BC hydro
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New Construction Program
Energy-Efficient Lighting Design

Reference Guide for Lighting Calculator

Version 2.7

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1. Introduction

This Reference Guide will provide information to help you fill out the luminaire schedule and lighting calculator, which are required to complete the online application for the BC Hydro Power Smart New Construction (NC) Program Lighting Design Offer Incentive. The lighting calculator spreadsheet can be downloaded from: http://www.bchydro.com/hpb.

When filling out the Lighting Calculator, please ensure you have checked off ***Analysis ToolPak*** found under ***Tools*** and ***Add-Ins***. You may need to re-open the spreadsheet once you check-off Analysis ToolPak to ensure the on mode is in effect.

2. Program Information

The BC Hydro Power Smart New Construction Program provides financial incentives and tools to help building developers and their design teams create and install more effective and energy-efficient lighting in new commercial development projects.

Applicability: The New Construction program applies to all *Part 3* and *Part 9 non-residential*, commercial buildings as defined in the BC Building Code in terms of building footprint and number of storeys. For the purposes of the New Construction program and in the Lighting Design Calculators:

1. **Small commercial buildings** and low-rise apartment buildings (Part 9 non-residential) are buildings with a gross area of 600 – 1,800 m^2 (6,000 – 18,000 ft^2), excluding health care facilities and places of assembly (e.g. church, restaurant, community hall)

2. **Large commercial buildings** and high-rise apartment buildings (Part 3) are buildings with a gross area of over 1,800 m^2 (18,000 ft^2), including all health care facilities and places of assembly (e.g. church, restaurant, community hall).

Incentives for Actual Electricity Savings: BC Hydro will offer financial incentives, based on electricity savings achieved, to offset any incremental costs of the energy-efficient measures implemented as a result of the energy-efficient lighting design. *The calculated annual energy savings must meet a minimum of 10,000 kWh threshold to be eligible for financial incentives.*

Lighting Design Incentive: A $1,000 incentive will be paid for the creation of lighting designs that:

- *meet or exceed the ASHRAE/IESNA 90.1 – 2004 code* - for small commercial buildings (as defined by Part 9 non-residential - BC Building Code) outside the City of Vancouver.
- *exceed ASHRAE/IESNA 90.1 – 2004 code by 10 per cent* - for large commercial buildings (as defined by Part 3 - BC Building Code) outside the City of Vancouver.
- *exceed ASHRAE/IESNA 90.1 – 2007 code by 10 per cent* - for small and large commercial buildings within the City of Vancouver.

In-suite ENERGY STAR® Package Rebates: For new multi-unit residential buildings and mixed-use buildings, rebates of $150 and $200 per suite are available for installing in-suite Energy Star® appliance and compact fluorescent lighting (CFL) packages. For more details about how to apply for this rebate, look for In-suite Energy Star® Package Rebates on the BC Hydro website http://www.bchydro.com/hpb.

Eligibility
New commercial buildings that are 6,000 square feet or larger are eligible for financial incentives *(min 10,000 kWh of annual energy savings),* and building types include: low-rise and high-rise residential and multi-use buildings, offices, retail outlets, restaurants, schools, institutional facilities and other government facilities. To be eligible, buildings must be located within BC Hydro's service territory.

Tender Documents
BC Hydro recommends the following language in your tender documents to ensure your project's lighting design is installed as intended to qualify for approved financial capital incentive:

> *The Intent to award the tender to the contractor that will install products that satisfy the BC Hydro New Construction Program Energy-Efficient Lighting Design requirements.*
>
> *For small commercial building (as defined by Part 3 - BC Building Code) projects outside the City of Vancouver, the installed lighting power density (LPD) must meet or exceed the ASHRAE/IESNA 90.1 – 2004 standard.*
>
> *For small commercial building (as defined by Part 9 non-residential - BC Building Code) projects outside the City of Vancouver, the installed lighting power density (LPD) must exceed the ASHRAE/IESNA 90.1 – 2004 standard by 10 per cent.*
>
> *For all commercial building projects within the City of Vancouver, the installed lighting power density (LPD) must exceed the ASHRAE/IESNA 90.1 – 2007 standard by 10 per cent.*

3. Luminaire Schedule

The luminaire schedule can be found within the first worksheet tab of the lighting calculator spreadsheet. The schedule allows you to enter your own luminaire symbols, input wattage and luminaire description as per your lighting design drawings. The schedule can then be used as a drop-down menu in the second worksheet tab, which contains the lighting calculator (as described in section 4).

3.1. Data Entry

Enter all luminaire types for interior and exterior lighting as follows:

Luminaire Symbol: Enter the symbols as per the lighting drawings to allow for easy identification and quantity counting, e.g., A1, FA.

Luminaire Description: Enter technical specification details, including detailed type of lamp and ballast, e.g., 1 x 4, recessed luminaire complete with 3" deep-cell reflectors.

Lamp Wattage: Enter nominal wattage for the lamps, e.g., 32W for 4ft T8's.

Number of Lamps: Enter the total number of lamps, e.g., 2.

Ballast Type: Click the blue-coloured cell and select the type of ballasts/ power supply used to power the luminaire's lamps, e.g., T8-Hi-Ef-IS-LBF from the drop-down list.

Total Wattage: Enter total input wattage for the luminaire, including ballast or transformer, e.g., 47W.

Total number of Luminaires: There is no need to fill in anything on this page as filling in the lighting calculator, located in the next worksheet tab, will automatically populate the total number of luminaries.

Demand and Energy Savings: You do not need to make any entries in these columns. See Section 5.3, Output Summary for a detailed description.

Click on **next** to go to the lighting calculator or simply click on the lighting calculator worksheet tab. Return to previous worksheets by clicking **previous** or simply click on the tab label.

4. Lighting Calculator

As mentioned earlier, the lighting calculator automatically links the data you entered from the luminaire schedule. You can view the calculation results of incentives and energy savings in the output summary, which is located in cell K3.

If you make an entry that is not permitted an error message will appear. You must follow the instructions below in order to perform the calculations correctly.

4.1. Lighting Power Allowance

The total lighting power allowance of a building is determined using the space-by-space method within the ASHRAE/IESNA 90.1 standard –, i.e., by adding up the power allowances for each individual space in the building. (See Section 6, Design Guidelines, for a detailed explanation.)

The total lighting power allowance is calculated as the sum of the interior and exterior lighting power allowances.

The spreadsheet calculates the total lighting power allowance for both the baseline and the minimum criteria target, and compares the total allowance with the total installed lighting power. The total installed lighting power is the sum of all wattages of the proposed lighting design and the installed luminaires in the new building, as entered using the space-by-space method.

According to the building size (see Section 2, Applicability), the New Construction Program has set the following baselines and minimal targets for the projects:

Baselines:

- ASHRAE/IESNA 90.1 – 1999, for small buildings outside the City of Vancouver
- ASHRAE/IESNA 90.1 – 2004, for large buildings outside the City of Vancouver
- ASHRAE/IESNA 90.1 – 2007, for all buildings within the City of Vancouver

Minimum Targets:

- ASHRAE/IESNA 90.1 – 2004, for small buildings outside the City of Vancouver
- ASHRAE/IESNA 90.1 – 2004 minus 10% for large buildings outside the City of Vancouver
- ASHRAE/IESNA 90.1 – 2007 minus 10% for all buildings within the City of Vancouver

To be eligible for an incentive, both the interior and the exterior installed lighting power must be lower than the interior and the exterior lighting power allowances for the minimum criteria target. The proposed lighting design must meet (for small buildings) or exceed (with at least 10% for large buildings) the ASHRAE/IESNA 90.1 – 2004 lighting power allowance. If the criteria target is met, the lighting calculator will display the dollar amount of the capital incentive, and show **PASSES** under **Compliance to Minimum LPD** in the Output Summary of the lighting calculator worksheet.

Important note: The calculated annual energy savings must be at least 10,000 kWh to qualify for program participation.

If the proposed lighting design does not meet the minimum target, the lighting designer may want to incorporate more energy-efficient lighting options. (See Appendix A for suggestions.)

4.2. Energy Savings

Energy savings are calculated using the space-by-space method and indicate the difference between the energy usages of the baseline ASHRAE 90.1 (power allowance typical usage hours) and proposed installed lighting design (installed power installed and controlled usage hours).

To qualify for financial incentives, the installed lighting power density (LPD) must:

- meet or exceed the ASHRAE/IESNA 90.1 – 2004 standard, for projects within small commercial buildings and outside the City of Vancouver,
- exceed the ASHRAE/IESNA 90.1 – 2004 standard by 10 per cent, for projects within large commercial buildings and outside the City of Vancouver,
- exceed the ASHRAE/IESNA 90.1 – 2007 standard by 10 per cent, for projects within large commercial buildings and within the City of Vancouver.

The hardwired savings and control savings are calculated separately.

4.3. Interior Lighting Power

The interior lighting power allowance of the building is the sum of the lighting power allowances of all interior spaces.

For each interior space, the lighting power allowance is determined by multiplying the Lighting Power Densities (LPD) as defined in Appendix B, Table 5, by the respective area.

For projects within the City of Vancouver, the calculator allows for an increase in the interior lighting power for retail spaces, as per the ASHRAE/IESNA 90.1 – 2007 standard.

BC Hydro recommends that installed LPD values be less than the target LPD. For an incentive to be awarded, it is not mandatory that installed LPD values in all spaces meet the minimum target LPD. Trade-off among spaces is permitted provided that the total installed interior lighting power does not exceed the interior lighting power allowance.

4.4. Exterior Lighting Power

The exterior lighting power allowance of the building is the sum of the lighting power allowances of all exterior spaces.

For each exterior space, the lighting power allowance is determined by multiplying the LPDs, as defined in Appendix B, Table 6, by the respective area.

Note: Not all the LPD values from the ASHRAE/IESNA 90.1 – 2004/ 2007 standard are used for the New Construction Program lighting calculations. Do not enter exterior spaces that are not listed in Table 6. Architectural (building) façade highlighting areas are not eligible for code compliance or incentives; do not enter these areas. Uncovered Parking lots are accounting towards the code compliance calculations but are not eligible for energy savings incentives.

To be eligible for an incentive, the installed exterior lighting power has to be lower than the exterior lighting power allowance for the minimum target.

5. Lighting Calculator Instructions

Input the following data:

- **Project Name:** name of building or development
- **Site Address:** street address and location of new building
- **Design Date:** completion date of the lighting design calculator
- **Revision Date:** revision date of the lighting design calculator (that has been previously submitted to BCH)

Step 1: Input of Critical Information

The following information is required to calculate the savings and capital incentive:

- **City of Vancouver**: confirm if the building is located within the City of Vancouver municipality boundaries by selecting "Yes" or "No" from the drop-down menu.

- **Building Size**: Confirm if the building size by selecting **LARGE** or **SMALL** from the drop-down menu.

- **Project Completion Date**: Enter the estimated date of completion in the YYYY-MM-DD format. An incentive will not be calculated if the project completion date is not entered and the system will generate an error message.

- **Measurement Units**: Choose the measurement units as dictated by your project construction drawings and/or specifications. The calculator allows the use of either imperial (ft, ft^2) or metric (m, m^2) units. Select and use the same measurement units throughout the project application.

- **Estimated Area Size**: Enter the total interior building surface of the facility including any underground parkade. Do not enter the exterior surfaces, e.g., exterior parkade or walkways surrounding the building.

Step 2: Indoor Lighting Calculations

Once you have entered the general project data you can start calculating the interior lighting energy use by entering data row by row in the lighting calculator. The following sections will give step-by-step details for the lighting calculations.

Step 2B: Lighting Credits (for City of Vancouver only)

Additional Interior Lighting Power Allowance is permitted in ASHRAE/IEASNA 90.1-2007 for specific lighting equipment installed in sales areas and specifically designed to highlight merchandise. The additional retail allowance is only applicable for City of Vancouver for code compliance and will not be used for incentive calculations.

If applicable (retail space within the City of Vancouver) complete the interior lighting calculations credits (Watts) by entering the appropriate floor areas for displays (ft^2 or m^2) in the Lighting Calculator. The total retail credited Watts will be added to the overall power allowance for interior spaces. More information about retail credits can be found in chapter *6.3. LPD Calculation Credits*.

Step 3: Outdoor Lighting Calculations

Complete the exterior lighting calculations by entering data in the Lighting Calculator. The following sections provide step-by-step details.

5.1. Instruction for Entering Building Data

In the Lighting Calculator, data must be entered directly in the white cells. The remaining cells are filled automatically.

Fill in all the white cells that pertain to the design using the space-by-space method.

Area: Enter the space description as per your lighting drawings. If there is more than one identical space enter a number in brackets to designate the correct space to drawing, e.g., classroom (1), classroom (2).

Identical Areas: Select the number of identical areas from the drop-down menu. Each identical area must reflect the same size, lighting design, control options and hours of use.

ASHRAE/IESNA 90.1 Common Space Type: Select the best representation of the proposed use of the space from the drop-down menu, e.g., court sports area, indoor playing field area.

Area Surface: Enter the floor space of the area as taken from drawings, using the selected measurement unit (m^2/ft^2).

Annual Hours: Enter the estimated annual number of hours of operation for the respective space. If the hours of operation are unavailable or unknown, then use the estimated typical annual hours of operation from Section 6.6, Table 2, Typical Annual Hours of Operations.

Note: An error message will appear if you enter a value greater than 8,760 hours. Click **Cancel** and re-enter the value.

Lighting Control Reduction: For specific areas of the building that use timers, occupancy and/or photocell sensors, BC Hydro will allow a maximum of 30 per cent reduction in the hours of operation for the automated controlled load in that specific area.
The only notable exception (45 per cent control savings) is when using combinations of individual dimmable luminaires, occupancy and photo sensors all in private area, zoned or individual workstation (i.e. addressable, networked luminaires with integral sensors).

Manual dimming controls could also qualify for a 10 per cent reduction in the hours of operation. This applies to the primary lighting system (that provides more than 50 per cent of the lighting in the space and more than 50 per cent of the usage time). Dimming credits are available for interior lighting only.

For photoelectric (dimming) controls the control area applies only to the daylight zones (usually for the perimeter workstation areas,15 to 20 ft from the window).

Simple on/off switches are not applicable for incentive calculations. The same will apply to DDC or Building Management Systems for large buildings.

For a specific area where lighting is controlled, select the appropriate automated control option from the drop-down menu. The program will adjust the energy-saving calculations for the entire area.

A comment text for each cell will show suggested usage reductions. For detailed information, refer to Section 6.4, Automatic Lighting Control Credits.

For example, without timers or occupancy sensors, the total hour of operations is 4,000 hours. With occupancy sensors, the maximum allowed reduction is 30 per cent, which means total hours of operation will be 2,800 hours. The worksheet will adjust the calculation automatically. This ultimately means a reduction of energy use for the specified area and a slightly higher capital incentive payout.

5.2. Instructions for Entering Interior and Exterior Lighting System Data

Luminaire Type Concept
The Lighting Calculator will allow a maximum of four different luminaire types to be used in a room or space. Luminaire types in a space can be powered by the same circuits or by more than one circuit and can be controlled.

The program assumes:

- All the luminaire types in a space will be controlled by one automated control point; and
- The hours of use for the space are dictated by the main luminaire type, which provides over 50 per cent of the area's required illumination and is used more than 50 per cent of the time.

For example, a meeting room has a four fluorescent 1x4 recessed luminaire type for ambient lighting, 6 PAR 30 for accent lighting and 2 MR16 wall washers for the white board. It is expected that the fluorescent luminaire type will be used most of the time. A maximum of 3,800 hours as per Section 6.6, Table 2, Typical Annual Hours of Operation will thus dictate the number of hours. The occupancy sensor will control all of the luminaire systems.

For each luminaire type, fill in the white **entry** cells. Repeat for up to four luminaire types for each area.

Luminaire Type (Lumin.): Select from the drop-down menu the luminaire symbol that corresponds to the proposed lighting design system in the specified room or space. The luminaire symbol comes from data entered in the luminaire schedule.

Quantity (Q-ty): Enter the number of luminaires in the luminaire system.

Wattage (W): This field uses the data entered in the luminaire schedule.

Remaining Columns under the Demand and Energy Saving section:

The columns titled Design LPD, Min. Criteria Compliance, Demand Savings, Energy Saving Hardwired, Energy Saving Control and Energy Saving Total are automatically calculated. Table 1 defines these terms:

Table 1. Definition of Terms under Demand and Energy Savings

Design LPD – The design LPD after any allowable dimming credits have been applied. **Min. Criteria Compliance**: Denotes whether minimum design LPD criteria have been reached for the space. It is not mandatory that all spaces meet the LPD criteria. **Demand Savings:** Total installed power for the specified area. This information may provide estimated size circuits and balance electrical panels. **Energy Savings Hardwired:** Energy savings from the lighting equipment, used to determine the capital incentive amount **Energy Savings Control:** Energy savings from the automated controls, used to determine the capital incentive amount **Energy Savings Total:** The sum of energy savings from hardwired lighting equipment and automated controls

5.3. Output Summary

The Output Summary, located at the top right corner of the page, displays values for:

- **Compliance to Minimum LPD** – Denotes whether the design passes the test of minimum Lighting Power Design criteria.
- **Co-incident Demand Savings** –the estimated lighting demand (kW) savings if 70 per cnet of lighting system was operating at any given moment.
- **Energy Savings Hardwired** – See Table 1.
- **Energy Savings Control** – See Table 1.
- **Energy Savings Total** – See Table 1.
- **Energy Savings Total Cost** – Estimated annual energy cost based on commercial BC Hydro electrical tariff that considers both demand (kW) and electric rates charges (kWh).
- **Capital Incentive** – Incentive based on predetermined incentive rate, energy savings from the proposed lighting design, and equipment life expectancy of installed lighting and automated control technologies.

The annual energy savings must be at least 10,000 kWh for program participation. If the savings do not meet this requirement, an error message will read "The project does not meet the minimum energy threshold" and the building project will not qualify for participation in the NC program. The lighting designer may want to incorporate more energy-efficient lighting options. See Appendix A for suggestions.

Return to the previous worksheets by clicking the **Previous** button.

6. Design Guidelines

6.1. Lighting Design Practice Baseline

The NC program applies to all *Part 3* and *Part 9 non-residential*, commercial buildings as defined in the BC Building Code in terms of building foot-print and level of storeys. For the purposes of the NC program and in the Lighting Design Calculators:

- **Small commercial buildings** and low-rise apartment buildings (Part 9 non-residential) are buildings with a gross area of 600 – 1,800 m^2 (6,000 – 18,000 ft^2), excluding health care facilities and places of assembly (e.g. church, restaurant, community hall)

- **Large commercial buildings** and high-rise apartment buildings (Part 3) are buildings with a gross area of over 1,800 m^2 (18,000 ft^2), including all health care facilities and places of assembly (e.g. church, restaurant, community hall).

Until further notice from BC Hydro, the ASHRAE/ IESNA 90.1 will be considered as the baseline for current design practice. Also, customers must comply with existing local municipal energy code bylaws.

The baseline sets the installed lighting power densities and is part of the mandatory provisions as outlined below. The baseline will constitute the starting point in calculating demand and energy savings, as well as the financial incentive.

New Construction Program Baselines:

- ASHRAE/IESNA 90.1 – 1999, for small buildings outside the City of Vancouver
- ASHRAE/IESNA 90.1 – 2004, for large buildings outside the City of Vancouver
- ASHRAE/IESNA 90.1 – 2007, for all buildings within the City of Vancouver

Lighting Power Density (LPD) is defined as the installed lighting power, in wattages, in a building space divided by the space area in square meters or square feet (watts/ft^2 or watts/$m^{2)}$. See Appendix B, Tables 5 and 6, for list of LPDs by common space types. A spreadsheet calculator determines the LPD, using the space-by-space method.

6.2. Lighting Design Minimum Criteria

In order to receive a BC Hydro incentive, the following minimum design criteria are required:

- The proposed lighting installations must result in an installed lighting power density that meets or exceeds the ASHRAE/IESNA 90.1 – 2004/ 2007 standard for the space or building type:
    - meet or exceed the ASHRAE/IESNA 90.1 – 2004 standard, for projects within small commercial buildings and outside the City of Vancouver,
    - exceed the ASHRAE/IESNA 90.1 – 2004 standard by 10 per cent, for projects within large commercial buildings and outside the City of Vancouver,
    - exceed the ASHRAE/IESNA 90.1 – 2007 standard by 10 per cent, for projects within large commercial buildings and within the City of Vancouver.

- For calculations, refer to the code's space-by-space method in Appendix B.

- Energy savings are calculated by multiplying the hours of operation (see Table 2) by the difference of LPD values between the baseline and the proposed energy efficient lighting design.

- The system must still provide adequate lighting levels as recommended by the Illuminating Engineering Society of North America (IESNA).

- To help promote energy-efficiency technologies, BC Hydro recommends that the lighting design include two or more of the following lighting measures:
    - High-efficiency lamps
    - High-efficiency ballasts
    - Pulse-Start/Ceramic metal halide technology
    - Highbay fluorescent luminaires
    - Occupancy sensors/timers
    - Photoelectric/daylight (dimming) controls
    - Lighting design software to provide sample calculations for significant areas

6.3. Lighting Power Density (LPD) Calculation Credits

When using the space-by-space method, reductions in the interior LPD allowance will be calculated for:

- Specific lighting functions as defined in paragraph 9.6.2 of ASHRAE/IESNA 90.1 – 2004/ 2007.

- Additional Interior Lighting Power Allowance is permitted in ASHRAE/IEASNA 90.1-2007 for specific lighting equipment installed in sales areas and specifically designed to highlight merchandise. Specific lighting for merchandise shall be controlled separately from the general lighting and be capable to be turned off during non-business hours. The additional allowance will affect the code compliance only and not the incentive calculation.

- Additional Retail Space LP allowance will be equal to 1000W + (Retail Area 1 X 1.0 W/ft^2 + Retail Area 2 X 1.7 W/ft^2 + Retail Area 3 X 2.6 W/ft^2 + Retail Area 4 X 4.2 W/ft^2), where:

    - Retail Area 1 = the floor area of all products not listed in the other Retail Areas

    - Retail Area 2 = the floor area used to sell vehicles, sporting goods and small electronics

    - Retail Area 3 = the floor area used to sell furniture, cloths, cosmetic and artwork

    - Retail Area 4 = the floor area used to sell jewellery, crystal and china

6.4. Automatic Lighting Control Credits

Space Control
BC Hydro recommends the use of automated space controls as per ASHRAE/IESNA 90.1 – 2004 (for exceptions please consult the code). However, for participation in the program the use of automated space controls is only mandatory for large commercial buildings. Automated space controls are not mandatory for small commercial buildings.

BC Hydro will award energy savings credit as follows:

- For small commercial building projects, which have interior lighting designs that use timers and occupancy and/or photocell sensors, BC Hydro will approve savings up to a maximum of 30 per cent of the hours of operation of the controlled load. The savings must be calculated using the space-by-space method, based on the lighting load multiplied by the estimated controlled usage hours (the difference between the usage hours without lighting controls and with lighting controls). To be granted control savings, the control devices must be able to turn the lighting completely off.

- For large commercial buildings projects, for interior lighting designs that use timers and occupancy and/or photocell sensors for classrooms, conference or meeting rooms, employee lunch and break rooms and any other spaces not included in ASHRAE/IESNA 90.1 – 2004,

BC Hydro will approve savings up to a maximum of 30 per cent of the hours of operation of the controlled load. The savings must be calculated as above.

- For exterior lighting, photocells or timers from dawn-to-dusk lighting applications are mandatory under the ASHRAE/IESNA 90.1 – 1999 and 2004 code and therefore considered as baseline design; resulting savings will not be approved for incentive under this program.

- For exterior lighting designs, BC Hydro will approve savings up to a maximum of 30 per cent of the hours of operation of the controlled load only for systems with a means of supplementary time control beyond the dawn-to-dusk hour mechanisms. The savings must be calculated space-by-space, based on the lighting load multiplied by the estimated controlled usage hours. The difference between the usage hours only with dawn-to-dusk controls and with supplementary lighting controls.

- For example, an outdoor parking area should not be in use more than 4,380 hours per year (operating 12 hours/7 day per week) since it uses dusk-to-dawn photocells. However, if a timer is added, the parking lights could turn off earlier than dawn, allowing for energy savings.

- For upgrades involving multiple-switched luminaires (using multiple ballasts, Hi-Lo mechanisms, etc.), BC Hydro will approve savings up to a maximum of 30 per cent where the load is controlled by automated controls: occupancy sensors, timers, photo-sensors, etc. The savings must be calculated as above, reflecting the expected usage hours for each set demand, e.g., luminaire will work 80 per cent of the time at 50 per cent power when space is unoccupied and the remainder 20 per cent of the time at 100 per cent power when the space is occupied.
- The true energy savings related to dimming and automatic lighting controls may exceed the limits described above, however, the capital incentive amount will be calculated as described.

Building Automated Lighting Control Upgrades
Both ASHRAE/IESNA 90.1 – 1999 and 2004 codes require the use of automated control devices to shut off lighting in all building spaces. Therefore, BC Hydro will not approve energy savings for using whole or partial (split floors) building control devices: DDC, BMS, relay panels, etc. The baseline usage hours should reflect the presence of automated building control devices. See the typical hours of use in Table 2, Typical Annual Hours of Operation.

6.5. Recommended Lighting Levels

Refer to the most up-to-date Illuminating Engineering Society of North America (IESNA) Handbook (9^{th} Edition, 2000 or updated versions) for appropriate lighting levels and other lighting quality parameters for the studied areas/sites. The illumination values recommended in the handbook are based on IESNA's judgement of best practice for typical applications. Consult a professional engineer or certified lighting designer for specific spaces to ensure the space is properly designed to IESNA, WCB and any other industry or government specific regulations.

6.6. Typical Hours of Use for Various Installations

BC Hydro will use the following maximum hours of use for lighting applications in calculating the approved savings for incentive applications, unless the consultant or owner can provide an acceptable documented rationale for longer hours of operations.

Table 2. Typical Annual Hours of Operation

Facility	Maximum Hours of Use / Year	Facility	Maximum Hours of Use / Year
Elementary Schools		**Secondary Schools**	
Classrooms	2200	Classrooms	2500
Corridors / Gymnasiums	2800	Corridors / Gymnasiums	3200
Storage Rooms	600	Storage Rooms	600
College / University		**Strata Units / Hotels**	
Classrooms / Offices	3000	Common areas	8760
Parking Garages	8760	Parking garages	8760
Storage Rooms	600	Offices	2600
Gymnasiums	3200	Guest rooms	1500
Hospitals	8760	Storage Rooms	600
Warehouses	3600	**Restaurants**	4000
Shopping Malls	4800	**Convenience Stores**	6500
Office Buildings		**Retail (food)**	5800
Low rise	3800	**Retail (non food)**	4500
High rise	4000	**Industrial**	Confirm on site-by-site basis

Source: Building Check Up (BCU) Data 1999

6.7. Lighting Design Software

BC Hydro encourages the use of computer-aided lighting design simulations. Effective use of lighting simulation software allows for quick and detailed calculations with effective graphic visualizations. This is helpful to effectively communicate the designer's concept and enable other stakeholders in the project to visualize and understand the lighting solution.

The programs listed in the following sections are approved for use in the New Construction program.

Assisted Lighting Design

Table 3 lists lighting software approved for assisted lighting design, based on the ability to provide inter-reflected calculations of illuminance and effective graphic visualizations. Any upgraded release of these software programs will be automatically approved. Software programs not included on the list must be reviewed and approved by BC Hydro before use in this program.

Table 3. BC Hydro-approved Lighting Software

Product	Vendor
Genesys II/ III/ Genesys Lite	Canlyte/ Genlyte
Lite Pro 1.0/ 2.0	Columbia Prescolite Moldcast
Luxicon 2.2.8	Cooper Lighting
Autolux 6.20	Independent Testing Laboratories Inc.
Agi 32/ 1.1	Lighting Analysts, Inc.
Simply Indoor 2.0	Lighting Technologies, Inc.
Lumen Micro 7.5	Lighting Technologies, Inc.
Light Works Pro 4.5	Light Work Design
Micro-Site-Lite 2.2	Lighting Sciences, Inc.
Light 3.0.	Optis
Light Star 3.20	Oxytech
Simple 3.20	Oxytech
Visual basic 2.0	Lithonia Lighting
Visual pro 2.0	Lithonia Lighting

Energy-Efficient Lighting Analysis

Table 4 lists free lighting software which helps designers evaluate alternatives for energy-efficient lighting (e.g., day-lighting). The use of the freeware program is not mandatory; however, it can be a valuable feedback tool and may help achieve better designs.

Table 4. Energy-Efficient Lighting Software

Product	Vendor (free)	Source
Lightswitch Wizard	NRC	www.buildwiz.com
Daysim	NRC	www.daysim.com
COMcheck-EZ	PNW National Laboratory	www.energycodes.gov
SPOT	Architectural Energy Co.	www.archenergy.com/SPOT

APPENDIX A: Specifications for Standard Lighting Equipment

To help promote energy-efficiency technologies and design, BC Hydro recommends the lighting design include any of the following lighting measures:

- High-efficiency lamps
- High-efficiency ballasts
- Pulse-Start/Ceramic metal halide technology
- Highbay fluorescent luminaires
- Occupancy sensors/timers
- Photoelectric/daylight (dimming) controls
- Lighting design software to provide sample calculations for significant areas

The following specification outlines the minimum acceptable requirements for lighting equipment to qualify projects for BC Hydro incentive.

Fluorescent Lighting Systems

T12 Lighting

BC Hydro does not approve incentives for luminaires equipped with T12 lamps and magnetic or electronic ballasts, nor with T8 lamps and magnetic ballasts.

T8 Lighting

T8 lamps and electronic ballasts must meet the following criteria.

1. Fluorescent T8 lamps must have the following maximum rated input wattage:
    - 8’ lamps must be 59 watts or lower (high efficiency, premium lamps)
    - 4’ lamps must be 32 watts or lower (high efficiency, premium lamps)
    - 3’ lamps must be 25 watts or lower (high efficiency, premium lamps)
    - 2’ lamps must be 17 watts or lower (high efficiency, premium lamps)
2. High efficiency/lower wattage T8 lamps usually have some limitations such as min. 60F/16C operating temperature and no dimming abilities that have to be considered when choosing the suitable design for the given application.
3. Minimum lamp life for all T8 lamps must be 18,000 hours but it is recommended that they be 24,000 hours or more, at three hours per start regardless of the type of electronic ballast.
4. Colour rendering index (CRI) must be 82 minimum. There is no restriction on lamp colour temperature.
5. T8 lamps may be remote tandem-mounted as recommended by the ballast manufacturer usually up to 20 feet.
6. Ballasts must be dedicated only for T8 systems and must be high-frequency electronic type. Ballasts must operate lamps between 20 kHz and 60 kHz and must have a 5-year warranty.
7. Instant start electronic ballasts, dimming electronic ballasts and programmed start ballasts are eligible for incentive. Rapid start ballasts are not eligible for incentive as they are currently being replaced by programmed start ballasts.
8. Instant start electronic ballasts must have low power input for two to four lamp ballasts. Low power input means the ballast has a low ballast factor. The input wattage must not exceed:

Standard Efficiency Ballast	Maximum Input Watts for Number of Lamps – Standard T8 lamps (Low BF)			
Lamp Length	**1 lamp**	**2 lamp**	**3 lamp**	**4 lamp**
2 foot	17 W	29 W	43 W	56 W
3 foot	24 W	43 W	60 W	84 W
4 foot	29 W	52 W	78 W	102 W
8 foot	57 W	100 W	N/A	N/A

Standard Efficiency Ballast	Maximum Input Watts for Number of Lamps – Standard T8 lamps (Normal BF)			
Lamp Length	**1 lamp**	**2 lamp**	**3 lamp**	**4 lamp**
2 foot	18 W	31 W	47 W	61 W
3 foot	26 W	46 W	64 W	87 W
4 foot	31 W	60 W	90 W	112 W
8 foot	60 W	110 W	167 W	220 W

9. High-efficiency electronic ballasts must provide a minimum 3 watts energy savings over comparable standard-efficiency electronic ballasts of similar ballast factor.
10. Instant start ballasts are not recommended in applications where the lamps are turned on and off frequently (i.e., with occupancy sensors) because they may shorten lamp life. Programmed start ballasts are recommended for these applications.
11. Ballast power factor must be 0.95 minimum (lead or lag).
12. For 4-foot linear 32 watts (or lower) T8 lamps and electronic ballasts, the mean system efficacy must be:
    - Greater or equal to 90 MLPW (mean lumens per input watts) for instant start ballasts
    - Greater or equal to 88 MLPW for programmed start ballasts
13. Normal ballast factor ballasts have a ballast factor of between 0.85 and 1.00, as per ANSI C82.11.
14. Low ballast factor ballasts must have a ballast factor between 0.70 and 0.85.
15. High ballast factor ballasts must have a ballast factor between 1.10 and 1.20.
16. For the standard electronic T8 ballasts, the total harmonic distortion (THD) limit must not exceed 20 per cent rated at either 5 per cent above or 5 per cent below nominal primary voltage. For high efficiency electronic ballasts, THD must be less than 10 per cent.

T5 Fluorescent

1. This measure will apply to T5 systems with linear lamps rated 18 watts to 80 watts inclusive.
2. Ballasts must be dedicated for T5/ TT5/ T5HO systems and must be high-frequency electronic type. Ballasts must operate lamps between 20 kHz and 60 kHz.
3. Total harmonic distortion (THD) limits for input current must not exceed 17 per cent rated at either 5 per cent above or 5 per cent below nominal primary voltage.
4. New T5 luminaires must have an efficiency of minimum 70 per cent to qualify for incentive.

Compact Fluorescent

1. For the present incentive program, BC hydro does not approve luminaires for screw-base compact fluorescent lamps.
2. The measures apply to all hardwired compact fluorescent lamps of two-pin, four-pin and double, triple 2D, biax tubes, etc.
3. Lamps must start and operate reliably at temperatures down to +10° C throughout their rated lives. Low temperature ballasts to be suitably rated for cool temperature applications.
4. There is no restriction on the lamp colour temperature, but the colour rendering index (CRI) must be 82 minimum.
5. It is recommended that CFL luminaires be operated by high power factor ballasts (>0.95) to limit stress to the electrical distribution system and to avoid possible power factor penalties to the Owner.

Highbay Fluorescent Luminaires

1. It is recommended that high-bay fluorescent luminaires save a minimum of 100 input watts/ luminaire when compared with incandescent or HID technology.
2. Accepted lamps for high-bay fluorescent luminaires are: T8, T5, T5HO, CFL and induction lamps. Ballasts must be high power factor electronic and suitable for the lamp type.
3. High-bay fluorescent luminaires must be capable of multiple switching.
4. Luminaires should be provided with optimal heat dissipation for electronic ballasts.

LED Exit Sign

1. LED exit signs are considered baseline design and do not qualify for an incentive.

High Intensity Discharge Luminaires (HID)

1. The incentive applies to both interior and exterior lighting systems. HID ballasts can be magnetic or electronic type.
2. All HID ballasts must have a ballast factor of 0.95 minimum and a high power factor of 0.90 minimum.

Occupancy Sensor Switches

1. Occupancy sensor switches must use passive infrared energy or ultrasonic energy response or a combination of both, and must be of commercial quality.
2. The switch format must be either a wall-mounted type to replace conventional wall switches, or a ceiling-mounted version. Switch contacts must be suitable for application on fluorescent and HID lighting systems. Switching must be via parting / making of mechanical contacts and not solely

electronic. Sensor switches used in conjunction with approved low-voltage relay systems will also be permitted. Switches must have no minimum loading requirement to stay activated.

3. Sensor switches must have **Off / Automatic** selector modes with no **On** position.

4. Sensor switches may have an optional ambient light sensing feature with an adjustment range to keep the lighting system off when there is enough daylight during occupancy.

5. An adjustable **On** time feature must be provided with a continuous range of one to 15 minutes. The occupancy scan frequency must be at least once every two seconds, with automatic timing function reset. An LED will indicate when activity has been detected.

6. All sensors must have a sensitivity adjustment feature to adjust the proper operation for a variation of room or area geometrics.

7. Systems may use two or more sensor switches suitably interconnected for situations such as highly irregular areas, partitioned work station areas, very large areas, etc.

8. Occupancy sensor layout and arrangement must be in accordance with individual manufacturer's recommendations.

9. When the use of ceiling sensors requires an **Off** option during room occupancy, a wall switch is suggested to switch the occupancy sensor off electrically.

10. Switches must have humidity resistant circuitry and components.

11. Sensors must have adequate inrush current capability for the application, particularly on electronic ballasts.

APPENDIX B: Lighting Power Density Tables

The following LPD tables (taken from the ASHRAE / IESNA Standard 90.1) are embedded in the Lighting Calculator spreadsheet and these tables are for reference only.

Table 5. Lighting Power Densities (LPD) using ASHRAE / IESNA Standard 90.1 Space-by-Space Method

Common Space Types		90.1-1999[a]		90.1-2004/2007[b]		90.1-2004[c]/2007[d] less 10%	
		W/m^2	W/ft^2	W/m^2	W/ft^2	W/m^2	W/ft^2
Office – Enclosed		17	1.6	12	1.1	11	1.0
Office – Open Plan		14	1.3	12	1.1	11	1.0
Conference/Meeting/Multipurpose		16	1.5	14	1.3	13	1.2
Classroom/Lecture/Training		17	1.6	15	1.4	14	1.3
	For Penitentiary	15	1.4	14	1.3	13	1.2
Lobby		19	1.8	14	1.3	13	1.2
	For Hotel	18	1.7	12	1.1	11	1.0
	For Performing Arts Theater	13	1.2	36	3.3	32	3.0
	For Motion Picture Theatre	9	0.8	12	1.1	11	1.0
Audience/ Seating Area		17	1.6	10	0.9	9	0.8
	For Gymnasium	5	0.5	4	0.4	4	0.3
	For Exercise Center	5	0.5	3	0.3	3	0.3
	For Convention Center	5	0.5	8	0.7	7	0.7
	For Penitentiary	20	1.9	8	0.7	7	0.7
	For Religious Buildings	34	3.2	18	1.7	16	1.5
	For Sports Arena	5	0.5	4	0.4	4	0.3
	For Performing Arts Theatre	19	1.8	28	2.6	25	2.3
	For Motion Picture theatre	14	1.3	13	1.2	12	1.1
	For Transportation	11	1.0	5	0.5	5	0.4
Atrium – First Three Floors		14	1.3	6	0.6	5	0.5
Atrium – Each Additional Floor		2	0.2	2	0.2	2	0.2
Lounge/Recreation		15	1.4	13	1.2	12	1.1
	For Hospital	15	1.4	9	0.8	8	0.8
Dining area		16	1.5	10	0.9	9	0.8
	For Penitentiary	15	1.4	14	1.3	13	1.2
	For Hotel	11	1.0	14	1.3	13	1.2
	For Motel	13	1.2	13	1.2	12	1.1
	For Bar Lounge/Leisure Dining	13	1.2	15	1.4	14	1.3
	For Family Dining	24	2.2	23	2.1	21	1.9
Food Preparation		23	2.1	13	1.2	12	1.1
Laboratory		20	1.9	15	1.4	14	1.3
Restrooms		10	0.9	10	0.9	9	0.8
Dressing/Locker/Fitting Room		9	0.8	6	0.6	5	0.5
Corridor/Transition		8	0.7	5	0.5	5	0.4
	For Hospital	17	1.6	11	1.0	10	0.9
	For Manufacturing Facility	6	0.6	5	0.5	5	0.4
Stairs – Active		10	0.9	6	0.6	5	0.5

Common Space Types		90.1-1999[a]		90.1-2004/2007[b]		90.1-2004[c]/2007[d] less 10%	
		W/m^2	W/ft^2	W/m^2	W/ft^2	W/m^2	W/ft^2
Active Storage		12	1.1	9	0.8	8	0.8
	For Hospital	31	2.9	10	0.9	9	0.8
Inactive storage		4	0.4	3	0.3	3	0.3
	For Museum	15	1.4	9	0.8	8	0.8
Electrical/ mechanical							
Workshop		27	2.5	20	1.9	18	1.7
Gymnasium/ Exercise Center							
	Playing Area	20	1.9	15	1.4	14	1.3
	Exercise Area	12	1.1	10	0.9	9	0.8
Courthouse/Police Station/Penitentiary							
	Courtroom	23	2.1	20	1.9	18	1.7
	Confinement Cells	11	1.0	10	0.9	9	0.8
	Judges Chambers	11	1.0	14	1.3	13	1.2
Fire Stations							
	Fire Station Engine room	10	0.9	9	0.8	8	0.8
	Sleeping Quarters	11	1.0	3	0.3	3	0.3
Post Office – Sorting Area		18	1.7	13	1.2	12	1.1
Convention Center – Exhibit Space		36	3.3	14	1.3	13	1.2
Library							
	Card File & Cataloguing	15	1.4	12	1.1	11	1.0
	Stacks	20	1.9	18	1.7	16	1.5
	Reading Area	19	1.8	13	1.2	12	1.1
Hospital							
	Emergency	30	2.8	29	2.7	26	2.4
	Recovery	28	2.6	9	0.8	8	0.8
	Nurse station	19	1.8	11	1.0	10	0.9
	Exam/Treatment	17	1.6	16	1.5	14	1.3
	Pharmacy	24	2.2	13	1.2	12	1.1
	Patient Room	12	1.1	8	0.7	7	0.7
	Operating Room	82	7.6	24	2.2	22	2.0
	Nursery	11	1.0	6	0.6	5	0.5
	Medical Supply	32	3.0	15	1.4	14	1.3
	Physical Therapy	20	1.9	10	0.9	9	0.8
	Radiology	5	0.5	4	0.4	4	0.3
	Laundry/Washing	8	0.7	6	0.6	5	0.5
Automotive – Service/Repair		15	1.4	8	0.7	7	0.7
Manufacturing							
	Low-Bay (<7.6 m (25 ft) Floor to Ceiling Height)	23	2.1	13	1.2	12	1.1
	High-Bay (>=7.6 m (25 ft) Floor to Ceiling Height)	32	3.0	18	1.7	16	1.5
	Detailed Manufacturing	67	6.2	23	2.1	21	1.9
	Equipment Room	8	0.7	13	1.2	12	1.1
	Control Room	6	0.6	5	0.5	5	0.4
Hotel/ Motel Guest Rooms		26	2.4	12	1.1	11	1.0
Dormitory – Living Quarters		21	2.0	12	1.1	11	1.0

Common Space Types		90.1-1999[a]		90.1-2004/2007[b]		90.1-2004[c]/2007[d] less 10%	
		W/m^2	W/ft^2	W/m^2	W/ft^2	W/m^2	W/ft^2
Museum							
	General Exhibition	17	1.6	11	1.0	10	0.9
	Restoration	27	2.5	18	1.7	16	0.9
Bank/Office – Banking Activity Area		26	2.4	16	1.5	14	1.3
Religious Buildings							
	Worship –Pulpit, Choir	56	5.2	26	2.4	23	2.2
	Fellowship Hall	24	2.2	10	0.9	9	0.8
Retail (General – No Accent) Should this be recreation?							
	Court Sports Area	46	4.3	25	2.3	23	2.1
	Indoor Playing Field Area	20	1.9	15	1.4	14	1.3
Warehouse							
	Fine Material Storage	18	1.7	15	1.4	14	1.3
	Medium/Bulky Material Storage	12	1.1	10	0.9	9	0.8
Parking Garage – Garage Area		3	0.3	2	0.2	2	0.2
Transportation							
	Airport – Concourse	7	0.7	6	0.6	5	0.5
	Air/Train/Bus – Baggage Area	14	1.3	11	1.0	10	0.9
	Terminal – Ticket counter	19	1.8	16	1.5	14	1.3

[a] Baseline for small commercial buildings outside COV (City of Vancouver)

[b] all NC projects should meet ASHRAE/IESNA 90.1 – 2004, respectively 2007 for projects within COV

[c] NC for large commercial buildings is on average 10% more restrictive than ASHRAE/IESNA 90.1 – 2004, outside COV

[d] NC for commercial buildings is on average 10% more restrictive than ASHRAE/IESNA 90.1 – 2007 for projects within COV

Table 6. Lighting Power Densities (LPD) for Selective Building Exteriors using ASHRAE / IESNA Standard 90.1

Common Space Types[e]	90.1-1999[a]		90.1-2004/2007[b]		90.1-2004 [c] /2007 [d] less 10%	
	W/m^2	W/ft^2	W/m^2	W/ft^2	W/m^2	W/ft^2
Walkways 3 Meters Wide or Greater Plaza areas or Special Feature Areas	N/A	N/A	2.2	0.2	2.0	0.2.
Stairways	N/A	N/A	10.8	1.0	9.7	0.9
Canopies and Overhangs	32.4	3.0	13.5	1.3	12.2	1.1
Open Areas (incl. Auto Sales)	N/A	N/A	5.4	0.5	4.9	0.5
Entrances and Gatehouse Inspection Stations at Guarded Facilities	N/A	N/A	13.5	1.3	12.2	1.1
Loading Areas for Law Enforcement, Fire, Ambulance and Other Emergency Service Vehicles	N/A	N/A	5.4	0.5	4.9	0.5
Parking Uncovered [f]	N/A	N/A	1.6	0.1	1.4	0.1
	W/m	W/ft	W/m	W/ft	W/m	W/ft
Main entries (per linear door width)	108.3	33.0	98	29.9	88.2	26.9
Other doors (per linear door width)	65.6	20.0	66	20.1	59.4	18.1

[a] Baseline for small commercial buildings outside COV (City of Vancouver)

[b] all NC projects should meet ASHRAE/IESNA 90.1 – 2004, respectively 2007 for projects within COV

[c] NC for large commercial buildings is on average 10% more restrictive than ASHRAE/IESNA 90.1 – 2004, outside COV

[d] NC for commercial buildings is on average 10% more restrictive than ASHRAE/IESNA 90.1 – 2007 for projects within COV

[e] NC projects use selective ASHRAE/IESNA 90.1 exterior LPD values. All exterior lighting allowances are tradable among listed exterior spaces. Do not use for calculations non-listed exterior common/typical areas.

[f] Exterior, uncovered parking lots are tradable for code compliance but would not affect incentives.

Please note that for the Exterior spaces that had not assigned LPD values for the release 1999 of the ASHRAE-IESNA 90.1 code, the energy saving baseline will be the release 2004 values. For example, the exterior stairways of a Burnaby building will have the baseline set at 10.8W/m2, respectively 1.0 W/ft2, and the design should meet or exceed these values to qualify for incentives.