation

A visual vocabulary of various proposed luminaires and techniques for the rotunda and circulation throughout much of the Capitol is shown in *Table O.12*.

Extant historic luminaires are proposed to be restored and replicated as necessary to provide general illumination of the rotunda and circulation areas. New historic luminaires re-created from the 1915 Beardslee catalog and 1916 Beardslee chandelier order are proposed to be used as necessary to fit-out the rotunda and circulation areas. In most corridors, restored extant pendants fitted with the originally-specified Beardslee glass globe 3776 (*see Figure O.118*) are proposed in conjunction with replicas and then re-spaced in corridors and around the rotunda to meet lighting criteria. The extant surface-mounted luminaire in the 1st floor south corridor or entrance lobby (*see Figure O.117*) is proposed to be restored. Re-creations are proposed to be used to light each of the four corners of the 1st floor rotunda as identified in the 1916 Beardslee chandelier order.

Where notable artwork is displayed, recreated period picture lights are proposed.

The dome lantern is proposed to be restored and the laylight treated similarly to those in the chambers. Here, upper rotunda windows and re-arrangement of the rotunda attic stairs and superstructure could provide more efficient and uniform daylighting. To maximize efficiency, all architectural and structural material in the interstitial zone are proposed to be painted out matte white. An LED tunable-white-and-color flood light system is proposed for backlighting the laylight. Automated controls can then balance between daylight and electric light and make the transition from day to night and night to morning.

In the rotunda at the base of the dome, low-profile LED uplights mounted to the top surface of the cove detailing is proposed to softly wash the dome ceiling. This helps to balance the brightness of the laylight and accentuates the architectural detailing and form of the ceiling.

Re-created versions of 1915 Beardslee catalogued luminaires are proposed on the north stairs (*see Figure O.120*). The 1916 Beardslee chandelier order does not cite any stair lighting.

On the 3rd floor the laylights/skylights shown on the 1916 DuBois' plans are proposed to be re-opened and backlighted with tunable-white LED floodlights. These occur at the east and west wing corridors and in the open grand stair wells just to the east and west of the rotunda dome.

To meet code requirements for elevator thresholds, it is likely modern pinhole downlights, surface mounted adjustable accents, or in-door-frame steplights will be necessary. The lighting equipment and lighting effects are a modern intervention.

Supreme Court and Elected Officials

A visual vocabulary of various proposed luminaires and techniques for the Supreme Court and elected officials offices is shown in *Table O.12*.

The extant historic chandelier in the Supreme Court (*see Figure O.121*) will be restored. The laylight/skylight is proposed to be opened to daylight. An LED tunable-white-and-color flood light system is proposed for backlighting the laylight.

For modern function, very discreet arrays of pinhole and slot LED downlights/accents are proposed for the Supreme Court (*see Figure O.128*). Additionally, depending on the design of the hearing table, a task light at each seat may be appropriate.

Where notable artwork is displayed, re-created period picture lights are proposed.

Automated shade control is proposed for the windows and laylight to mitigate glare, accommodate AV situations, limit nighttime spill light, and offer some nighttime security.

Pending coordination with security system operation, controls should use discreet occupancy sensors with keypads exhibiting HEARING, HISTORIC, AV, and OFF preset scenes.

Where other ceremonial spaces or significant historic spaces are re-introduced, ca. 1918 historical precedents are proposed to be used to develop the historic luminaires. For example, in the Secretary of State's suite, a single extant Beardslee luminaire remains from the 1916 Beardslee chandelier order. In the reception space, the Secretary's office, or conference room or other such space in this elected officials suite, this extant luminaire is proposed to be restored and replicas made to fit out the respective significant space or spaces. This same luminaire is identified in the 1916 Beardslee chandelier order as being used in the Treasurer's office and Auditorium (which no longer exists). Notably, the original globes from these missing luminaires now appear on the House of Representatives wall brackets at the dais and on pendant luminaires at the 1st floor House and Senate Chambers' north and south circulation corridors – presumably a "retrofit" change made in one of the Capitol's later renovations as original 1918 globes in the chambers became lost or broken and parts were scavenged from original luminaires deemed outmoded in other parts of the building.

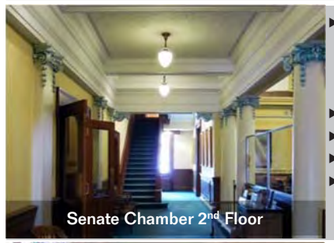
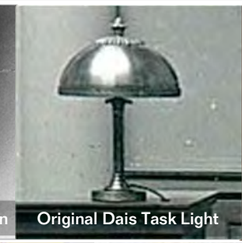
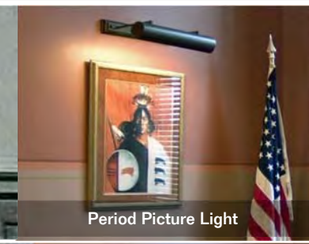
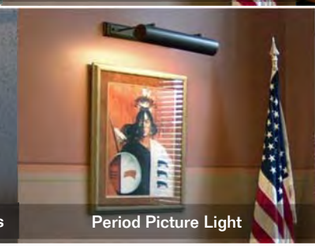
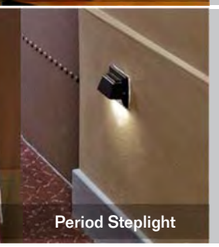
Conference and Committee Rooms and Offices

No extant historic luminaires were observed in typical conference, committee, and office spaces. In the restoration of these spaces, simple historic chain- or stem-suspended bowls using something similar to the 16-inch diameter Beardslee Doric bowl (*see Figure O.110 "Period Pendant"*) are proposed. In those spaces where AV is used, and it is best supported with darkened room conditions, in addition to NORMAL and DIM scenes, an AV scene is proposed on the lighting control keypad. Discreet pinhole downlighting may be necessary to accommodate AV with as little spill light

Figure O.96. ca. 1918 Senate Chamber | Basis for Recommended Lighting Work

The salient components of lighting work recommended to achieve an overall functional, aesthetic, and historically-sympathetic restoration for the Senate Chamber are based on Phase 3/1918 and outlined in the accompanying text on Senate Chamber.

Table O.11. Recommended Lighting Vocabulary: Senate Public Areas

Area	Proposed Strategies	Proposed Lighting Vocabulary				
 Senate Chamber 2nd Floor	▶ Restore/replicate/recreate new historic luminaires ▷ Use historic photos, 1916 fixture order, and historic catalogs as basis ▷ Recreate missing ▷ Add new as needed to meet lighting criteria ▶ Introduce period task lights at desks ▶ Introduce period picture lights at key artworks ▶ Use dimmable incandescent-color LED lamping ▶ No modern downlights	 Original Globe for Circulation	 Original Dais Task Light	 Period Picture Light	 Period Task Light	Figures numbered from far left to right: **Figures O.97, O.98, O.99, O.100, O.101.**
 Senate Chamber 3rd Floor	▶ Restore/replicate/recreate new historic luminaires ▷ Use historic photos, 1916 fixture order, and historic catalogs as basis ▷ Recreate missing ▷ Add new as needed to meet lighting criteria ▷ Add modern discreet uplight to chandeliers ▶ Introduce period picture lights at key artworks ▶ Introduce period or modern steplights pending design of gallery steps ▶ Introduce modern discreet uplight into balcony ledges to brighten ceiling ▶ Use dimmable incandescent-color LED lamping ▶ No modern downlights	 Original Chandeliers	 Original Pendants	 Period Picture Light	 Period Steplight	**O.102, O.103, O.104, O.105, O.106.**
 Senate Chamber Laylight/Skylight	▶ Restore laylight lantern for more functional electric light and daylight ▷ Redesign upper-most skylight glazing to higher transmittance ▷ Redesign lantern protective layer to near-clear higher transmittance ▷ Redesign maintenance access to eliminate shadowing ▶ Introduce automated shading system ▷ Control daylight glare and night spill light ▶ Introduce tunable LED floodlights at perimeter of interstitial space ▷ Contribute functional light to chamber for night sessions ▷ Photocell control to respond to daylighting ▷ Replay dynamics and whiteness of daylighting at night for sessions					**O.107.**

as practical on the viewing screen. However, if LED monitors are used for AV, then no special lighting may be needed, as most of these monitors are sufficiently bright to work in typical ambient lighting conditions.

Where notable artwork is displayed, re-created period picture lights are proposed.

On the 3rd floor the laylights/skylights shown in committee/office spaces on the 1916 DuBois' plans are proposed to be re-opened and backlighted with tunable-white LED floodlights. These occur at the east and west wings.

Preservation Zone 3 Spaces, Back-of-house, and Equipment Rooms

In areas where the degree of preservation is deemed to be of low importance and/or where public-corridor- and street-views are unlikely or impossible or where the space function demands special lighting, such as might be found in server rooms, present-day (modern) lighting equipment is proposed. In all such spaces, however, color of light and brightnesses will be suitably planned to limit harsh and overly obvious transitions to/from the more historic spaces. Pending coordination with security requirements, vacancy sensors are proposed to be used to limit energy use and maximize lighting equipment in-service life where this does not negatively affect security aspects.

O.04.03 Exterior Lighting Strategies

Site and facade lighting are important aspects of security and perceived senses of safety and security, an acknowledgement of the Capitol's civic prominence, and its contribution to the cityscape. *Figure O.129* outlines proposed lighting strategies for the site and facade.

Building-mounted Lighting

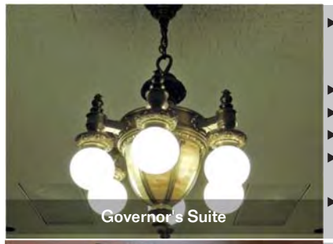
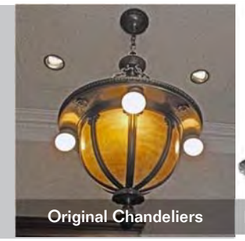
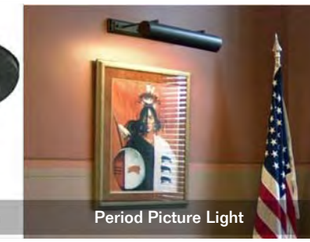
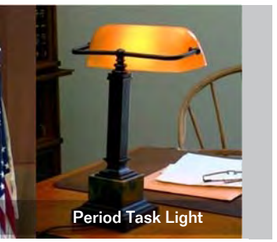
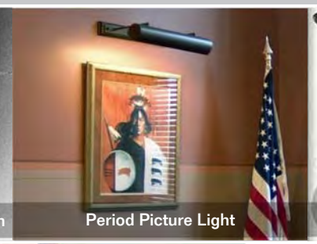
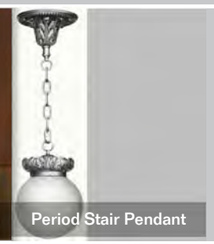
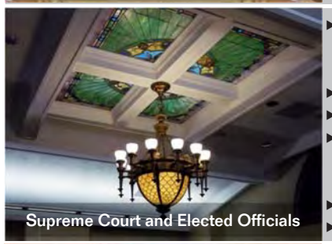
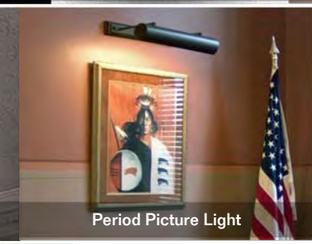
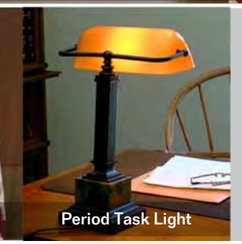
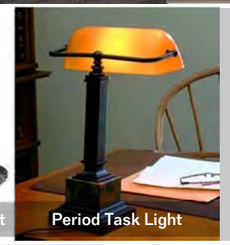
Except perhaps where historic luminaires already exist or had or could have existed on the building, the mounting of visually-obvious luminaires or those that are destructive to the visual integrity of the architecture must be done with considerable deliberation and, mechanically, with great care. At primary ingress/egress points, additional lighting at the porches will be necessary. Replicas of historic ceiling globes rated for damp applications are proposed for illuminating the porches. This creates a soft wash at the doors and porch.

At secondary ingress/egress points, surface mounted continuous linear LED luminaires at the door lintels are proposed. These very shallow luminaires accommodate the door swing given anticipated door and framing styling. These linear luminaires can be mounted tight to the door face to graze the door or mounted some distance away to soften light on the face of the door. The lighting can be interlocked with the door operation and motion sensors to allow for dimmed operation much of the time. Depending on the design of the landing, step(s), and walkway at these secondary points, single-globe historic postlights are likely to be needed in the vicinity.

Security Lighting

There are two criteria subsets to security lighting – those related to the users' senses of security and those related to the policing and surveillance

Table O.12. Recommended Lighting Vocabulary: Other Interior Areas

Area	Proposed Strategies	Proposed Lighting Vocabulary	
 Governor's Suite	▶ Restore/replicate/recreate new historic luminaires ▷ Use historic photos, 1916 fixture order, and historic catalogs as basis ▷ Recreate missing and add new as needed to meet lighting criteria ▶ Introduce period task lights at desks ▶ Introduce period picture lights at key artworks ▶ Use dimmable incandescent-color LED lamping ▶ Limit modern downlights to Executive and Ceremonial Conference Rooms ▷ Trimless pinholes or slots used for discreet appearance ▶ Introduce automated shading system ▷ Control daylight glare and night spill light	 Original Chandeliers  Period Pendant  Period Surface-mount for Circulation  Period Picture Light  Period Task Light	Figures numbered from far left to right: **Figures O.108, O.109, O.110, O.111, O.112, O.113.**
 Governors' Portraits	▶ Restore/replicate/recreate new historic luminaires ▷ Use historic photos, 1916 fixture order, and historic catalogs as basis ▷ Recreate missing and add new as needed to meet lighting criteria ▶ Introduce period picture lights at key artworks ▶ Use dimmable incandescent-color LED lamping ▶ No modern recessed adjustable accent lights	 Original Globe for Circulation	**O.114, O.115.**
 Rotunda and Circulation Throughout	▶ Restore/replicate/recreate new historic luminaires ▷ Use historic photos, 1916 fixture order, and historic catalogs as basis ▷ Recreate missing and add new as needed to meet lighting criteria ▶ Introduce period picture lights at key artworks ▶ Restore dome laylight lantern ▷ Introduce tunable LED floodlights at perimeter of interstitial space ▶ Use dimmable incandescent-color LED lamping ▶ Introduce dome cove lighting ▶ Restore well laylights at east and west grand stairs	 Original Surface-drop at 1st Floor  Original Globe for Circulation  Period Picture Light  Period Stair Pendant	**O.116, O.117, O.118, O.119, O.120.**
 Supreme Court and Elected Officials	▶ Restore/replicate/recreate new historic luminaires ▷ Use historic photos, 1916 fixture order, and historic catalogs as basis ▷ Recreate missing and add new as needed to meet lighting criteria ▶ Introduce period task lights at desks ▶ Introduce period picture lights at key artworks ▶ Restore Supreme Court laylight lantern ▷ Introduce automated shading to control night spill light ▷ Introduce tunable LED floodlights at perimeter of interstitial space ▶ Use dimmable incandescent-color LED lamping ▶ Limit use of modern trimless pinhole downlights or slots to Supreme Court	 Original Electeds Chandelier  Period Picture Light  Period Task Light	**O.121, O.122, O.123, O.124.**
 Conference/Committee Rooms/Offices	▶ Recreate period pendants ▷ Use Beardslee catalog ca. 1915 as basis ▶ Introduce period task lights at desks ▶ Introduce period picture lights at key artworks ▶ Use dimmable incandescent-color LED lamping ▶ Limit use of modern trimless pinhole downlights or slots to meeting rooms	 Period Pendant  Period Task Light	**O.125, O.126, O.127.**

of the site. To complicate matters, historical lighting designs were limited to the lighting of important or significant ingress/egress points, but rarely addressed secondary ingress/egress points and seldom addressed long contiguous paths. For modern-day senses of security, relatively uniform or consistent light along a defined path is usually considerated appropriate and more acceptable than spotty or over-lighted situations which would require the eyes to adapt from bright-to-dark-to-bright-etc. when walking through and/or viewing across sites with such conditions. Additionally, vertical illuminance at face height in at least the two opposing directions of primary travel are as important, if not more so, than light level on grade. Facial recognition is established with vertical illuminance. Color rendering (on a scale where 100 is best) should be at least 85 if skin, clothing, and vehicle colors are to be distinguished with some degree of accuracy. Finally, some element of uplight to softly illuminate adjacent foliage or building faces mitigates the foreboding cave effect common with "sharp cutoff" area and floodlight techniques. Not all paths need to be illuminated to these various criteria if just one path is so lighted for passage. For modern-day live or remote visual surveillance, uniform, soft, and low-glare lighting is very helpful, though actual light levels can be quite low. Facade lighting acts to silhouette objects in the foreground, making movement extremely obvious, particularly in peripheral vision. Facade lighting also helps mitigate effects of postlight glare by providing an illuminated backdrop. Motion sensors can be used to activate or brighten lighting and activate surveillance cameras or remote alarms. However, for remote surveillance, some camera systems rely on and work better with infrared or very-low-light situations. Final security system selection(s), layouts, and mounting heights need to be coordinated with lighting levels, techniques, and luminaire locations. Mounting infrastructure for cameras should be independent of the historic lighting equipment. The development of the landscape and hardscape as the project progresses along with the extent of campus coverage will affect final lighting layouts and equipment quantities.

Site Lighting

Noted above under Security Lighting, key pedestrian paths are proposed to be illuminated to meet horizontal (on pavement), vertical (on standing-height face), and uniformity criteria with a high-color-rendering lamp. To better accommodate the circadian rhythm, exterior lighting are proposed to be warm white. The soft diffuse light from historic postlights can make for a comfortable setting promoting a sense of safety and security. Areas where pedestrians are picked-up or dropped-off during dark hours are proposed to be illuminated to somewhat greater light levels in accordance with Illuminating Engineering Society criteria to account for the pedestrian-vehicular interface. The cluster postlights seen in *Figure O.129* remain available today from Union Metal and are recommended for use at the four primary street-site-axis zones (even on the north side, though no formal "street" exists). A single-globe version of this postlight is recommended for illuminating key pedestrian paths such as from the west entrance to Carey Avenue and the south entrance to 24th Street. If the south entry portal is re-introduced, the pedestal postlights seen in *Figure O.129* are proposed to be re-introduced. At the north, west, and south entry stair cheek walls, the postlights seen on the cheek walls in *Figure O.129* are proposed to be re-created. All postlight globes are proposed to be of a UV-resistant, DR® or similar damage-resistant acrylic to exhibit some degree of hail-hardiness. Posts should have durable finishes.

Facade Lighting

As indicated under Security Lighting, an illuminated facade can provide a backdrop for silhouetting. This works best when the lower portion of the facade is relatively uniformly illuminated. This also avoids an unfortunate "levitated structure" appearance when only upper features of the facade are lighted.

The detail of the structure is best appreciated when several lighting techniques are layered. Simply washing a portion or the entire facade top-to-bottom will generally result in a flat, institutional, and uninteresting presentation during dark hours. Highlighting select building features in conjunction with a low-facade wash will create visual depth and interest. LED accent luminaires are now available with pinspot distributions to throw light long distances onto small features, such as from the lower roof to the cupola on the dome. Accenting of various components of the dome and drum and illuminating the pediments and parapet and chambers skylight cupolas will render the dimension and detailing of the structure which is so evident in daylight in a manner befitting such a historic landmark. All facade luminaires are proposed to be fitted with durable, damage-resistant lensing to exhibit some degree of hail-hardiness. LEDs proposed for facade lighting are so efficient, that when covered with more than several inches of snow, they are unable to melt the snow. There may be stretches in the winter when such lighting is marginally effective.

O.04.04 Controls Strategies

A whole-building control system is proposed which would allow for manual and automated control of discrete portions of the building to the entire building and immediate site. Discreet vacancy sensors are proposed to be used to extinguish lights when spaces or areas are unoccupied. Discreet interior- and/or exterior-mounted photocells are proposed to be used to adjust electric lighting in response to daylighting and time of day. Sun trackers can be used to adjust blinds for glare control, with nighttime settings of "full deployment" to limit light spill and undesirable surveillance from exterior positions. Controls can reduce electric lighting loads. Lumen maintenance adjustments can be made over time to address the slow, but inevitable loss of light as lamps lose output.

Controls for exterior lighting are proposed to be automated for essentially "all on" at dusk, set-back at some predetermined curfew, such as midnight, which may include switching off of most facade lighting equipment, some site lighting equipment, and dimming of others to establish a "night light" scene, and then "all on" at 5 a.m. with "all off" an hour after sunrise. With discrete zoning of site and facade luminaires and the whole building control system, the lighting can evolve through re-programming with functional, aesthetic, environmental, and security needs. Switching off some lighting and dimming others at a predetermined curfew and shading windows and skylights at night contribute to an improved dark-sky condition during the period of astronomical twilight.

Figure O.128. Ceremonial Conference Room | Discreet Accent Lighting

The Governor's Ceremonial Conference Room at the Virginia Capitol is fitted with re-created historic luminaires from the period of significance (1906) with discreet linear accent lights for fill and focal lighting (barely visible in the top of the photo just to the left and right of the chandelier ceiling medallion).

O.04.05 Emergency/Egress Lighting Strategies

Luminaires will be selected from the normal-power lighting design layout to meet egress lighting criteria along paths of egress and will be circuited to emergency lighting circuits. Regardless of their intended state of normal-power operation, during an emergency these lights will automatically transfer to "on" by means of emergency transfer relays.

LED exit signs with integral batteries will be provided per building code requirements and circuited to unswitched emergency circuits. For a more historically-sympathetic appearance, these can be framed in antiqued bronze.

Multi-lamp emergency lighting on photocell control will be provided at all building exterior exits.

In addition to addressing emergency lighting of egress paths, auxiliary power from generators is proposed for operation of the entire Capitol and site or at least a significant portion of selective lighting in function-critical areas, such as the chambers, governor's suite, and site in the event of prolonged or civil-defense related normal power outages.

O.04.06 Maintenance

Most, if not all, proposed light sources exhibit relatively long operating lives. LEDs typically exhibit rated operational lives of 35,000 to 100,000 hours. For LEDs, this is the time over which the light output will dim to 70% of its initial value and at which time the lamp should be replaced. In-service lives of LEDs can be even greater with automated controls and vacancy sensors – the longer a lamp is off, the greater it's in-service life.

Nevertheless, lamps will ultimately fail or most likely, slowly degrade and, therefore, need to be changed. More frequent servicing is probable for lamp power supplies, many of which exhibit 20,000- to 25,000-hour operational lives. Additionally, dirt build-up can reduce light output by up to 10% over just a few years of time and luminaires should be cleaned on a regular schedule, typically once every few years, unless the environment consists of fine dust or particulates, in which case every 18 months is more appropriate.

The Capitol has of relatively high ceilings. Provisions should be made for purchasing and storing at least one single-person lift that can be accommodated by one of the building's elevator cabs (in physical size and weight). Where furnishings preclude use of man-lifts, such as the chambers, electric winches or lifts for the chandeliers are proposed.

No electric lighting is intended to be mounted directly over the lanterns or laylights of the rotunda and chambers. However, dirt build-up on the top-side of these surfaces may easily reduce light levels by 10% or more given attic conditions. Provisions should be made for the periodic cleaning of these laylights.

A plan of periodic inspections of luminaires, including exterior for weathering effects and lamp operation, should be one component of maintenance procedures. Manufacturers' instructions should guide cleaning,

Figure O.129. ca. 1915 South Site and Facade | Outlining Recommended Lighting Work

The salient components of lighting work recommended to achieve an overall functional, aesthetic, and historically-sympathetic restoration for the site and facade are identified. The photograph illustrates historically-appropriate lighting hardware for a 1918 period of significance. None of this equipment survives. See Figures O.74 and O.76 for detailed views of post lights. Figure O.130 illustrates two preliminary facade lighting schemes based on the recommended lighting work identified above.

relamping, and replacement of power supplies. Consideration should be given to maintaining an attic stock of globes, lamps, power supplies, and, in the case of key historic equipment, spare decorative components. An initial stock will be proposed as part of the project specifications.

Post-construction training on the control system operations and programming and of the operation of winches, lifts, and other lighting-maintenance devices is proposed as part of the project specification close-out. Similarly, an on-site session by the restoration lighting manufacturer is proposed to review the various components involved and recommended maintenance procedures.

O.04.07 Cost Budget Magnitudes

To help establish planning budgets, cost magnitudes of proposed lighting work outlined in this report are identified in the estimate document. Much work remains to be done to refine costs – including design development that addresses specific criteria and programming needs, calculations to establish more definitive hardware quantities and the extent of new details and techniques, implications to other disciplines such as structural and electrical, reviews and assessments by construction professionals on installation, and so forth. Hardware cost magnitudes are based on experience of similar projects in scope and scale. For restoration work of this scale and scope, guesstimates are intended to include careful removal/packing/transport of historic luminaires to the lighting restoration and re-creation manufacturer and include markups for distribution and contractor handling. Installation magnitudes are intended to account for the physical receipt and unpacking and installing of lighting equipment, wiring, and controls. However, the lighting guesstimates do not include electrical infrastructure such as conduiting from luminaires back to electrical service panels, the electrical panels, transformers, related gear, substations, and generators. The degree to which final costs will vary will also depend on market conditions at time of bidding, the length of time between the date of this report and the date work is commissioned, the ultimate programming requirements and degree to which lighting is restored, refurbished, reintroduced, and/or re-created, and, perhaps most significant, the breadth of work commissioned. Where only a few historic luminaires are re–created or restored, individual hardware costs will likely be much greater than if quite a variety of quite a number of historic luminaires are restored and/or re-created at one time.

Costs may also be affected by lead time requirements. If the project is on an expedited schedule, contractor and factory overtime may be necessary.

O.04.08 Lead Times

Historic luminaire restoration, replication, and re-creation are time-intensive and, therefore, time-sensitive tasks. These are long-lead items. It is not uncommon for the entire process, outlined below, to take up to 18 months, longer if contract and funds are waylaid, with an approximate time line of:

- Factory supervises removal and packing of all extant historic luminaires: 4 weeks after factory receives order
- Ship to factory on dedicated/insured truck(s): 1 week
- Shop drawing initial work-ups: 6 weeks after receipt of historic luminaires
- Team review shop drawings: 3 weeks
- Revise shop drawings: 2 weeks
- Team review revised shop drawings at factory: 1 day
- Team formalizes approval of revised shop drawings: 2 weeks
- Undertake restoration work and development of mold patterns and finish samples based on approved shop drawings: 8 weeks after receipt of deposit (which may contractually occur here or at other milestones as stipulated in manufacturer's quote)
- Team review of mold patterns, finish samples, and restoration progress at factory: 1 day
- Revise finish samples and restoration techniques: 6 weeks
- Team review of revised finishes and restoration progress at factory: 1 day
- Re-creation and replication work: 18 weeks after review of mold patterns and finishes
- Team review of re-creation and replication progress during above time frame: 1 day
- UL/NRTL testing and certification: 8 weeks from substantial completion of restoration and/or re-creation work
- Crate and ship: 2 weeks after completion at factory
- Ship to site on dedicated/insured truck(s): 1 week
- Factory supervises unpacking and installation of historic luminaires: complete within 2 weeks of delivery

Some tasks overlap or are performed simultaneously. Availability of one copy of key extant specimens prior to actual shut-down of the Capitol and during the design development phase will help facilitate confirmation of LED options and optics for historic luminaires and likely expedite the mold-pattern process for replicas. This will help maintain an aggressive overall completion schedule. Such an approach requires an advancement in the selection of a pre-qualified restoration lighting manufacturer and procurement of the historic lighting package prior to the traditional bid timeframe. Lighting pre-qualifications will be identified and pre-qualified lighting manufacturers will be cited in the lighting specification document.

The factory work identified above is dependent on the timeliness of team submittal and sample reviews and on timeliness of contractual arrangements and deposits through procurement channels. Direct-purchase of historic lighting by the Construction Manager, General Contractor, and/or state may result in some expedited turnarounds on shop drawing reviews and may also result in some reduction in costs. Clearly defined lines of communication and definition of the tasks of pre-restoration disassembly, removal of toxic materials, such as asbestos in luminaires, taking delivery, storage, on-site assembly, installation, scheduling, and handling of warranty services must be addressed by all parties, including the Electrical Contractor, as necessary with any of these or other purchasing strategies, including the traditional approach of purchasing through distribution channels and the Electrical Contractor.

A 1-day site walkthrough is proposed as part of the bidding process with specified restoration luminaire manufacturers with ladders and, in the chambers, a lift available to allow firsthand inspection opportunities and an overview of the historic lighting scope. This reduces the possibility of misunderstanding the condition of extant luminaires and, therefore, the extent of restoration work required which could affect quotations and quality of work.

Lead times on non-historic luminaires typically range from 6 to 12 weeks after manufacturers receive approved shop drawings, an official order release from the purchaser, and the necessary deposits. This process begins only after a credit-approved purchaser places an order through a credit-approved distributor. The entire process may take 12 to 24 weeks.

Figure O.130 Preliminary Facade Lighting Studies

Based on the lighting work outlined in Figure O.129, two preliminary facade lighting studies are illustrated. The top image illustrates the effects of the integration of small very-long-life LED luminaires onto the dome proper and at the base of the roof parapet to highlight these architectural features. The top image also illustrates the effects of integrating larger very-long-life LED spot- and flood-light luminaires at key positions on the roof and ground. This results in visual articulation of much of the facade architecture at night. In the bottom image, the small LED luminaires have been removed at the dome proper and the roof parapet along with accents at the skylight structures, resulting in a more traditional lower cost facade lighting approach. In any event, these LEDs use controlled-beam optics and are dimmable to respect the dark-sky. Switching off some lighting and dimming others at a predetermined curfew and shading windows and skylights at night contribute to an improved dark-sky condition during the period of astronomical twilight. In both images, window- and skylight-shades are deployed which further reduces light spill and limits the opportunity of unwanted surveillance.

Brightness

Brightness is the phenomenon experienced from luminance and depends on the conditions of the observers' eyes, such as cataracts and state of adaptation, and on the background or surrounding luminance. A classic example is car headlights, which appear dim during daylight hours, but glary at night.

CCT

Typical abbreviation for correlated color temperature or just color temperature.

CFL

Typical abbreviation for compact fluorescent lamp.

CMH

Typical abbreviation for ceramic metal halide lamp.

Candlepower

Candlepower represents the specific intensities and directions of light attributable to a lamp and/or luminaire. This information is documented with a photometric test report. Candlepower is used to establish lighting layouts to meet illuminance criteria and to determine patterns of light. Some historical luminaires were photometrically tested when they were introduced, but these tests, documented on paper, have been lost in many cases. As such, guesses must be made on the photometric performance of restored and re-created luminaires.

Color rendering

Color rendering is a lamp property indicating a lamp's ability to render colors. A scale or index, the color rendering index, or CRI, is used to rate lamps color rendering properties (where 100 represents best or truest color rendering and where values less than zero represent extreme color distortion). Daylight, by definition is rated at 100. Household incandescent lamps have CRI's of 95 to 100. Generally, lamps with CRI's less than 80 are considered inferior. Better color rendering enables users to more readily identify skin, clothing, and surface colors, and makes for a more normal and comfortable setting.

Color temperature

Color temperature is a numeric designation of the lamp's color of whiteness when energized. Color temperature is measured in Kelvin (K), with 0K referencing an object that emits no light (and therefore is black). Consider an iron ingot. At room temperature (nearly close to 0K), the ingot emits no light. If heat is applied to the ingot (placing it over a very hot fire), it eventually glows a faint cherry red. If allowed to become hotter, the ingot glows orange and then yellow orange – which is about 2100K or equivalent to candle flame. Incandescent lamps have a color temperature of about 2600K to 2800K. Some LEDs have color temperatures of 2700K and 3000K. Anything greater in color temperature, such as 3500K or 4000K is reminiscent of insipid cool white institutional fluorescent lamps.

Combination Light (or Fixture)

Historical reference to a luminaire, typically a chandelier or wall bracket, that is fitted for both electric light and gas light operation.

Daylighting

Lighting achieved through the use of daylight, typically through windows, skylights, clerestories, and other apertures.

Efficacy

The effectiveness of a lamp in producing light (lumens) relative to the power (watts) required to operate the lamp. Expressed as lumens per watt (LPW). Sometimes incorrectly called "efficiency."

Electroliers

Historical reference to early electric-light chandeliers. Just "chandeliers" would have referred to gas chandeliers.

Fenestration

The opening(s) and aperture(s) in a building that permit the entry of daylight. These usually consist of clerestories, skylights, and windows.

Footcandle

Footcandle is the US Customary measurement used for illuminance – the quantity of light falling on a surface. The SI measure is lux (10.76 lux equal 1 footcandle though this is usually rounded to 10 lux to 1 footcandle).

HID

Typical abbreviation for high intensity discharge lamp.

Horizontal Illuminance

See illuminance.

IES or IESNA

The Illuminating Engineering Society (of North America) is a technical society devoted to the dissemination of information on all aspects of good lighting practice.

IR

Abbreviation for infrared radiation. IR degrades many materials, but some more quickly than others. Many historical and some modern paints and artworks are highly susceptible to IR degradation. IR filters can limit the speed with which damage occurs, but limiting exposure time is best. Electric lighting and daylighting exhibit IR, though many LEDs are the exception.

Illuminance

Illuminance is the quantity of lighting falling on a surface or point of interest. Oddly, people don't see illuminance, but rather see the effects of illuminance as it reflects from or transmits through surfaces/objects. Lots of illuminance on very dark or black surfaces will result in poor viewing conditions – hence illuminance alone cannot establish the quality of the visual environment. Nevertheless, because illuminance is relatively easy to calculate and measure (with a simple, inexpensive meter), it is used nearly exclusively as the criterion of "choice." Horizontal illuminance is the quantity of light falling onto a horizontal surface or plane – typically the floor in circulation areas or the table top in conference settings. Horizontal illuminance is important where the essential part of the visual task is on a horizontal plane. Vertical illuminance is the quantity of light falling onto a vertical surface or plane – typically the imaginary plane of the face(s) of seated individuals at about 4 feet above finished floor in conference settings or of standing individuals at about 5 feet/3 inches above finished floor. Vertical illuminance is important if facial recognition by other people or cameras is desired.

Illuminating Engineering Society of North America

See IES or IESNA, above.

Kelvin

Typical measure associated with lamp color temperature or whiteness of light emanating from a lamp. See color temperature, above.

LED

Typical abbreviation for light emitting diodes, an electric light source with no filament.

LED Tunable-white-and-color

LEDs which allow for the tuning of white light from very warm white, such as sunrise/sunset at 2100K, to very cool white, such as overcast sky at 7500K. Effective for creating daylight-like settings. Additionally, color tints can also be tuned to enhance specific surface colors, such as those of stained glass.

LPD

Typical abbreviation for lighting power density or watts per square foot.

Lamp

Lamp is the formal reference to the light bulb. Technically, the "bulb" is the glass jacket or enclosure. The lamp is comprised of the bulb and all of the electrical/electronic components, any phosphor coatings and/or gases, as well as the mechanical hardware (e.g., socket) to connect the lamp to the luminaire and ultimately to the electrical system.

Lamp Life

Rated lamp life is an industry standard. The definition, however, is different for LEDs compared to that for all other (traditional) lamps. Rated lamp life for traditional lamps is defined as that point in time at which half of the lamps in a large group will have failed. For LEDs, since these are less likely to fail, but will fade over time, rated life is the point at which the light output is expected to diminish to some amount less than 100% of its original output. For example, rated life for many LEDs is reported at 70% original output, which typically is 50,000 hours or more of operation.)

Lantern

Reference to a luminaire or the illuminated part of a luminaire. Also a reference, historically, to stained-glass-filled apertures or laylights below skylights.

Laylight

Reference to a glass-filled aperture below skylights. Glass may be stained glass, art glass, or non-decorative, such as etched or opal.

Light

Reference to a luminaire. Also a reference, historically, to non-decorative glass-filled apertures or laylights below skylights

Lumens

A measure of the amount of total light output by a light source (lamp).

Luminaire

A luminaire, commonly called a light fixture, is the entire, complete device that contains all electrical, optical, lamp, and power supply components in a structurally and mechanically secure fashion. For a typical streetlight, the luminaire consists of a pole and a lantern or head.

Luminance

Luminance is the quantity of light reflected from or transmitted through a surface and is responsible for what people see. Luminance is the result of illuminance reflected from or transmitted through a surface. Luminance differences result in contrast. A lot of light reflected from glossy surfaces can yield very high luminance – also known as glare. Luminance can be sufficiently high or glary even on dark colored surfaces. For example, highly polished walnut or black granite table tops result in harsh reflections in specific directions, creating glare.

Lux

See footcandle.

Man-made Lighting

Lighting achieved through the use of man-made sources, such as candles, oil lamps, gas jets and mantels, and electric lamps.

Presets

Predetermined scenes of light typically designed to accommodate specific functions such as best hardcopy reading situation (BRIGHT), best computer display reading (NORMAL), or best audio-video viewing (AV) and which are then recalled through a keypad with buttons assigned to each scene.

Re-creation

Where historic luminaires do not exist, but are desired, historic documentation can be used to re-create the luminaires. Since no historic luminaires exist, exact replication is unnecessary (and probably unachievable).

Replica

Where historic luminaires exist and where more are needed, the extant luminaires should be replicated so that these cannot be readily distinguished from the originals. See re-creation.

Sustainability

Sustainability is the practice of designing materials/systems to limit their overall negative effects on the earth and human conditions. This may include any or all of the following aspects: extrication/development of basic materials needed for production; the actual manufacturing cycle; transportation; installation; operation; replacement; and maximal recycling.

UV

Abbreviation for ultraviolet radiation. UV degrades most materials, but some more quickly than others. Many historical and some modern fabrics, dyes, and artworks are highly susceptible to UV degradation. UV filters can limit the speed with which damage occurs, but limiting exposure time is best. Electric lighting and daylighting exhibit UV, with many LEDs being the exception.

Uniformity

Uniformity of illuminance and hence of luminance helps minimize adaptation by the eyes as they scan a room or surface. Uniformity is also important for camera views — minimizing harsh shadows and contrasts as a camera scans a face, a series of faces, or the entire room.

Vertical Illuminance

See illuminance.

Wall Bracket

Reference to a wall-mounted luminaire which, given its size, consisted of a structural bracket or arm supporting a lantern.

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FRED R. FARMER, Mgr.

FRANK S. BEARDSLEE, President
GEO. M. BEARDSLEE, Vice Pres.

ROBT. C. WHITE, Secretary
ROBT. SCHRUMPF, Treasurer

TRADE MARK

BEARDSLEE
CHANDELIER MANUFACTURING COMPANY

THE HOUSE OF QUALITY

TELEPHONE
MONROE 6530

MANUFACTURERS OF
GAS, ELECTRIC AND COMBINATION CHANDELIERS

CABLE ADDRESS
"BEARDSLEE"
WESTERN UNION CODE.

216-218-220 SOUTH JEFFERSON STREET

CONSOLIDATED WITH
THE DAVID J. BRAUN MFG. CO.

CHICAGO.

October 19, 1916.

Mr. Wm. DuBois, Archt.,
Cheyenne, Wyo.

Dear Sir:

We are sending to you via Wells Fargo Express, prepaid, to-day, designs of the fixtures contracted for by Mr. Forsythe and yourself while here, for the Wyoming State Capitol building.

By comparing same with your contract you will notice the locations where the fixtures are to be used, which will give you the necessary information to check up the contract. We are also enclosing herewith a copy of the Government specifications under which these goods are constructed, as requested by you when here. We would be pleased to have you check over the list with the designs and see if every item isn't made the way you understand the order, as we desire very much to have every item come out just exactly as understood by you when here.

We have been taking a little extra time in getting the designs out, as we are very anxious to have them presented in good shape to the rest of the Committee and have all the fixtures in harmony. We feel confident that we have accomplished this in the selection made, and believe you will be convinced of this after the fixtures are installed. In the meantime we have not delayed putting the order in the factory, and they are working on same at the present time, as well as to order the necessary glass and material to complete the order, from the Glass factories.

In addition to the designs ordered on the contract, we are sending you also designs for the Old building, as selected by you when here. You will notice that our selection of fixtures for the Front Entrance - Entrance Lobby and Rotunda, harmonize with the Corridor and Entrance fixtures in the new wings, so that the fixtures will correspond entirely throughout the building. They will be finished in the Bronze and Green to harmonize with the other fixtures in the new wings; will have the same glass and the same ornamentation.

We have modified the five light fixture for the Entrance Lobby, by putting a stronger supporting member between the band and the separate lights; this to have the appearance that the holder and shade is connected to the fixture instead of simply

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being placed on with a loop. We think you will appreciate this, as it will make the angle more substantial and prevent same from looking lop-sided, as the ring would be apt to do if slightly bent.

In the smaller Corridors on the ground floor we are using the same type of fixture as used in the new wings. In addition to this, we have sent you design #Y-4296, a 31 light fixture, using 12 - 40 or 60 watt lamps in the center of the stem; 12 - 100 watt lamps in the upper stalactites; 6 - 60 watt lamps in the middle tier and 1 - 400 watt lamp for the lower globe, for dome of Rotunda.

You can increase the capacity of light in the upper tier to 150 or 200 watt and the middle tier to 100 watt lamps, if you prefer. The capacity above enumerated amounts to 2440 watts, which would be equal to 50 - 50 watt lamps, but by increasing the lamps in the two circles you can add 1500 watts, or giving you a capacity of 4000 watts or 80 - 50 watt lamps without any additional expense, except the cost of the lamps.

In figuring the price of $1100. on this fixture, we have figured to give you a ribbed band for the top and bottom ring; a complete round rings, i.e., the round beading toward the inside of the band as well as to the outside, so that the band will look as complete from the inside as it does from the outside. A good many times we make these bands with the rounding to the outside, making the band finished but flat on the inside without ornamentation, in this way reducing the expense.

The price ($1100) on this fixture, includes the brass chain, cast recessed braces between upper and lower band. You can reduce this considerably by substituting iron chain for the upper ring and the lower braces finished to match the rest of the fixture, using half cast bands as described above and a heavy rectangular tube brace instead of the cast recessed shown and omitting the Honeysuckle or steels on top of the upper band. This will take off $260.00 from the price of the fixture, making our price for the fixture as described above, $840.00.

For the Supreme Court-room we are sending you a beautiful design, #Y-4299, having six lights in the heavy art

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TRADE MARK

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CHICAGO.

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glass bowl; made in heavy fish scale pattern, of such glass as will correspond with the twelve Calcite bowls on the outer arms. You will notice that we have changed the arms on this fixture to a torchere effect, as we found on designing the fixture that the curved arm as shown would not look well, and fill up the spaces.

As this is the only chandelier in the Court-room, it would of necessity have to be larger than those in the Senate and the House where there are four fixtures hanging from the ceiling. In designing the fixture we have endeavored to give a good deal of dignity to it, which we think has been accomplished by the heaby cast arm.

We have gone into explanation on this a little more fully, as we have made changes from the fixtures selected, as we found they did not look satisfactory and consequently changed it to fit the requirement.

The Calcite glass used on the outer bowl is the two-toned glass that you and Mr. Forsythe admired while here, and this is really the place where it can be used to advantage. We are at the same time returning to you the plans of the building, as requested, marked up by you, so you can see same in checking up the list of your requirements, and see if you have all points covered.

We trust that the designs as made will prove acceptive to you and the Capitol Commission, and if you desire any changes or have any suggestions to make, we will be pleased to take same up and submit the additional sketches required.

Yours very truly,

BEARDSLEE CHANDELIER MFG.CO.

Per Chas. G. Ricklefs
Pres.

CGR/RM.

Agreement made the tenth day of October, 1916 between the Beardslee Chandelier Manufacturing Company, a Delaware Corporation, whose principal office is in Chicago, Illinois, party of the first part and the Wyoming State Capitol Building Commission of Cheyenne, Wyoming, through Mr. R.B. Forsythe, Chairman and Mr. Wm. DuBois, Architect for the State of Wyoming, party of the second part.

The party of the first part agrees to furnish the Lighting Fixtures for the East and West Wing of the Wyoming State Capitol Building as set forth in the itemized list and schedule hereto attached, (the numbers thereon having reference to designs submitted and approved by the party of the second part) for the sum of Eight Thousand One hundred seven and 15/100 dollars ($8107.15) F.O.B. cars, Chicago, Illinois. The fixtures for the Offices are to be finished in a Light Brushed Antique Brass; for the Corridors in a Bronze finish with Green relief, and for the House of Representatives and Senate in a Statuary Bronze finish. All fixtures are to be made according to Government standard; shells over eight inches to be #18; under eight inches to four inches - #20 and under four inches #22 gauge brass. The above does not refer to special holders, which shall be made heavier. All castings are to be cast from metal patterns in fine grain sand without sand or blowholes and such parts as are necessary are to be re-chased so as to show no joints. All spinnings are to be checked well together and all casings are to be fitted so as to show no openings or joints; casing to be not less than #22 gauge and arm tubing not less than #18 gauge; goods are to be the best of their respective kind and well finished; the glass to be furnished shall be Moonstone glass or similar glass as has been selected by the Architect; fixtures are to be wired so far as possible; i.e., wherever fixture can be wired complete and packed safely for transportation, the sockets and joints are to be attached permanently.

The large fixtures are to be wired so far as possible and shipped safely; otherwise knocked down. Goods are to be wired according to the standard of the National Board of Fire Underwriters and furnished with Edison type sockets.

As time is the essence of this contract, the Beardslee Chandelier Manufacturing Company agrees to ship the Lighting Fixtures for the Senate and House of Representatives on or before December 15th, 1916.

The party of the second part, in consideration of the above, agrees to pay to the party of the first part within thirty days after the fulfillment of the above requirements and upon issuance of certificate of approval by the Architect, the amount stipulated above, towit; Eight Thousand One Hundred Seven and 15/100 dollars ($8107.15) in legal tender of the United States.

It is further agreed that any addition or deduction in the quantity of fixtures will be made at the established unit prices set forth in the attached schedule.

BEARDSLEE CHANDELIER MANUFACTURING CO.
Per Chas. G. Ruhlen Pres.

STATE OF WYOMING CAPITOL BUILDING COMM.
Per Wm. DuBois

Attest: Robt. C. White Secy

Witness: Fred P. Farmer

approved Oct 16-1916
R B Forsythe
Chairman

Chicago, Illinois,
October 10th, 1916.

SCHEDULE OF LIGHTING FIXTURES
FOR
WYOMING STATE CAPITOL
CHEYENNE, WYO.

****

WEST WING
FIRST FLOOR

Office #101	6 - #C-4283 - 4 E. 6'6" - Lt. B.A.B. - 60 watt Doric B-1202½	$27.00	$162.00
Office #102	2 - #H-4221 - 1 E. - 6' - Lt. B.A.B. - 16" - #456	40.25	80.50
Vault #103	1 - #F-4278 - 1 E. - 3' " " " " #5437 En.		4.75
Office #104	1 - #C-4277 - 2 E. - 6'6" " " " " - 60 watt Doric B-1202½		18.00
Anteroom #105	1 - #H-4221 - 1 E. - 6' - Lt. B.A.B. - 16" #456		40.25
Vestibule	1 - #E-4290 - 1 E. Bronze - Green Relief - #3776		42.00
Corridor #106	2 - #P-4291 - 1 E. " " " #3776 $66.00		132.00
Office #107	1 - #F-4279 - 1 E. - Lt. B.A.B. - 6' B-1213½ - 100 watt		5.50
Office #108	1 - #H-4222 - 1 E. - Lt. B.A.B. - 6' - 20" - #457		54.00
Office #109	2 - #H-4222 - 1 E. " " " " 6' 20" - #457	54.00	108.00
Vault #110	1 - #F-4278 - 1 E. " " " " 3' - #5437 En.		4.75
Vault #111	1 - #F-4278 - 1 E " " " " 3' 5437 En.		4.75
Office #112	2 - #H-4221 - 1 E. " " " " 6' 16" #456	40.25	80.50
	SECOND FLOOR 11'6"		
Committee Room #201	1 - #H-4222 - 1 E. - Lt. B.A.B. 3'6" -20" #457		54.00
	Amt. bro't forward		$791.00

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Amt. bro't forward $791.00

Committee Room #202	2 - #H-4221 - 1 E. - Lt. B.A.B - 3'6" - 16" #456	$40.25	$80.50
Toilet #203	1 - #F-4279 - 1 E. - Nickel - 3' - B-1213½ Nickel		5.50
Toilet #204	1 -#F-4279 do do		5.50
Telephone #205	1 - #N-4281 - 1 E. - Lt. B.A.B.		1.
Hall #206	3 - #E-4293 - 1 E. - Bronze - Green Relief - #3773 Alba	15.00	45.
Office #207	1 - #C-4277 - 2 E. - Lt. B.A.B. - #B-1202½		18.
Office #208	1 - #C-4277 - 2 E. " " " " #B-1202½		18.
Office #209	1 - #C-4277 - 2 E. " " " " #B-1202½		18.
Senate Chamber #210	2 - #N-4276 Antique Bronze - #B-1260	41.75	83.
Desks #210	2 - #J-4272 - 2 E. Portable - Ant. Bronze - Metal White Opal shade- Canopy switch.	31.75	63.
Desks #210	2 - #J-4273 - 2 E. Portable - Ant. Bronze - Metal White shade - canopy switch		26.
Hall #211	3 - #E-4293 - 1 E. - Bronze (Green Relief) - #3773 Alba shades	15.00	45.
Comm. Room #212	1 - #H-4222 - 1 E. - 3'6" - Lt. B.A.B. - 20" - #457		54.
Comm. Room #213	2 - #H-4221 - 1 E. - 3'6" - Lt. B.A.B. - 16" - #456	40.25	80.
Comm. Room #214	1 - #H-4221 - 1 E. - 3'6" - " " " " - 16" - #456		40.
Lobby #215	5 - #E-4292 - 1 E. - Bronze (Green Relief) - #3773 Alba shades	18.00	90.
Office #216	2 - #H-4221 - 1 E. - 4'6" - Ant. Bronze - 16" - #456	40.25	80.
	Forwarded		1546.

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Amt. bro't forward $1546.75

Office #217	2 - #H-4221 - 1 E. - 4'6" - Ant. Bronze - 16" - #456	$40.25	$80.50
Corridor #218	1 - #F-4291 - 1 E. - 4'6" - Bronze (Green Relief) #3776 Alba shade		66.00
Office #219	2 - #H-4221 - 1 E. - 4'6" - Lt. B.A.B. - 16" - #456	40.25	80.50
Office #220	2 - #H-4221 - 1 E. - 4'6" " " " " 16" - #456	40.25	80.50
	THIRD FLOOR		
Comm. Room #301	1 - #C-4283 - 4 E. - 4' - Lt. B.A.B. - B-1202½		27.00
Comm. Room #302	2 - #C-4277 - 3 E. - 4' - " " " " - B-1202½	22.00	44.00
Toilet #303	1 - #F-4279 - 1 E. - Nickel - 3' - B-1213½ Nick.		5.50
Toilet #304	1 - #F-4279 - 1 E. " 3' B-1213½ "		5.50
Balcony#305	3 - #H-4275 - 1 E. - 3'3" - Ant. Bronze - #6016 - 16" bowl	42.00	126.00
Balcony #306	2 - #H-4275 - 1 E. - 3'3" - " " - #6016 - 16" bowl	42.00	84.00
Senate Chamber #307	4 - #Y-4274 - 12 E. 11' - Ant. Bronze (2 Circuits) #6036 - 1260	288.00	1152.00
Balcony #308	5 - #H-4275 - 1 E. - 3'3" - Ant. Bronze - #6036 - 16" bowl	42.00	210.00
Balcony #309	3 - #H-4275 - 1 E. - 3'3" - Ant. Bronze - #6036 - 16" bowl	42.00	126.00
Comm. Room #310	1 - #C-4283 - 4 E. - 4' - Lt. B.A.B. - B-1202½	27.00	27.00
Comm. Room # 311	2 - #C-4277 - 3 E. - 4' " " " " B-1202½	22.00	44.00
Comm Rm. #312	1 - #C-4283 - 4 E. - 4' - " " " " B-1202½		27.00
	Forwarded		3732.25

NOTE:- Hall & Corridor - Statuary Bronze (Green Relief)
House and Senate - Brushed Antique Bronze.
Offices .....Brushed Antique Brass.

SCHEDULE OF LIGHTING FIXTURES
FOR
WYOMING STATE CAPITOL
CHEYENNE, WYO.

****

EAST WING

FIRST FLOOR

Amt. bro't forward $3732.25

Library #113	15 - #H-2547 - 1 E. - 4' - Lt. B.A.B. - 20" - #1198 Holophane shade	$28.80	$432.00
L. Office #114	1 - #H-4221 - 1 E. - 6' - Lt. B.A.B. - 16" - #456 shade		40.25
L. Office #115	2 - #H-4221 - 1 E. - 6' - " " " " - 16" - #456	40.25	80.50
	SECOND FLOOR		
Office #221	1 - #H-4221 - 1 E. - 4'6" - Lt. B.A.B. - 16" - #456		40.25
Lavatory #222	1 - #N-4282 - 1 E. - Bkt. - Nickel - B-1201½	3.75	3.75
Lavatory #223	1 - #N-4282 - 1 E. " " B-1201½		3.75
Office #224	2 - #H-4222 - 1 E. - 4'6" - Lt. B.A.B - 20" - #457	54.00	108.00
Vault #225	1 - #F-4278 - 1 E. - 3' - Lt. B.A.B - #5437 En.		4.75
Corridor #226	1 - #P-4291 - 1 E. - 4'6" - Bronze (Green Relief) - #3776 Alba		66.00
Vault #227	1 - #F-4278 - 1 E. - 3' - Lt. B.A.B. - #5437 Alba		4.75
Lavatory #228	1 - #N-4282 - 1 E. - Bkt. - Nickel - #B-1201½ shade		3.75
Lavatory #229	1 - #N-4282 - 1 E. - " " #B-1201½		3.75
Office #230	1 - #H-4221 - 1 E. - 4'6" - Lt. B.A.B. - 16" - #456		40.25
Office #231	2 - #H-4222 - 1 E. - 4'6" - Lt. B.A.B. - 20" - #457	54.00	108.00
Lobby #232	5 - #E-4292 - 1 E. - Bronze (Green Relief) - #3773 Alba	18.00	90.00
	Forwarded		$4762.00

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EAST WING

	Amt. Bro't forward		$4762.00
Toilet #233	1 - #F-4279 - 1 E. - 3' - Nickel - B-1213½		$5.50
Toilet #234	1 - #F-4279 - 1 E. - 3' " B-1213½		5.50
Telephone #235	1 - #N-4281 - 1 E. Bkt. - Lt. B.A.B.		1.50
Comm. Room #236	1 - #H-4281 - 1 E. - 3'6" - Lt. B.A.B 16" - #456		40.25
Comm. Room #237	1 - #H-4281 - 1 E. - 3'6" - " " " " - 16" - #456		40.25
Comm. Room #238	1 - #H-4281 - 1 E. - 3'6" - " " " " - 16" - #456		40.25
Hall #239	3 - #E-4293 - 1 E. - Ant. Bronze (Green Relief) - #3773 Alba	$15.00	45.00
Office #240	1 - #C-4277 - 2 E. - Lt. B.A.B. - #B-1202½		18.00
Office #241	1 - #C-4277 - 2 E. - Lt. B.A.B. - #B-1202½		18.00
Office #242	1 - #C-4277 - 2 E. - Lt. B.A.B. - #B-1202½		18.00
House Chamber #243	2 - #N-4271 - 2 E. Bkt. - Ant. Bronze - #1260 Canopy switches	66.00	132.00
Desks #243	2 - #J-4272 - 2 E. Portable - Antique Bronze - Metal Opal shade - Canopy switch	31.75	63.50
	1 - #J-4273 - 2 E. Portable - Antique Bronze - Metal shade - canopy switch		26.50
Hall #244	3 - #E-4293 - 1 E. - Bronze (Green Relief) - #3773 Alba	15.00	45.00
Comm. Room #245	1 - #H-4281 - 1 E. - 3'6" - Lt. B.A.B - 16" - #456		40.25
Comm. Room #246	2 - #H-4281 - 1 E. - 3'6" - Ant. Bronze 16" - #456	40.25	80.50
Comm. Room #247	1 - #H-4281 - 1 E. - 3'6" - " " - 16" - #456		40.25
	Forwarded		$5412.25

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EAST WING
THIRD FLOOR

	Amt. Bro't forward		$5412.25
Toilet #313	1 - #F-4279 - 1 E. - 3' - Nickel - B-1213½		$5.50
Comm. Room #314	1 - #C-4277 - 2 E. - 4' - Lt. B.A.B - B-1202½		18.
Comm. Room #315	1 - #C-4277 - 2 E. - 4' - " " " " - B-1202½		18.
Comm. Room #316	1 - #C-4277 - 2 E. - 4' - " " " " - B-1202½		18.
Toilet #317	1 - #F-4279 - 1 E. - 3' - Nickel - B-1213½		
Balcony #318	3 - #H-4270 - 1 E. - 3'3" - Ant. Bronze - #6016	$31.80	95.
Balcony #319	5 - #H-4270 - 1 E. - 3'3" - " " #6016	31.80	159.
House Chamber #320	4 - #Y-4269 - 12 E. - 10' - " " #6036-8 - #1260 - (2 circuits)	281.00	1124.
Balcony #321	2 - #H-4270 - 1 E. - 3'3" - Ant. Bronze - #6016	31.80	63.
Balcony #322	3 - #H-4270 - 1 E. - 3'3" " "	31.80	95.
Comm. Room #323	1 - #C-4277 - 2 E. - 4' - Lt. B.A.B. - #B-1202½		18.
Comm. Room #324	2 - #C-4277 - 2 E. - 4' - Lt. B.A.B. -#B-1202½	18.00	36.
Comm. Room #325	1 - #C-4277 - 2 E. - 4' " " " " B-1202½		18.
	FIRST FLOOR ADDITIONAL		
Corridors	2 - #F-4291 - 1 E. - 6' - Bronze (Green Relief) - #3776 Alba	66.00	13
Reference Library	2 - #H-4282 - 1 E. - 6' - Lt. B.A.B. - 20" - #457	54.00	10
	4 - #J-4280 - 2 E. - Lt. B.A.B. - 18" to bottom - with 10" green domes	15.00	6
Gov. Private	2 - #C-4286 - 9 E. - 6' - Lt. B.A.B. - Art glass	150.00	30
Gov. Business	4 - #C-4288 - 4 E. - 6' " " " " - 16" Art glass	101.00	40
	Forwarded		809

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EAST WING
FIRST FLOOR ADDITIONAL

	Amt. Bro't forward	$8090.65
Gov. Toilet	1 - #F-4279 - 1 E. - 3' - Nickel - B-1213½	$5.50
	1 - #F-4279 - 1 E. 3' " B-1213½	5.50
Ante Toilet	1 - #F-4279 - 1 E. - 3' - Nickel - B-1213½	5.50
	TOTAL.....	$8107. 15

SCHEDULE OF LIGHTING FIXTURES
FOR
STATE CAPITOL COMM.
CHEYENNE, WYO.

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OLD BUILDING
FIRST FLOOR

Front Entrance:		
1 - #E-4290 - 1 E. Ceil. Lt. - #3776		$42.0
Entrance Lobby:		
1 - #E-4294 5 " " "		
1 - #3775 -- 4 - #3773		104.5
Rotunda:		
4 - #E-4294 - 5 E. Ceil. lt.		
1 - #3775 -- 4 - #3773	$104.50	418.0
Corridors:		
3 - #F-4291 - 1 E. - Electrolier - #3776	66.00	198.0
1 - E-4292 - 1 E. - Ceil lt. #3773		18.0
Auditorium:		
2 - #C-4297 - 6 E. - Electrolier - #1381 - 8"	121.50	243.0
Secretary of State:		
2 - #C-4297 - 6 E. " #1381 - 8"	121.50	243.0
Treasurer 2 - C-4297 6 E " 1381 - 8"	121.50	243.0
SECOND FLOOR		
Lobby & Rotunda:		
6 - #E-4295 - 1 E. - Electrolier - #3776	49.50	297.0
Rotunda Dome:		
1 - #Y-4296 - 31 E. " 12 - #3774 & 6 - #3773 - 1 - #3776		1100.0
Supreme Court:		
1 - #Y-4299 - 16 E. - Electrolier - Art glass panels and 12 Calcite		558.0
Judge's Chamber:		
3 - #H-14222 - 1 E. - Electrolier - 20" - #457	54.00	162.0
Clerk:		
1 - #H-4222 - 1 E. - " 20" - #457		54.0
State Examiner:		
1 - #H-4222 - 1 " " 20" - #457		54.0
Board of Control:		
1 - #H-4222 - 1 " " 20" - #457		54.0
Attorney General:		
1 - #H-4222 - 1 " " - 20" #457		54.0

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Engineer's Private:		
1 - #H-4222 - 1 E. Electrolier - 20" - #457		$54.00
Engineer's Drafting Room:		
5 - #F-4298 - 1 E. " - 100 watt Denzar	$22.50	112.50
Total		$4009.00

Respectfully submitted,

BEARDSLEE CHANDELIER MFG. CO.

Per Chas. G. Rickles
V Pres

Chicago, Ill.
Oct. 19, 1916.