Pacific Gas and Electric Company

Emerging Technologies Program

Application Assessment Report #0720

HID Electronic Ballast
San Francisco Bay Area, CA

Issued: May 6, 2008

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1. Executive Summary

Salas O'Brien, Inc under contract to PG&E evaluated an emerging technology that potentially provides energy efficiency improvements on HID lighting. The main objectives of this assessment were (1.) to evaluate energy use of the emerging technology as compared to the existing technology and (2.) to characterize the performance of the emerging technology as compared to the existing technology.

This assessment retrofitted nine (9) HID lighting fixtures with new metal halide bulbs and electronic ballasts within a room of an educational facility. This was accomplished by completing the lighting assessment in phases, with the evaluation team recording measurements at each change in test condition. For this assessment, the original nine (9) indirect HID fixtures using 400W metal halide lamps and magnetic ballasts were retrofit with new 400W metal halide lamps and electronic ballasts. This was an indirect lighting application in which the HID lamp was in a vertical down position and covered with an opaque lens. (See adjacent photos.)

Results of our evaluation revealed potential reductions in both electrical demand and electrical consumption due to the HID electronic ballast retrofit. The installed cost was economical and associated cost savings were significant - especially since lumen depreciation (which represented for lumen matching to the mean lumen level) was taken into account within the savings calculation. This combination resulted in a payback period that was satisfactory.

Results of the various performance testing of the electronic ballasts were "as-expected" in many of the categories tested, yet surprisingly unexpected in others. The electronic ballasts used less energy than their magnetic counterparts, with less harmonic distortion and quieter operation. However, surprisingly, lamp temperatures ran significantly hotter when powered by electronic ballasts than when powered with existing magnetic ballasts. Furthermore, bulbs driven by the retrofit did not produce more light level output to the test space, as expected, at standard surface heights. Only equivalent light levels were found (albeit using less energy demand and consumption in the process.) Energy savings were based on typical operating hours of 16 hours per day, 5 days per week.

Total Demand Reduction per fixture:	0.039 kW
Total Energy Usage Reduction per fixture:	404 kWh/yr
Total Estimated Cost Savings per fixture (@$0.120/kWh):	$48 per yr
Installed Cost per fixture:	$317 each
Overall Simple Payback per fixture:	6.6 yrs

2. Project Background

Strides in the efficiency of lighting technology are made continuously. However, not much progress has been made in the High-Intensity Discharge (HID) lighting field until the past few years. The MetroLight Corporation has designed and manufactured an electronic ballast for HID fixtures they call the "Smart Electronic Ballast." According to MetroLight, "Smart Electronic Ballasts offer improved energy efficiency, light output and reliability." Using the Smart Electronic Ballast, MetroLight claims "lamps can be dimmed across a continuous range from 50-100% of full power, without flickering and without any damage to the lamp." Several brochures on product information are included in the Appendix of this report outlining product features, details and specifications.

HID lighting is mainly used for large bay or high ceiling type environments, where adequate lighting is required at "standard surface heights" (i.e. 3 to 4 feet above finished floor) from lighting fixtures mounted 20 to 30 feet high. Examples of these types of environments include: gymnasiums, warehouses, and manufacturing plants. In the lighting industry, there are only a handful of manufacturers with electronic ballast options available for HID lighting. Because most buildings of this nature were built prior to the availability of HID electronic ballasts, most existing buildings with HID lighting use magnetic ballasts. With the introduction of the electronic HID ballast, such as this product from MetroLight (as well as others), a new plateau of energy efficiency in lighting can be reached. In general, all types of lighting technology with electronic ballasts use less energy, burn brighter, last longer, and start up faster. With HID lighting, the expectations are the same. Furthermore, lighting with electronic ballasts also costs more typically, and is not easily compatible with existing light fixtures – thus making retrofit options harder. As a result, an entire fixture change-out is usually considered and done, which increases up-front costs significantly. Because of this, it is important to evaluate the economics of an electronic ballast retrofit on a case-by-case basis.

3. Project Hypothesis/Objectives

In this assessment, the objective was to quantify performance and savings claims of the energy-saving HID electronic ballast under study. The plan for attaining this objective was defined as:

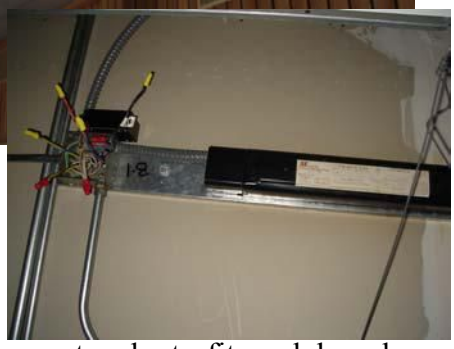
(1) To measure performance parameters of several HID fixtures under existing conditions for a minimum of one (1) hour,
(2) To replace the existing 400 watt metal halide bulbs with in-kind types (thus eliminating the effect of "lumen depreciation"), allowing a burn-in period of at least 200 hours minimum. Performance parameters were then re-measured,
(3) To replace the existing magnetic ballasts with electronic ballasts, then re-measure performance parameters again,
(4) To adjust (i.e. tune-down or dim-down) the electronic ballasts, *as needed*, to provide light output "as-equal" as the original measured existing conditions. Performance parameters were re-measured a final time, and
(5) Then all measured results were compared and analyzed.

Selected criteria were created by the assessment team through discussions with the evaluation team, test site representative, and PG&E representative. The final implementation plan was documented and agreed upon after further evaluation of the product to be installed and after a pre-monitoring inspection of the test site by both the assessment team and the PG&E representative. Testing criteria, selected for evaluation of the product, included electrical power consumption (kW, kWh, volts, amps, power factor & harmonics), light output (at standard surface height and at locations between and directly below the luminaires), and temperature & sound readings.

The pre- and post-installation monitoring procedure can be seen in its entirety in Appendix A of this report.

4. Methodology

The host site participating in this study is an educational facility located in the San Francisco Bay Area. The room selected is primarily used for practice of self-defense tactics by a local law enforcement academy. The assessment team inspected several test room options at the educational facility and found that the room selected would be the best candidate to perform product evaluation testing. The room has a T-bar ceiling at a height of 12 feet. Nine (9) existing HID fixtures hang from the ceiling at 7'-11" high and are full indirect types with opaque lenses. The associated existing magnetic ballasts are remotely installed above the T-bar ceiling area. (Examples of the fixture and ballast are shown in the adjacent photos.) Wires in conduit connect the hidden ballast to the exposed HID hung from the ceiling grid.



The assessment team constructed a timeline for measurement and retrofit work based on the set of criteria described in the previous Section (and as shown in Appendix A.) The time line for this project was as follows:

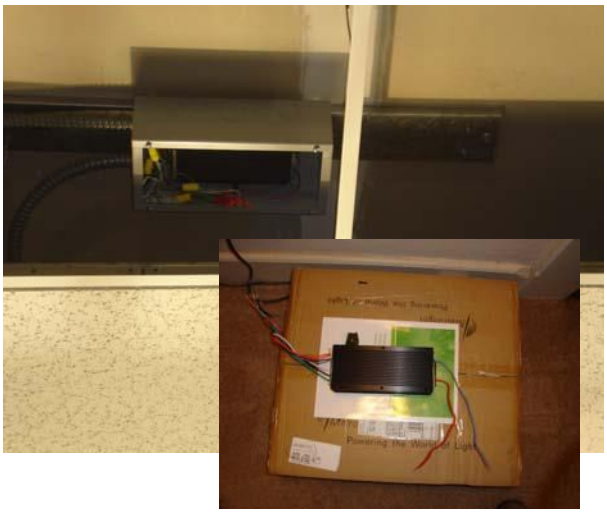
Pre-Installation Monitoring	September 24, 2007
Monitoring after Lamp Burn-In	October 26, 2007
Delivery of electronic ballasts	November 7, 2007
Installation of electronic ballasts	November 22, 2007
Post-Installation Monitoring	December 4, 2007
Tune-down of electronic ballasts	*deferred; future assessment*

INSTALLATION:

As stated in most recent publications from MetroLight, new configurations of different ballasts and lamps are continuously tested at their facilities. As new combinations of ballast + lamp configurations are tested and approved for use with the Smart Electronic Ballast, they are published by MetroLight as "acceptable for use." A copy of the most recent Compatibility Chart is shown as Appendix C within this report. In addition, MetroLight frequently updates its website with a list of approved configurations (www.metrolight.com).

In planning for this case study, we verified that all ballast and lamp configurations used within this assessment have been tested and are compliant with MetroLight's current documentation.

Next, with assistance from our in-house electrician, the old Magnetek magnetic ballasts were removed from each fixture and were replaced with new MetroLight electronic ballasts. Overall, the installation went smoothly. There was only one slight modification determined just prior to installation – a metal enclosure was purchased and installed to house the new electronic ballast and keep all conductor connections contained. This eliminated any electrical components from being exposed to the environment (safety hazard), as well as provided for a clean, professional installation.



All ballast equipment was shipped from the manufacturer directly to the assessment team. The team then subsequently delivered to the testing site and planned for immediate installation. (An example of the new HID electronic ballast installation can be seen in the adjacent photos.) T echnical specifications on this product are provided in the Appendix of this report.

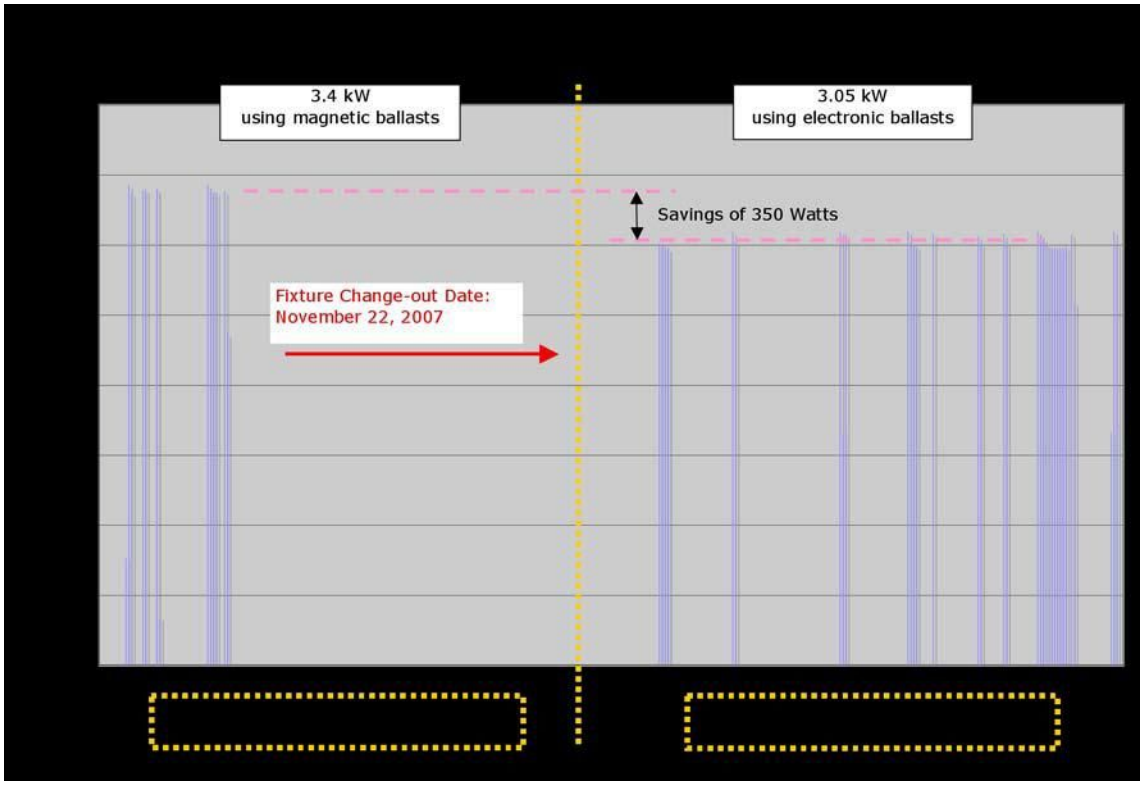
5. Project Results

Following the criteria identified in the Pre- and Post-Installation Monitoring Procedure, the key findings from this lighting demonstration project are summarized as follows.

Energy Usage:

With approval from Site Facilities staff, our in-house electrician connected a current transducer to the electrical circuit providing power to the nine (9) HID fixtures within the test space. A power meter data recorder was subsequently connected to the current transducer in order to record a number of electrical properties: *amps, volts, kW, kWh, power factor and harmonics*. Unless otherwise stated, recorded data spanned over a period of at least 7 days each for all pre- and post-installation phases.

As a result, power consumption for the pre- and post-installation phases are shown in the following graph:

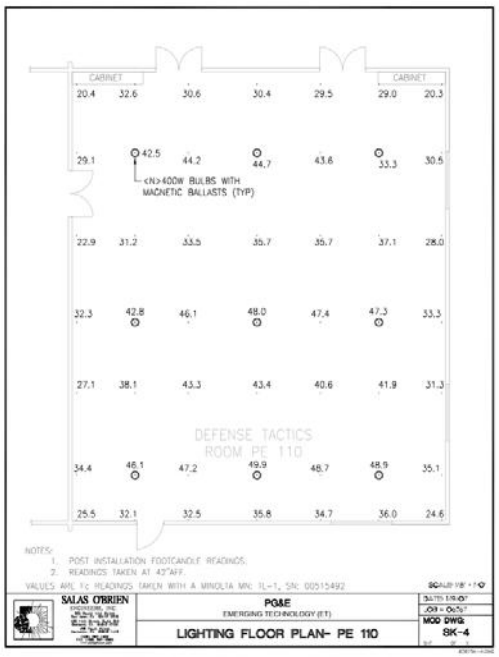


This graph shows that the existing electrical power demand is about 3.4 kW and, after change-out, the electrical power demand drops slightly to 3.05 kW, **a savings of about 0.35 kW overall (11.5%), or 0.039 kW per fixture**. It can be concluded that the retrofitted HID fixtures operate at a lower electrical power demand (kW) resulting in lower electrical energy usage (kWh) over time. Based on typical hours of operation for this type of facility, the average daily hours of operation of the lights, excluding weekends, was estimated at roughly 16 hours per day, 5 days per week.

Taking into account the average daily hours of operation of this facility, operational cost savings could be calculated. However, in order to obtain the most accurate representation of savings, the effect from lumen depreciation would also need to be factored in.

Light Output:

Shown on the following drawing is a floor plan of the testing area at the educational facility. A full, readable version of this and all other pre- and post-installation phases are included in Appendices D through G of this report.



Light level readings (measured in foot-candles) were taken at various points – underneath and between fixture locations - at standard surface height (i.e. 42" above finished floor) during pre- and post-installation phases to explore whether the new HID fixture yielded more/less or the same amount of light output at this height. For this test, the evaluation team used a portable light meter to measure light in a grid pattern at measured intervals. In addition, all windows within the room were covered to prevent any influence from outdoor light onto the light level readings.

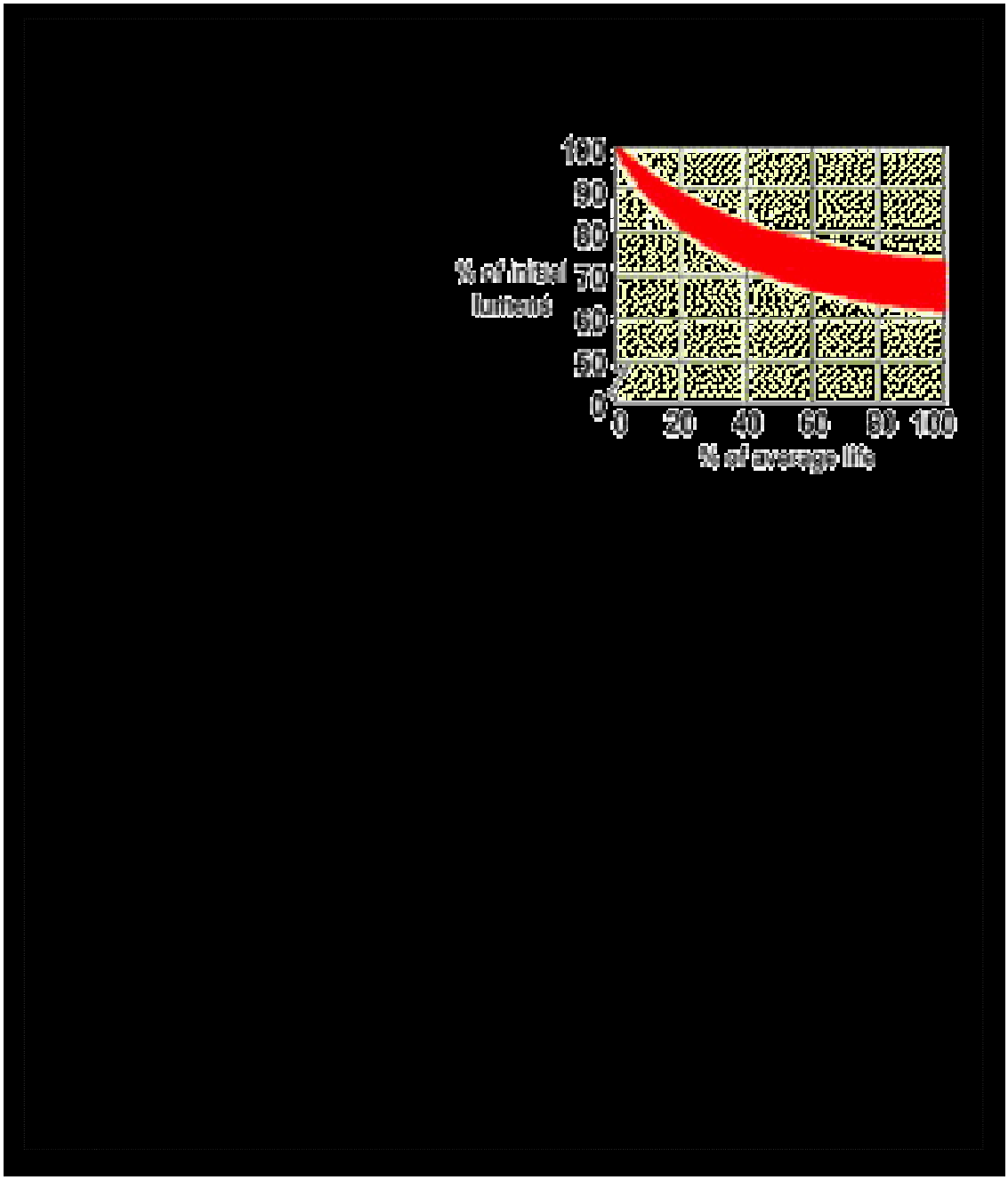
Typically, retrofits of electronic ballasts from magnetic ballasts result in a significant increase in lumen output delivered to the lit space. As a result, traditional electronic ballast retrofits include a secondary step of "dimming down" the ballast output, providing proper ***lumen matching**** to the existing conditions prior to retrofit – thus resulting in more energy savings. However, in this assessment, results were surprising.

The post-installation measurements revealed that light levels throughout the testing area *remained the same or slightly lower* than pre-installation conditions. The majority of measured points showed equal or slightly lower light output values with the new HID fixtures. Only a handful of measured points revealed an increase in light output with the new HID fixtures. The average percent (%) change across the entire testing area was *a <u>decrease</u> of about 1%.*

As a result, our test procedure was adjusted to *exclude* the secondary

**** Lumen Matching better explained:***
Lumen matching is a term used by electronic HID ballast manufacturers. It means that the electronic HID ballast brightness can be adjusted to a lumen value where the lumen output matches that of a typical magnetic HID ballast. The electronic HID ballast can be adjusted either through dimming or installing a ballast that will produce the equivalent of the mean lumen output of a magnetic HID ballast. The lumen matching adjustment of an electronic HID ballast results in the electronic HID ballast providing the equivalent brightness as the magnetic ballast's mean lumen while consuming less power. For example, electronic HID manufacturers claim that a 320W electronic HID ballast can produce the equivalent lumens as a 400W magnetic ballast. How does this impact power? A 400W magnetic ballast requires 469W to operate a 400W HID lamp. A 400W electronic HID ballast requires 421W to operate a 400W lamp. Initial expected energy savings are 48W or 11%. However, the electronic HID is suppose to deliver significantly more lumens than that of a magnetic ballast. Based upon the known lumen depreciation curves for magnetic ballast and those of electronic HID ballast, we can extrapolate to determine the appropriate wattage of an electronic HID ballast which can deliver the same mean lumen output as the magnetic ballast. Continuing with the example, a 320W electronic HID ballast requires 337W to operate a 320W HID lamp produces the equivalent lumens of the 400W lamp operating with a magnetic ballast resulting in energy savings of 132W or 28%.

step of dimming down for lumen matching that is historically completed to maintain a light level equal to existing conditions. It is unclear why light levels did not change. We speculate that the type of lens used and the direction of luminance (i.e. 100% indirect) on the tested fixtures provided too much light filtering to the ambient space to show a significant change in light levels. Regardless, this surprising result will be adjusted for in future lighting assessments.



The Power Consumption data shows that it is likely that the new HID fixtures are capable of providing "like-kind" performance (as measured in light level output) while using less energy in the process. In addition, taking into account lumen depreciation (and the ability

to "tune down" electronic ballast output wattage), ***energy savings can be more than doubled.*** In this assessment, taking into account the effects of lumen depreciation, a savings of 34% (vs. the original 11.5% based on straight electrical power demand reduction) would have been realized. Therefore, there is definite potential to attain energy and cost savings using the MetroLight ballast product. All calculations presented within this assessment include the effect of lumen depreciation.

Taking into account typical operating hours, the difference in Power Consumption readings, and the effect of Lumen Depreciation energy savings, the overall effect of converting to HID electronic ballasts is a savings of:

3,637 kWh per year total, or
404 kWh per year per fixture
$48 per year per fixture[1]

A detailed calculation is provided in Appendix M of this report.

Sound Levels:

Sound level readings were taken on at least 4 equidistant sides of one randomly selected fixture of the nine (9) HID fixtures during pre- and post-installation phases. This test was performed to determine if the new HID fixtures were more/less or equally noisy than their existing counterparts. Sound level readings for all pre- and post-installation phases are included in the Appendix of this report.

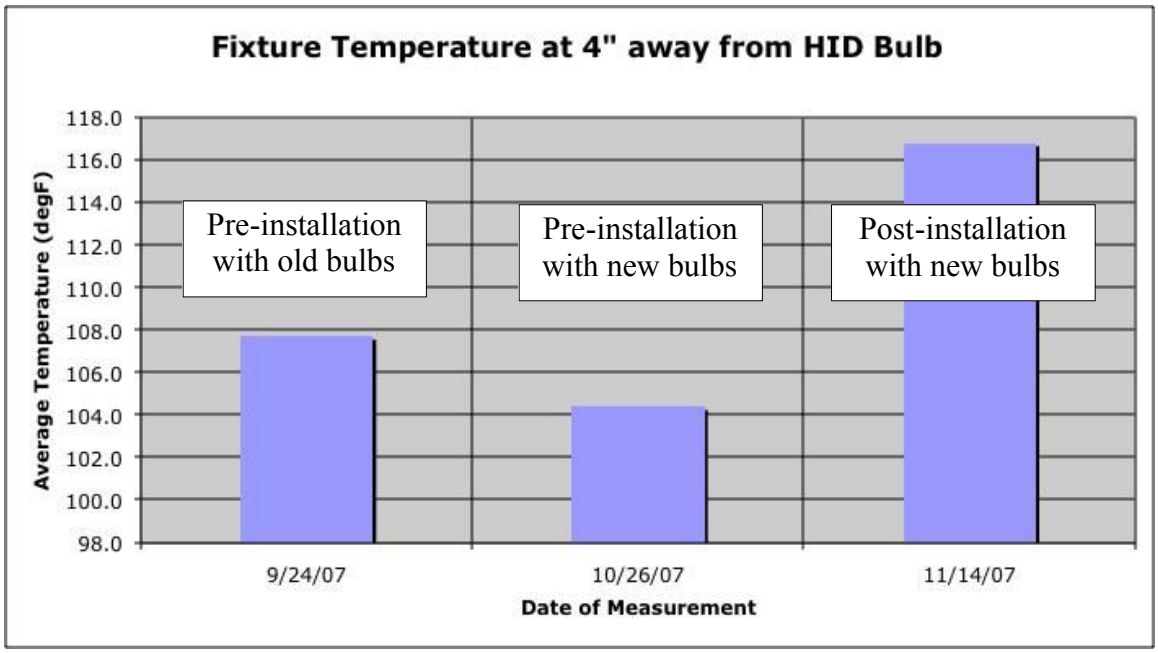
Our testing of sound levels found an average 7% drop in overall ambient noise surrounding the ballasts just by changing the existing 400 W bulbs with new like-kind bulbs. Subsequently, when the magnetic ballasts were replaced with the MetroLight electronic ballasts, sound levels dropped an average 21% more. Overall, with bulb and ballast change-out, ambient noise dropped an average 26% in total. With the most significant portion of this 26% drop attributed to the ballast change-out, it can be concluded that the MetroLight electronic ballasts run quieter providing the same service as its predecessor.

Temperature:

The temperature of one randomly selected fixture of the nine (9) HID fixtures was monitored during pre- and post-installation phases to explore whether the new electronic HID fixtures operated "cooler" at the lamp, or rather at a lower ambient temperature. For this test, a temperature sensor was installed 4" away from the bulb and temperature readings were taken throughout the monitoring phases.

[1] Estimated at $0.120/kWh electric utility cost.

The following graph shows results of this monitoring in all pre- and post-installation phases. (A full-page version of this graph is included in Appendix I of this report.):



From this graph, it can be seen that, when in operation, the HID fixtures generated enough heat to create an ambient air temperature between 104 and 117 degF.

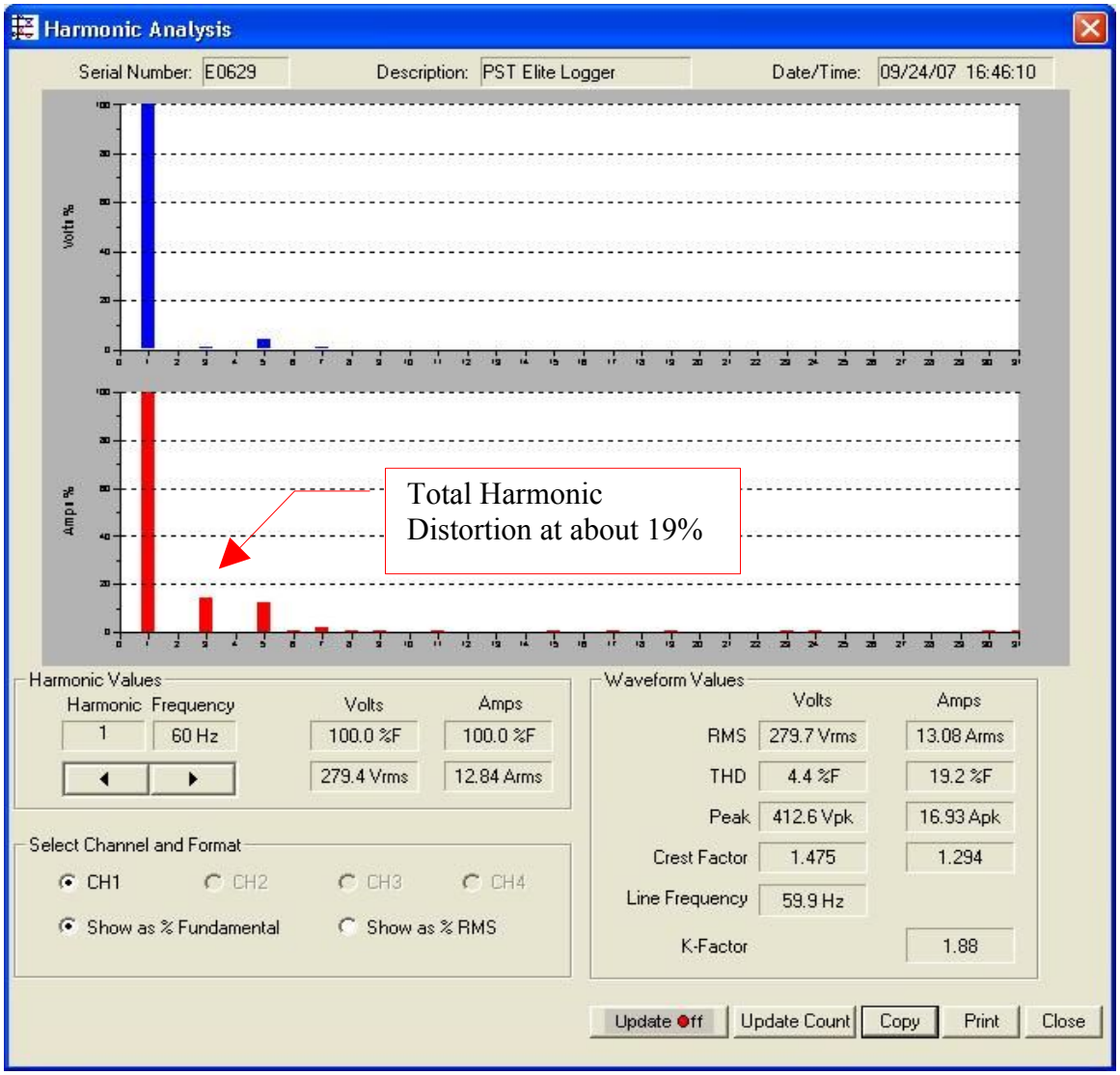
When the existing 400W bulb was replaced with a new like-kind 400W bulb, the average fixture temperature dropped from 108 degF to 104 degF. However, when the magnetic ballasts were replaced with the MetroLight electronic ballasts, there was a noticeable increase in fixture temperature past the existing pre-installation condition up to 117 degF, a change of almost 12% in increased fixture temperature.

Therefore, in this indirect lighting application in which the lamp was in a vertical down position, it can be concluded that HID bulbs with new electronic ballasts ran "hotter" by a significant 12% average increase. Why this is the case is still uncertain. It is possible that this single selection of 9 fixtures was a measurement anomaly. It is also possible that the output voltage from the electronic ballast to the lamp socket is actually *higher* than that of the output voltage from the magnetic ballast to the lamp socket, even though the input voltage to the electronic ballast is clearly documented as *lower* than that of the magnetic ballast (see previous Energy Usage section.) Whatever the explanation, this aspect of HID lighting is one that should be considered for exploration in future lighting assessments.

Harmonics:

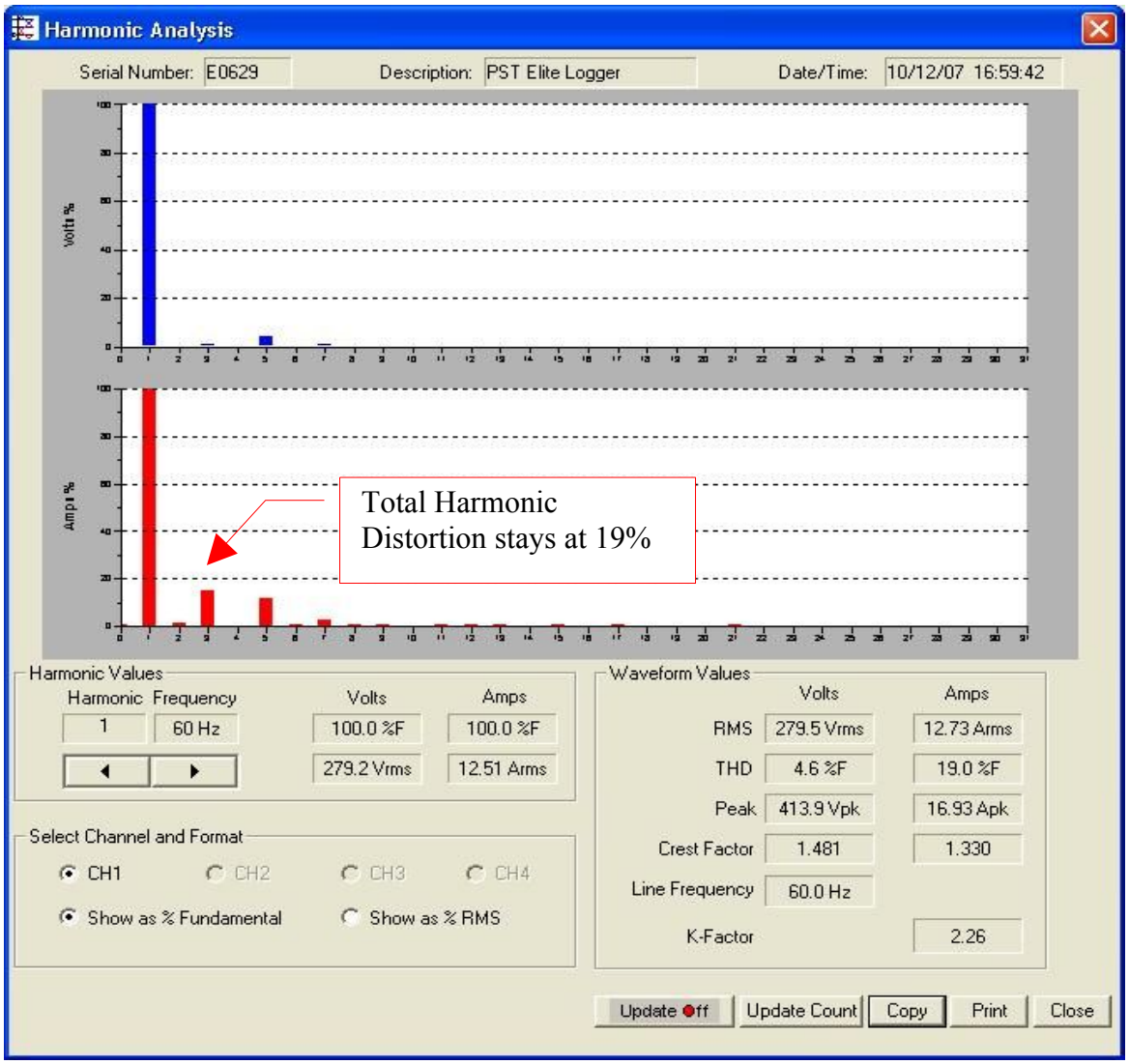
For harmonic analysis, instantaneous readings were taken during pre- and post-installation testing phases. Electrical harmonics are built-up "stray" currents and voltages that have multiplied and transpire as heat in the power system. A build-up of harmonics causes sensitive equipment to fail as well as introduces a significant amount of heat that may affect current interrupting capabilities and eventually needs to be dissipated.

The following graph shows the total harmonic distortion during pre-installation testing using the existing 400W bulbs. (All total harmonic distortion graphs can be seen in full-page view within Appendix K of this report.):



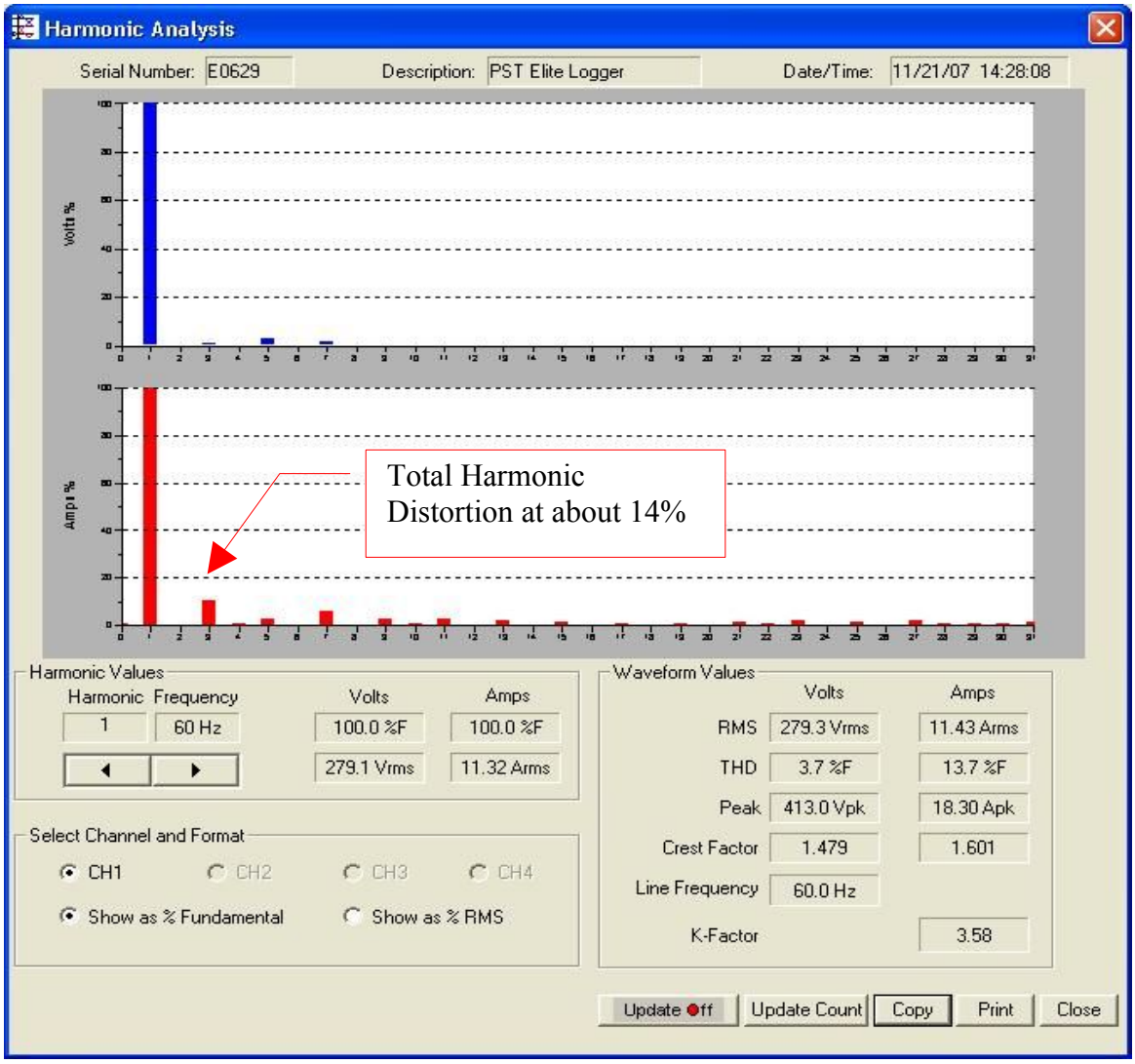
In the existing pre-installation case, THD (Total Harmonic Distortion) values for volts and amps are at about 5% (volts) and 19% (amps), respectively.

When the 400W bulbs were replaced with new like-kind 400W bulbs, the total harmonic distortion changed as follows:



In the pre-installation case with new 400W bulbs, THD changes were minimal – holding at about the same values with no more than 0.2% deviation.

Then, when the existing magnetic ballasts were changed with electronic ballasts, subsequent monitoring during this post-installation phase showed the following change in total harmonic distortion:



The preceding graph shows that THD voltage dropped about 1%, from 4.6% to 3.7%. THD current (amps) dropped about 5%, from 19.0% to 13.7%.

Additionally, it can be seen that the 5th harmonic (5th red bar on previous graph above) dropped significantly – thus suppressing THD effect more quickly than its magnetic counterpart.

Therefore, it can be concluded from this testing that the HID fixtures with new electronic ballasts operate at a lower total harmonic distortion than the existing HID fixtures, and suppress the effects of THD at a faster rate.

Unit Costs:

Based on conversation with the vendor of the MetroLight product and our own purchases, the following are typical current unit pricing for the equipment involved in this assessment project:

Cost of electronic ballast only:	$170 each
Cost of new 400 W metal halide lamp:	$34 each
Total cost of retrofit lamp and electronic ballast:	***$204 each***

**** *In comparison to other manufacturers of similar products, the MetroLight product is lower than comparable prices for the ballast.* ****

Installation for this project was completed using our in-house electricians. Therefore, labor costs for analysis can be derived from standard certified electrician's rates for time spent to install the nine (9) ballasts, as follows:

Installation of (9) electronic ballasts:	12 hrs
At $85/hr (standard certified electrician's rate), installation cost:	$1,020
	$113 each
Total estimated cost to retrofit one (1) HID fixture:	***$317 each***
Therefore, given the estimated cost savings per fixture is	$48 per year
And simple payback per fixture at this test site:	6.6 yrs

6. Conclusions

Results from this assessment, though slightly varied from its original intent, are still solid and quite conclusive indicating the following – MetroLight's Smart Electronic Ballast has:

- Energy savings due to ballast change-out
- Energy savings due to the ability to "lumen match" (to the equivalent of the core and coil ballast mean lumen light levels)
- Equivalent light levels at lower energy usage
- Quieter operation with lower sound levels
- Hotter operation with higher ambient temperatures
- Operation with less harmonic contribution to the overall power system, and ability to suppress the effects of THD at a faster rate

Overall, the results of this assessment provide conclusive results on the performance of the electronic ballasts, and it is our recommendation that this ballast be recommended for consideration in PG&E's future utility-administered programs. Also, because of its significant contribution to the overall energy savings potential, it is our recommendation that further testing be done on this (or similar) product to assess the effects of dimming

capabilities and further investigate the phenomenon of hotter lamp temperatures with electronic ballast operation.

7. Appendices

Appendix A	–	Pre- and Post-Installation Monitoring Procedure
Appendix B	–	MetroLight General Information and Installation Guide
Appendix C	–	MetroLight Lamp Compatibility List
Appendix D	–	Light Level Readings: Pre-Installation, Existing Conditions
Appendix E	–	Light Level Readings: Pre-Installation, Replaced Bulbs
Appendix F	–	Light Level Readings: Pre-Installation, Replaced Bulbs w/Covered Windows
Appendix G	–	Light Level Readings: Post-Installation
Appendix H	–	Sound Level Readings
Appendix I	–	Fixture Temperature and Light Intensity Readings
Appendix J	–	Cost Savings Calculations
Appendix K	–	Total Harmonic Distortion Graphs
Appendix L	–	kW Power Consumption Graph
Appendix M	–	Lumen Depreciation Calculations to yield lumen matching at mean lumens

Appendix A

PG&E Emerging Technology Demonstration

Electronic Ballast monitoring procedure

Pre-Installation Procedure:

1. Verify the wattage and condition (new/old, dirty/clean) of the existing ballasts and lamps, and record (manufacturer, model number, nameplate data). Ask staff about relamping and cleaning procedures to estimate lumen depreciation impacts.

2. Base Case Energy Usage:
    a. Coordinate with staff and isolate the electric circuit that serves the HID fixtures that will be retrofitted with the electronic ballasts and new lamps.
    b. Install the power data logger (with help from staff) to monitor the circuit and record an instantaneous power reading, including kW, volts, amps, power factor and harmonics. Remove after all readings have been completed and recorded.
    c. With a handheld illuminance meter, measure the amount of light striking the standard surface height (i.e. 3' AFF, at workbench, desk, etc.) in the area served by the HID fixtures to be retrofitted. Illuminance shall be recorded in a grid pattern to account for light under and between fixtures.
    d. Install a Hobo (H08-004-02) sensor directly adjacent to HID lamp to monitor light output (lumens) and temperature (degF) directly from the HID lamp. Leave sensor for a minimum period of 1 hour, recording at 5 min intervals.
    e. With a sound meter, record instantaneous sound readings near the existing ballasts for all the HID fixtures to determine existing noise levels.

Phase 1 Procedure:

3. Revised Base Case Energy Usage:
    a. Coordinate with staff to remove and replace the existing HID lamps with new lamps of same wattage as existing.
    b. Leave HID fixtures ON for a minimum period of 200 continuous hours to allow lamp "burn-in" to occur.
    c. After proper burn-in has occurred, repeat the standard test recordings as outlined in Step 2b through 2e above.

Phase 2 Procedure:

4. Test Case 1 Energy Usage:
    a. Coordinate with staff to remove and replace the existing HID magnetic ballast with new electronic ballast. Existing HID lamps will remain in place.
    b. Repeat the standard test recordings as outlined in Steps 2b through 2e above.

Phase 3 Procedure:

5. Test Case 2 Energy Usage:

a. Immediately after Test Case 1 parameters have been recorded, coordinate with manufacturer to re-adjust electronic ballasts to provide similar light output as in Pre-Installation scenario.
b. Repeat the standard test recordings as outlined in Steps 2b through 2e above. **Leave data logger on for a period of 7 days.**
c. In addition to standard test recordings, install an occupancy sensor logger to measure the potential for occupancy-based controls. **Leave sensor logger on for a period of 7 days.**

Post-Installation Procedure:

6. Remove power meter, sensors & Hobos from test area & return to normal operation.

Appendix B

METROLIGHT
LIGHT FORWARD

Metrolight Smart Electronic Ballast Installation Guide Models 250 – 450 W

ML 8638711 Edition 02

Content Summary

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Chapter 1: Product Information

Metrolight's Smart Electronic Ballasts are a breakthrough lighting solution that transforms the control of architectural and commercial lighting fixtures. They are available in a range of configurations to suit every need and operating environment.

The Metrolight Smart Electronic Ballast Installation Guide explains in detail how to safely install, operate and maintain a Smart Electronic Ballast.

Note: See the Warranty Terms and Conditions related to the sold area zone, in the attached Appendix.

Features

The Smart Electronic Ballasts offer improved energy efficiency, light output and reliability. They are built to be robust and operate reliably in situations which destroy magnetic ballasts.

Using a Smart Electronic Ballast, a lamp can be dimmed across a continuous range from 50 – 100% of full power, without flickering and without any damage to the lamp.

It is also possible to dim lamps remotely, preset automated usage and dimming schedules and monitor the status of the ballast using Metrolight's MADLI digital control and management system. Multiple Smart Electronic Ballasts can be networked together and operated from a single control computer, facilitating the centralized control of an entire lighting system.

Efficiency

Smart Electronic Ballasts are more energy efficient than magnetic ballasts, produce a higher average light output per lamp and significantly extend average lamp lifespan.

Magnetic ballasts will over-illuminate a lamp at the start of its life and reduce the lamp's Lumen output by 40-60% during the lamp's lifetime. By contrast, lamps operated with Smart Ballasts maintain almost constant Lumen output throughout their lifetime. This is achieved by the Smart Ballast's Micro-Start™ digitally controlled ignition, which reduces lamp electrode wear and prevents lamp "wall blackening".

In addition, Smart Electronic Ballasts can reduce energy costs. Since Smart Electronic Ballasts maintain optimal Lumen output, a lower wattage lamp will achieve the same lighting effects as higher wattages in magnetic ballasts.

Operating Conditions

The Smart Electronic Ballast is extremely robust, using the highest quality components, an extremely efficient thermal design and special heat regulating silicone potting materials. This allows it to run at an ambient temperature anywhere between -30 ºC and +65ºC and at a maximum case temperature of 85ºC Tc_{max}.

In addition, input voltage fluctuations do not affect the Smart Ballast's output power, ensuring steady light output for any input voltage within the entire specified voltage range.

The Smart Electronic Ballast is designed with a variety of safeguards to protect it in situations that would destroy a magnetic ballast.

These include mechanisms to protect it:

- if the lamp fails to light,
- at the end of the lamp's life,
- in the event of a short circuit, open circuit or output to ground,
- in the event of input surge, by use of an internal fuse,
- in the event of overheating, by automatically reducing power output or, if necessary, shutting off entirely.

WARNING: Always follow the directions in this guide exactly. If the Smart Electronic Ballast is installed incorrectly, it may not operate reliably and could endanger your safety.

Dimming

The Smart Electronic Ballast can dim lamps across a continuous range from 50 – 100% of full power without flickering and without any damage to the lamp. Lamps can be dimmed either by using an analog dimmer or from a computer, using Metrolight's MADLI digital control and management system to as low as 35% .

Analog dimming is operated by connecting a standard 0-10V dimmer to the ballast's double isolated 10V power supply. Digital dimming is operated by connecting the Smart Ballast to a computer via a MADLI communication unit.

MADLI - Digital Control and Management

Digital control is achieved through the Metrolight Control™ software or by integrating with existing monitoring and control systems. The system provides online two way communications and connects the Metrolight Smart Electronic Ballasts for HID into a controlled network and to a central computer. They connect via the Metrolight Interface Junction Box using MADLI™ communication protocol. The system connects up to 1026 ballasts on a single network segment. However, a maximum of 600 connected ballasts are recommended for optimal operation of the system.

Multiple ballasts can be connected to a single computer via a MADLI (Metrolight Addressable Digital Lighting Interface), communication unit, allowing an entire lighting system to be networked and controlled centrally.

Using Metrolight's custom designed software; lamps can be dimmed remotely and operated based on automated dimming schedules and scenarios. It is also possible to monitor the status of any ballast in the network, including its power output, operating temperature, dimming level, lamp status, operation time and number of ignitions.

Note: See the MADLI Installation and Control Manual for more information on how to use Smart Electronic Ballast's digital control features.

Models Available

The Smart Electronic Ballast is available in a range of configurations.

The following options are available in the 250-450W range:

Smart Electronic Ballast Configuration	Product Configuration order p/n
450W MH Non Dimming version	M450MH-3-US-C-ND-COM
450W MH Dimming version	M450MH-3-US-C-DD-COM
400W MH Non Dimming version (EU)	M400MH-3-EU-C-ND-COM
400W MH Non Dimming version	M400MH-3-US-C-ND-COM
400W HPS Non Dimming version	M400S-3-US-C-ND-COM
400W MH Dimming version	M400MH-3-US-C-DD-COM
400W MH Dimming version (EU)	M400MH-3-EU-C-DD-COM
400W HPS Dimming version	M400S-3-US-C-DD-COM
350W MH Non Dimming version	M350MH-3-US-C-ND-COM
350W MH Dimming version	M350MH-3-US-C-DD-COM
320W MH Non Dimming version	M320MH-3-US-C-ND-COM
320W MH Dimming version	M320MH-3-US-C-DD-COM
250W MH Non Dimming version (EU)	M250MH-3-EU-C-ND-COM
250W MH Non Dimming version	M250MH-3-US-C-ND-COM
250W HPS Non Dimming version	M250S-3-US-C-ND-COM
250W MH Dimming version (EU)	M250MH-3-EU-C-DD-COM
250W MH Dimming version	M250MH-3-US-C-DD-COM
250W HPS Dimming version	M250S-3-US-C-DD-COM
400W HPS Dimming version (EU)	M400S-3-EU-C-DD-COM
400W HPS Non Dimming version (EU)	M400S-3-EU-C-ND-COM
250W HPS Dimming version (EU)	M250S-3-EU-C-DD-COM
250W HPS Non Dimming version (EU)	M250S-3-EU-C-ND-COM

Note: All versions can be supplied with analog dimming, with digital dimming, or with both.

Metrolight are constantly testing new configurations of the Smart Electronic Ballast. Check our website, www.metrolight.com, for the most recent list of approved features and configurations.

For additional help, or for information about a Smart Electronic Ballast that is not listed here, please contact Metrolight customer support.

Chapter 2: Before You Begin

To avoid damage, always handle the Smart Electronic Ballast carefully. The Smart Electronic Ballast must be installed by a qualified electrician.

Only use approved lamps and always follow the wiring rules.

WARNING: Failure to install the Smart Electronic Ballast properly could void the product's warranty.

Unpacking: Handle with Care

CAUTION: The Smart Electronic Ballast contains sensitive electronic components. It must be unpacked and handled carefully.

Before installing the Smart Electronic Ballast, check that you have received all the items on the packing list and that no parts have been damaged.

Do not remove the data label, any permanent instructions, or any labels from the ballast's cover or from its panels.

Read these installation instructions carefully and follow them exactly. After installing the ballast, keep this guide in a safe place for future reference.

Qualified Installation

The Smart Electronic Ballast contains sensitive electronic components and outputs high frequency waveforms rated at up to 4000 volts. Do not try to install the ballast unless you are a qualified electrician and certified by Metrolight.

Always follow the directions in this guide exactly. Check the local National Electrical Code for any local requirements before installing the Smart Ballast. After installing the ballast, keep this guide in a safe place for future reference.

Never install or replace the ballast while the Mains power supply is connected.

Lamp Compatibility

Smart Electronic Ballasts in the 250-450W range can be used with a variety of Metal Halide and Sodium lamps. Only use lamps that have been approved by Metrolight in the ballast.

Types of Lamp

The following types of lamp are suitable for use in 250W – 450W Smart Electronic Ballasts:

Ballast	Lamp Type	ANSI Lamp code
250W	Pulse start	MH M138
		M80, M58
	HPS	S50
320W	Pulse start	MH M132, M154
350W	Pulse start	MH M131
	HPS	S129
400W	Pulse start	MH M135, M155
	HPS	S51
450W	Pulse start	MH M144

Approved Lamps

Metrolight are constantly testing new lamps for compatibility with the Smart Electronic Ballast. Check our website, www.metrolight.com, for the most recent list of approved lamps.

For additional help, or for information about a lamp that is not listed here, please contact Metrolight customer support.

WARNING: Only use lamps that have been approved by Metrolight for use with the ballast. Using an unapproved lamp could void the product warranty.

The following lamps have been tested and approved:

Manufacturer	Power Rating	Lamp Product Number	Lamp Type
EIKO	400W	MH400/U/T46	Pulse Start
GE	400W	MPR400/ MPR350/ MPR320/ MPR250/	Pulse Start
OSI	250W	M250/PS/BU	Pulse Start
	320W	M320/PS/BU	Pulse Start
	350W	M350/PS/BU	Pulse Start
	400W	M400/PS/BU	Pulse Start
	250W	MCP250/PS/BU	Ceramic

	320W	MCP320/PS/BU	Ceramic
Osram	250W	HCI-T 250/.., HQI-E/P 250/D, HQI-T 250/D	Ceramic Quartz
	400W	HQI-T 400/N, HQI-BT 400/D, HQI-E/P 400/D	Quartz
Philips	250W	MS250/BU/PS, HPI-T Plus 250	Pulse Start
	320W	MS320/BU/PS	Pulse Start
	350W	MS350/BU/PS	Pulse Start
	400W	MS400/BU/PS, HPI-T Plus 400	Pulse Start
Venture	250W	HIE250/HBU/PS, MP 250W/BU/UVS/PS, MP 250W/C/BU/UVS/PS/737, MP 250W/BU/UVS/PS/740	Pulse Start
	320W	HIE320/HBU/PS, MP 320W/BU/UVS/PS, MP 320W/V/EL/UVS/PS/740, MP 320W/C/V/EL/UVS/PS/737, MP 320W/BU/EL/UVS/PS/950, MP 320W/C/BU/EL/UVS/PS/950	Pulse Start
	350W	HIE350/HBU/PS, MP 350W/BU/UVS/PS, MP 350W/V/EL/UVS/PS/740, MP 350W/C/V/EL/UVS/PS/737, MP 350W/BU/EL/UVS/PS/950, MP 350W/C/BU/EL/UVS/PS/950	Pulse Start
	400W	HIE400/HBU/PS, MP 400W/BU/UVS/PS, MP 400W/V/EL/UVS/PS/740, MP 400W//C/V/EL/UVS/PS/737, MP 400W/BU/EL/UVS/PS/950, MP 400W/C/BU/EL/UVS/PS/950	Pulse Start
	450W	MP 450W/BU/EL/UVS/PS/740, MP 450W/C/BU/EL/UVS/PS/737	

Power Quality

The Smart Electronic Ballast's input power feed must meet quality requirements according to IEEE C62.41 .

Before installing the ballast, check the quality of the site's electricity feed. Monitor the site's electricity feed for at least one week, using a power quality analyzer.

For more information, please contact Metrolight customer support.

Wiring Requirements

HID ballasts use extremely high voltages and produce high frequency waveforms. To prevent arcing and damage always use the correct cables, follow the wiring requirements and ensure cables are fully isolated.

Correct Cables

The length of the cable between the lamp and the ballast must not exceed 2 meters (6.5 feet). For longer remote installations, contact Metrolight for guidance. Use double insulated cables or silicon insulated cables to connect the Smart Electronic Ballast to an MH or HPS lamp.

Note: To prevent interference, always keep the analog dimming and communication wires distanced from the power cables.

Metrolight recommends the following (or compatible) cables:

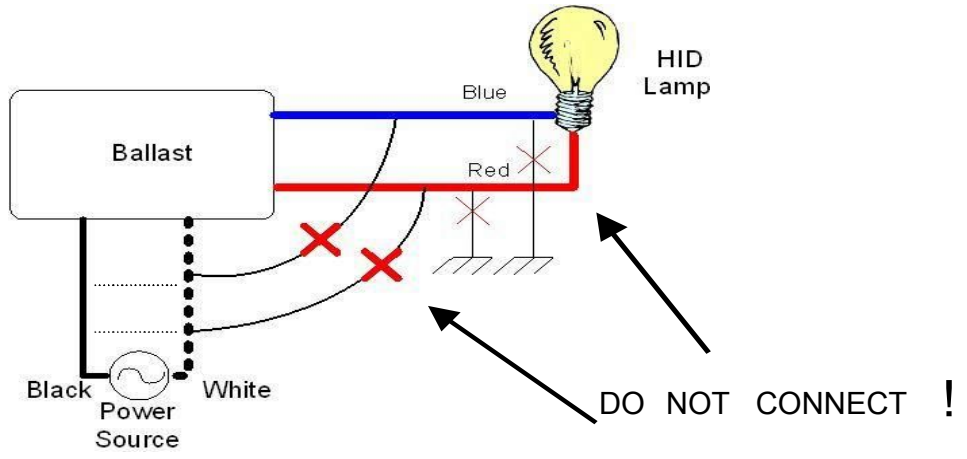
- Silicon isolated cables– 1.5mm^2, 5KV minimum rated
- N2XY cables– 1.5mm^2, 1KV, IEC 60502-1, FR-1 (double isolated cable)

WARNING: When using N2XY cables, do not connect the ground lead. Leave it loose on both sides and ground the lighting fixture with a separate wire.

Correct Wiring

Never connect the ballast's output wires to Neutral or COM. Output wires are marked in red and blue in North America, and in red and white in Europe. Neutral is marked in blue in Europe and COM is marked in white in North America.

Figure 1 Do not Connect Outputs to Neutral



Do not short the analog dimming wires or connect them together. If the dimming wires are shorted, the ballast will only operate at 50% power.

CAUTION: The ballast case and fixture must be grounded correctly. Shorting the ballast's output wires to Ground or to the case will permanently damage the ballast.

Correct Isolation

All sockets must be rated to at least 4KV. The socket's rating is marked on the connector. Sockets must also be pulse rated.

Ensure that all output wires from the Smart Electronic Ballast to the lamp are rated to the lamp's ignition voltage. Metrolight recommends the use of pure silicon isolated wires with 5KV minimum rating Ø18AWG.

When removing the outer isolation of a cable, always insert an extra isolation layer in its place. This is important when connecting the ballast's wires to a terminal block or to other wires.

When the cables are attached tightly to metal parts the cable isolation can easily become damaged. This will cause arcing.

Keep power and ground wires separated from each other by at least 1cm at all times.

WARNING: Arcing will occur if cables are not properly isolated or are too close to one another.

In regions with high humidity, isolate any terminals blocks between the ballast output wires and the lamp to avoid moisture condensation. Alternatively, keep the terminal blocks in a junction box.

Socket Wiring Example

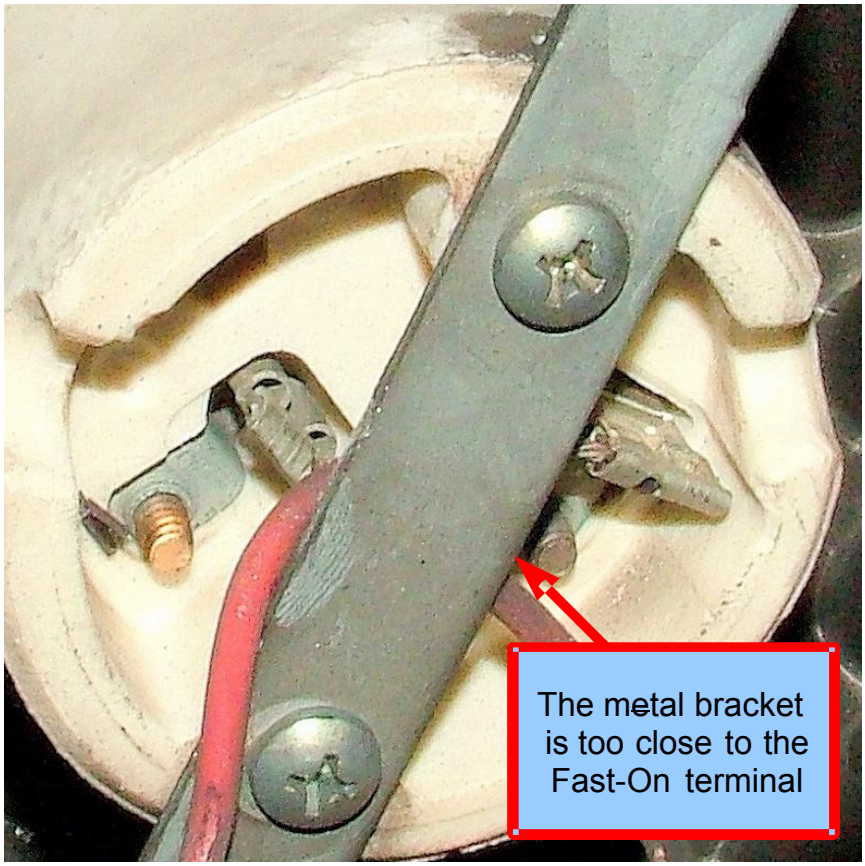
Figure 2 below, the ballast's sockets have not been wired correctly.

Note that:

- The Fast-On terminals have not been isolated.
- The metal bracket is too close to one of the Fast-On terminals. It could form a Ground connection.

When this ballast ignites, its high voltage output will arc to the metal bracket. This could result in permanent damage to the ballast.

Figure 2 Incorrect Socket Wiring



Chapter 3: Mounting the Ballast

Always mount the Smart Electronic Ballast on a surface with good heat conductivity and away from any avoidable sources of heat.

If the Smart Electronic Ballast is not correctly mounted it will overheat. Overheating reduces the performance of the ballast and could cause the ballast to shut down.

Mounting Surface

Attach the Smart Electronic Ballast tight and flush to a flat surface with good heat conductivity. Metrolight recommends making a metal mounting plate that will extend past the ballast by at least a 3cm margin on every side.

Use M3 mounting screws or Ø2.9mm tapping screws to attach the Smart Ballast. See Operating Specifications (page 21) for full details of the Smart Electronic Ballast's dimensions.

Never use adhesive tape, double-sided glue tape, Velcro fasteners or any other material that prevents heat flow and tight contact between the ballast and surface.

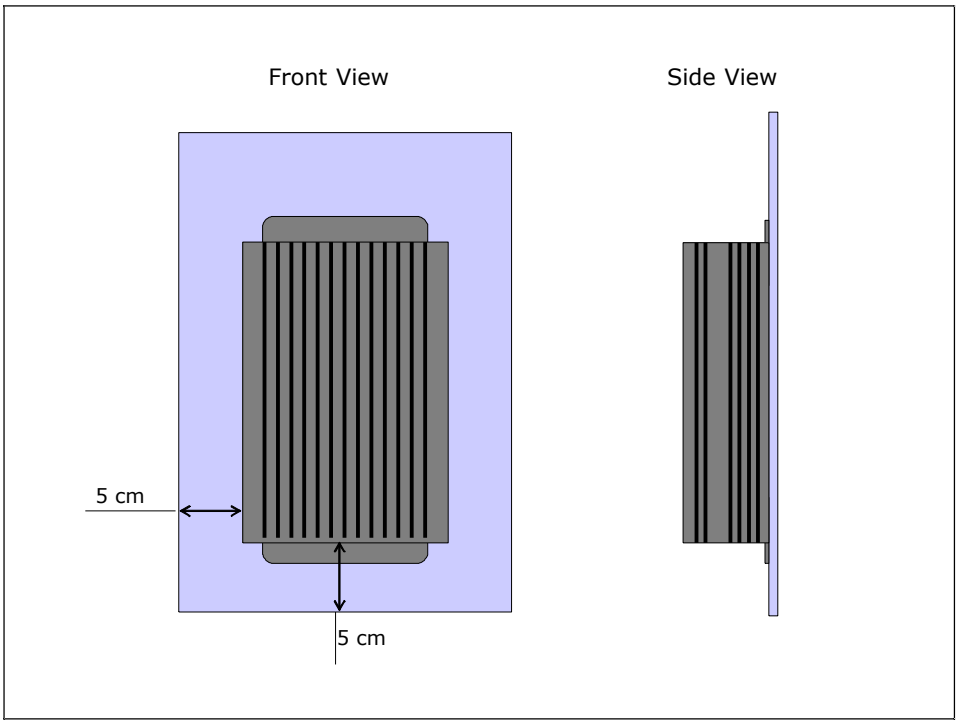
Mounting Position

Where possible, install the Smart Electronic Ballast vertically. This improves airflow through the ballast's fins.

When the Smart Electronic Ballast is installed within a lighting fixture, position it as far away from the lamp reflector as possible. To comply with EMC regulations, an external dedicated Metrolight Line Adapter may also be required. Contact Metrolight customer support for more information.

When many Smart Electronic Ballasts are installed together in one area, mount every ballast on a separate mounting plate. The plate must be at least with 3mm thickness, and longer by at least 5 cm from the ballast size. Alternatively, mount all the ballasts on one plate with at least a 5cm gap between each one.

How to mount the Smart Electronic Ballast



Chapter 4: Specifications

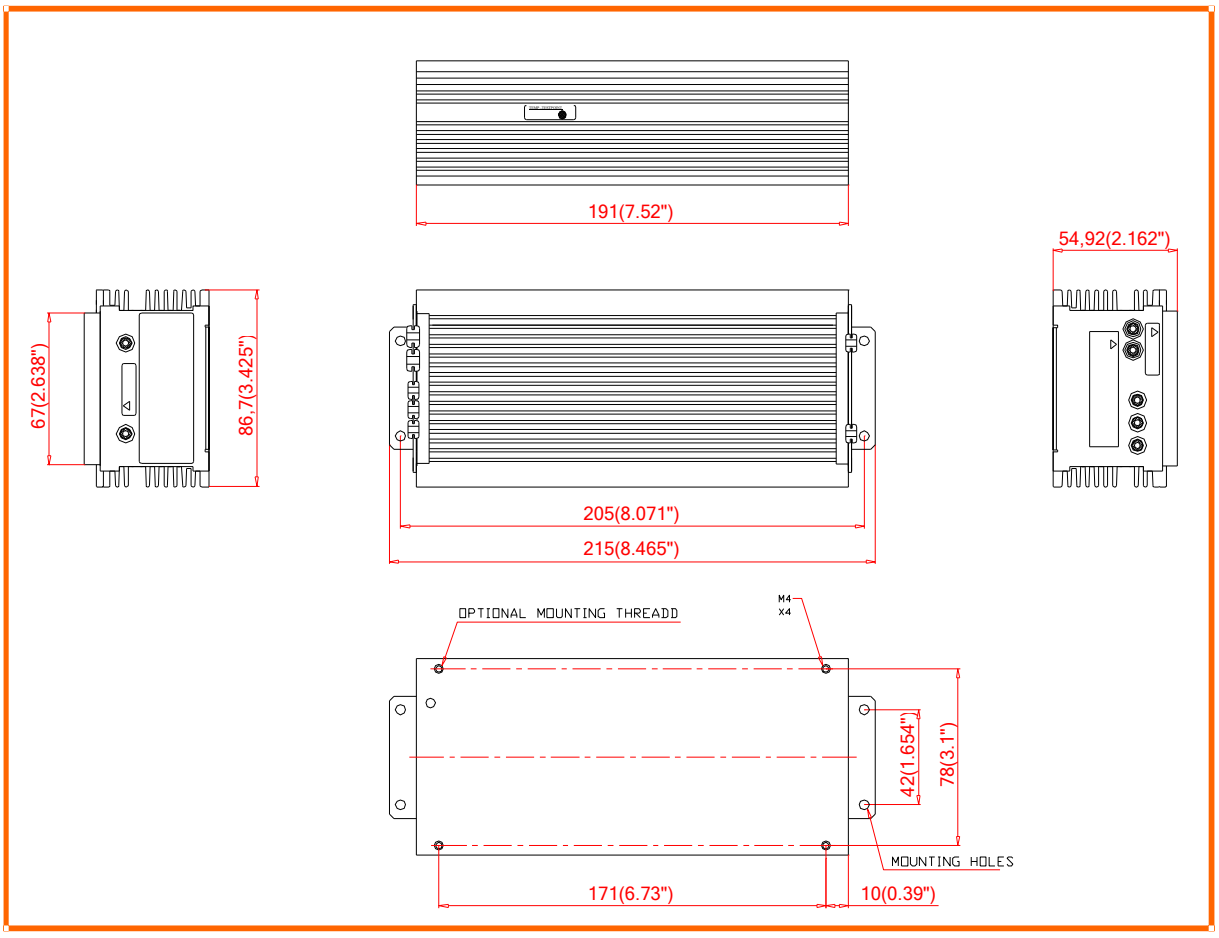
The Smart Electronic Ballast is designed to suit most lighting solutions. This section lists the Smart Electronic Ballast's operating specifications, its input and output characteristics and its built-in protections.

Operating Specifications

Dimensions (LxWxH)	8.46" x 3.43" x 2.16" 215mm x 87mm x 55mm
Weight	3.08 lb / 1.4kg
Operating temperature range	-30°C to +65°C, -13°F to 149°F
Maximum case temperature (Tc)	85°C
Operating Humidity	0 to 95% RH non-condensing
EMC	FCC Title 47 Part 18 C (non-consumer) EN55015, EN61547 (If the Smart Electronic Ballast is installed within a lighting fixture, an external dedicated Metrolight Line Adapter may be required. With this filter the application may be fully complying with the EN55015 and the EN61547. Contact Metrolight customer support for more information.)
Regulation	UL1029 & UL935, Outdoor Type 1, suitable for recessed use. EN 61347
Surge Protection	IEEE C62.41 Category B exposure category 3 - 6KV/0.5A 100KHz Ring wave & 1.2/50uS-8/20uS impulse

Metrolight Smart Electronic Ballast for HID™ 250/320/350/400/450W
Mechanical Dimensions

Figure 3 Smart Electronic Ballast Mechanical Dimensions



Input Specifications

Input values for power, voltage and current are dependent on the lamp wattage. Other input values apply across all Smart Electronic Ballasts.

Lamp Power, Input Voltage and Current Specifications

450W MH lamp	
Input Power	478W
Voltage	277VAC (+10% to -15%)

Current	1.75A @ 277V, 2.24A@ 220V, 2.02A @240V
Power Factor (at nominal conditions and full power)	>0.97

400W MH or HPS lamp	
Input Power	426W
Voltage	200 - 277VAC (+10% to -15%)
Current	2.1A @ 208V, 1.98A @ 220V, 1.83A @ 240V 1.58A @ 277V
Power Factor (at nominal conditions and full power)	>0.96

350W MH lamp	
Input Power	375W
Voltage	200 - 277VAC (+10% to -15%)
Current	1.8A @ 208V, 1.74A @ 220V, 1.61A @ 240V 1.4A @ 277V
Power Factor (at nominal conditions and full power)	>0.96

320W MH lamp	
Input Power	344W
Voltage	200 - 277VAC (+10% to -15%)
Current	1.7A @ 208V, 1.6A @ 220V, 1.48A @ 240V 1.2A @ 277V
Power Factor (at nominal conditions and full power)	>0.96

250W MH lamp	
Input Power	272W @ 120VAC, 269W @208-277VAC
Voltage	120 – 277VAC (+10% to -15%)
Current	2.3A @ 120V, 1.26A @ 220V, 1.16A @ 240V 1.0A @ 277V
Power Factor (at nominal conditions and full power)	>0.95

General Input Specifications

Frequency	50/60 Hz
Inrush current when Power is connected	<25A for 1mSec for one cycle
Harmonics (at nominal conditions)	Fully complying with EN61000-3-2
Input current protection	Fuse (internal)
Continuous full range dimming	50% – 100% of full power, by dimmer, ambient sensor, light sensor or any other compatible sensor. (Optional: 35% – 100% of full power subject to Metrolight approval)
Lumen maintenance	>90% over lamp life (dependent on lamp type)

Output Specifications

Open circuit voltage	300V
Ignition voltage	<4kV
Frequency	>106 KHz (MH), Sine wave >40KHz (HPS), Sine wave

Protections

Self-protection mechanisms:

- In the event of a short circuit, open circuit or output to ground
- If the lamp fails to light
- At the end of the lamp's life
- Input current protection by internal fuse

Heat Management:

The Smart Electronic Ballast will not start if its case temperature is more than Tc=80ºC.

If the ballast's Tc temperature reaches beyond 85ºC during use, the Smart Electronic Ballast will gradually reduce its output power to 50%, allowing the ballast to cool. When the Tc falls below 85ºC again, the ballast will return to full output power. Power is decreased and increased at a rate of 10 minutes time constant.

If the Tc rises beyond 91ºC during use, the Smart Electronic Ballast will switch itself off.

Chapter 5: Connecting the Ballast

Before connecting the Smart Electronic Ballast, please review the

Manufacturer	Power Rating	Lamp Product Number	Lamp Type
EIKO	400W	MH400/U/T46	Pulse Start
GE	400W	MPR400/ MPR350/ MPR320/ MPR250/	Pulse Start
OSI	250W	M250/PS/BU	Pulse Start
	320W	M320/PS/BU	Pulse Start
	350W	M350/PS/BU	Pulse Start
	400W	M400/PS/BU	Pulse Start
	250W	MCP250/PS/BU	Ceramic
	320W	MCP320/PS/BU	Ceramic
Osram	250W	HCI-T 250/.., HQI-E/P 250/D, HQI-T 250/D	Ceramic Quartz
	400W	HQI-T 400/N, HQI-BT 400/D, HQI-E/P 400/D	Quartz
Philips	250W	MS250/BU/PS, HPI-T Plus 250	Pulse Start
	320W	MS320/BU/PS	Pulse Start
	350W	MS350/BU/PS	Pulse Start
	400W	MS400/BU/PS, HPI-T Plus 400	Pulse Start
Venture	250W	HIE250/HBU/PS, MP 250W/BU/UVS/PS, MP 250W/C/BU/UVS/PS/737, MP 250W/BU/UVS/PS/740	Pulse Start
	320W	HIE320/HBU/PS, MP 320W/BU/UVS/PS, MP 320W/V/EL/UVS/PS/740, MP 320W/C/V/EL/UVS/PS/737, MP	Pulse Start

		320W/BU/EL/UVS/PS/950, MP 320W/C/BU/EL/UVS/PS/950	
	350W	HIE350/HBU/PS, MP 350W/BU/UVS/PS, MP 350W/V/EL/UVS/PS/740, MP 350W/C/V/EL/UVS/PS/737, MP 350W/BU/EL/UVS/PS/950, MP 350W/C/BU/EL/UVS/PS/950	Pulse Start
	400W	HIE400/HBU/PS, MP 400W/BU/UVS/PS, MP 400W/V/EL/UVS/PS/740, MP 400W//C/V/EL/UVS/PS/737, MP 400W/BU/EL/UVS/PS/950, MP 400W/C/BU/EL/UVS/PS/950	Pulse Start
	450W	MP 450W/BU/EL/UVS/PS/740, MP 450W/C/BU/EL/UVS/PS/737	

Power Quality

The Smart Electronic Ballast's input power feed must meet quality requirements according to IEEE C62.41 .

Before installing the ballast, check the quality of the site's electricity feed. Monitor the site's electricity feed for at least one week, using a power quality analyzer.

For more information, please contact Metrolight customer support.

Wiring Requirements section on page 12.

To connect the Smart Electronic Ballast in North America and Europe follow the color-coded wiring guidelines below:

North America: Connection color coding

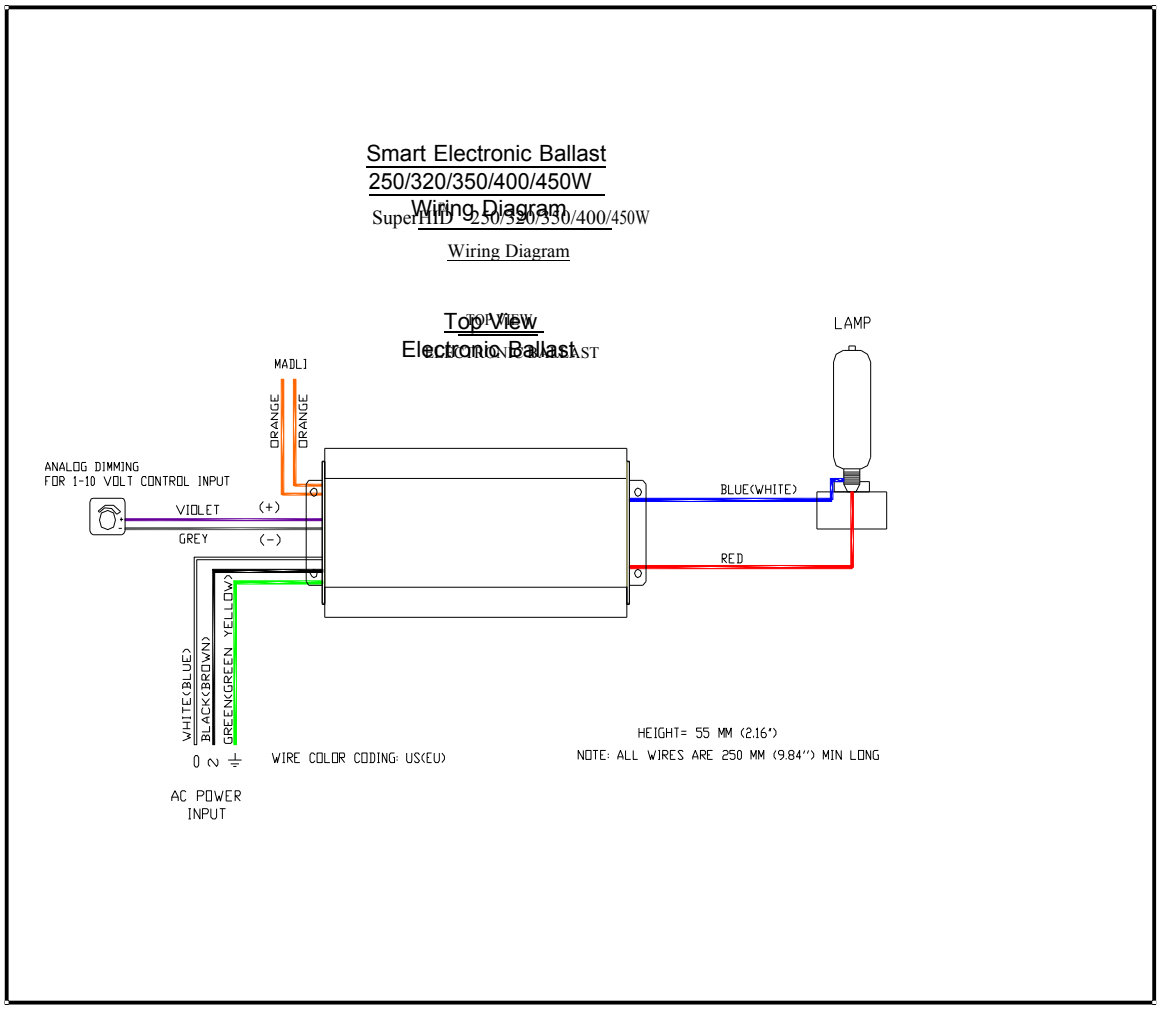
Description	Wire Color
LIVE	Black
COM	White
GROUND	Green
Lamp	Red
Lamp	Blue
Analog Dimming + (0-10V)	Violet
Analog Dimming - (0-10V)	Gray
MADLI Communication #1 (including Digital Dimming)	Orange
MADLI Communication #2 (including Digital Dimming)	Orange

Europe: Connection color coding

Description	Wire Color
LINE	Brown
NEUTRAL	Blue
EARTH	Green/Yellow
Lamp	Red
Lamp	White
Analog Dimming + (0-10V)	Violet
Analog Dimming - (0-10V)	Gray
MADLI Communication #1 (including Digital Dimming)	Orange
MADLI Communication #2 (including Digital Dimming)	Orange

The following diagram shows all wiring connection for the Smart Electronic Ballast:

Figure 5 Smart Electronic Ballast Wiring Diagram



Connecting the Smart Electronic Ballast to AC Mains (Power Line)

Before attempting to connect the Smart Electronic Ballast to the Mains power, please review the Essential Precautions when Connecting to Mains section carefully.

Essential Precautions when Connecting to Mains

To ensure the safe operation of the lamp and for your own safety, follow the following precautions carefully.

- Before connecting the Smart Electronic Ballast, check that the AC source voltage has been switched off.
- Check the Smart Electronic Ballast's label to confirm the ballast type is suitable for the local Mains voltage.
- Ensure all wires, block terminals, and other connections between the AC input power and the ballast conform to local codes.

How to Connect to the Smart Electronic Ballast to Mains (Primary)

In North America:

- Connect the Black wire to LIVE
- Connect the White wire to COM
- Connect the Green wire to GROUND

In Europe:

- Connect the Brown wire to LINE
- Connect the Blue wire to NEUTRAL
- Connect the Green-Yellow wire to EARTH

Connecting the Smart Electronic Ballast to a Lamp

Before attempting to connect the Smart Electronic Ballast to the lamp, please review the Essential Precautions when Connecting a Lamp section carefully.

Essential Precautions when Connecting a Lamp

Only use lamps that have been approved by Metrolight for use with the ballast. See Lamp Compatibility on page 11 for more information.

- The length of the cable between the lamp and the Smart Electronic Ballast must not exceed 2 meters (6.5 feet). For longer remote installations, contact Metrolight for guidance.
- Do not short the ballast's output wires to Ground or to the case. This will permanently damage the ballast.

- Never connect the ballast's output wires to Neutral or COM.

How to connect the Smart Electronic Ballast to a Lamp

In North America:

- Connect the Red wire to the lamp's hot (center) socket.
- Connect the Blue wire to the lamp's cold (ring) socket.

In Europe:

- Connect the Red wire to the lamp's hot (center) socket.
- Connect the White wire to the lamp's cold (ring) socket.

Lamp Dimming & Communication

To avoid interference, Metrolight recommend that the analog dimming and MADLI communication lines are kept at a distance from the power cables.

The analog dimming and MADLI communication wires must be shielded.

Use one of the following shielded cables:

COMMUNICATION & CONTROL

MULTICONDUCTOR, FOIL SHIELD.

For example, the following cables would be appropriate:

- Teldor 8551601101 1x2x16 AWG.
- Alpha PE/PVC 2432C.

The cable should have a 300V and 90C rating.

Connect the shielded cable to Ground on one side. Ideally, this should be the side where the electrical switchboard is located.

Note: The maximum communication cable that can be used for both the Madli & Dimming control, should no be exceeding 1KM (3280ft).

Analog Dimming

Analog dimming is operated by connecting a standard 0-10V dimmer to the Smart Ballast's double isolated 10V power supply. The following dimmers have been tested and approved by Metrolight for use with Smart Ballasts.

Manufacturer	Dimmer Model Number
OSRAM	HF DIM MCU P
LUTRON	NFTV-WH, NTFTV
LEVITON	IP710-DAW

Note: Dimming is only available after the Smart Electronic Ballast has been operating for 15 minutes.

How to Connect the Smart Electronic Ballast to an Analog Dimmer

Use an analog dimmer with a 0 – 10V range. See Analog Dimming, page 29.

- Connect the Violet wire to the positive input on the dimmer.
- Connect the Grey wire to the negative input on the dimmer.

MADLI Digital Dimming, Control and Management

To use digital dimming, as well as the additional digital control and management features, the Smart Electronic Ballast must be connected to a Metrolight MADLI communication unit. The MADLI unit connects many lamps to a control computer.

How to Connect the Smart Electronic Ballast for Digital Control

Both the wires that connect the MADLI unit are orange. The communication wires are not polarity sensitive.

- Connect the Orange wires to the MADLI communication unit.

The MADLI unit connects to a computer through an RS232 serial port (normally, COM1) or via USB, using a serial to USB cable.

To use digital dimming, Metrolight's custom designed software must be installed on the control computer.

Note: See the MADLI Installation and Control Manual for more information on how to use Smart Electronic Ballast digital control features.

Testing the Installation

After installing the Smart Electronic Ballast, monitor the ballast's operating temperature for at least 24 hours. This can be done either by using the TC point, the input power level or using MADLI's digital monitoring system.

The Smart Electronic Ballast's temperature should stabilize at below 80ºC, and remain below 85ºC at all times. If it does not, review the Metrolight Smart Electronic Ballast Installation Guide for possible causes.

Using the TC Point

On the side of the Smart Electronic Ballast there is a small TC point mark. Attach a thermocouple to this point to take a reading of the ballast's case temperature.

As above, the temperature reading should stabilize at below 80ºC during normal operation. It must remain below 85ºC at all times.

Monitoring Input Power

Confirm that the ballast's input power stays within its specified range over a 24 hour period. This indicates that the ballast is operating at optimal temperature.

If the Smart Ballast becomes too hot, it automatically reduces its own power. This allows the ballast to cool, protecting it from heat damage. When the output power reduces, the input power also drops.

For this reason, low input power usually indicates overheating.

Digital Monitoring

If the Smart Ballast is connected to a computer through a MADLI unit, it is possible to monitor the ballast’s temperature at all times using Metrolight’s custom designed software.

Chapter 6: Installation Checklist

Before completing the installation of the Smart Electronic Ballast, use the following checklist to confirm that the operating environment, mounting and wiring are all suitable for the Smart Ballast.

WARNING: If you do not install the Smart Electronic Ballast correctly, it may not operate reliably and could endanger your safety.

Operating Environment

Use an approved lamp

- Only use lamps that Metrolight have approved. See Approved Lamps, page 12.

Isolate against condensation

- In regions with high humidity, isolate terminals against condensation or keep the terminal blocks in a junction box.

Keep away from heat sources

- Install the Smart Electronic Ballast away from avoidable sources of heat.

Keep away from lamp reflector

- In a lighting fixture, install the Smart Electronic Ballast as far from the lamp reflector as possible.

Distance between lamp and Smart Electronic Ballast

- The length of the cable between the lamp and the Smart Electronic Ballast must not exceed 2 meters (6.5feet). For longer remote installations, contact Metrolight for guidance.

Check the quality of the site's electricity feed

- Monitor the quality of the site's electricity feed for at least one week, using a power quality analyzer.

Mounting the Smart Electronic Ballast

Heat conductive surface

- Always mount the Smart Electronic Ballast on a surface with good heat conductivity.

Use a mounting plate

- Use a metal mounting plate that extends past the ballast by at least a 5cm margin on every side.

Attach tight and flush

- Attach the Smart Electronic Ballast tight and flush to a flat surface.

No heat insulating materials

- Never attach the Smart Electronic Ballast with adhesive tape, double-sided glue tape, Velcro fasteners or any other material that prevents heat flow and tight contact between the ballast and surface.

Keep Smart Electronic Ballasts separated

- When installing many Smart Electronic Ballasts together in one area, mount every ballast on a separate mounting plate. Alternatively, mount all the ballasts on one plate with at least a 3cm gap between each one.

Wiring

Smart Electronic Ballast must match local power

- Check on the Smart Electronic Ballast's label that the ballast type is suitable for the local Mains voltage.

Connect to Ground

- Always connect the Smart Electronic Ballast case and the lighting fixture to Ground, using a dedicated Ground lead. Do not use the Ground wire within the power cable to the lamp, to Ground a remote fixture. Use a separated wire.

Do not short outputs

- Never connect the ballast's output wires to Neutral or COM. Do not short the ballast's output wires to Ground or to the case.

Do not connect analog dimming wires together

- Do not short the analog dimming wires or connect them together. If the dimming wires are shorted, the ballast will only operate at 50% power.

Use correct sockets

- All sockets must be rated to at least 4KV and must be pulse-rated.

Use correctly rated cables

- Connect the Smart Electronic Ballast to the lamp with pure silicon isolated wires with 5KV minimum rating Ø18AWG.

Use insulated cables

- Use double insulated cables or silicon isolated cables to connect the Smart Electronic Ballast to an MH or HPS lamp. See Correct Cables, page 14.

Isolation around connections

- When removing the outer isolation of a cable, insert an extra isolation layer in its place. Check the cable isolation has not been broken where the cables are attached to metal parts.

Keep power cables separated

- Keep power and ground wires separated from each other by at least 1cm at all times.

Keep power lines and control lines separated

- Keep the analog dimming and MADLI communication lines separated from the power cables.

Shield control lines

- The analog dimming and MADLI communication wires must be shielded. See Lamp Dimming, page 29.

Test the ballast

- After installing the Smart Electronic Ballast, monitor its operating temperature for at least 24 hours.
  See Testing the Installation, page 30.

Analog dimming using harvesting sensors

Analog dimming can operated also by connecting a standard motion or light sensors to the Smart Electronic Ballast's double isolated 10V power supply. The following sensors have been tested and approved by Metrolight for use with Smart Ballasts.

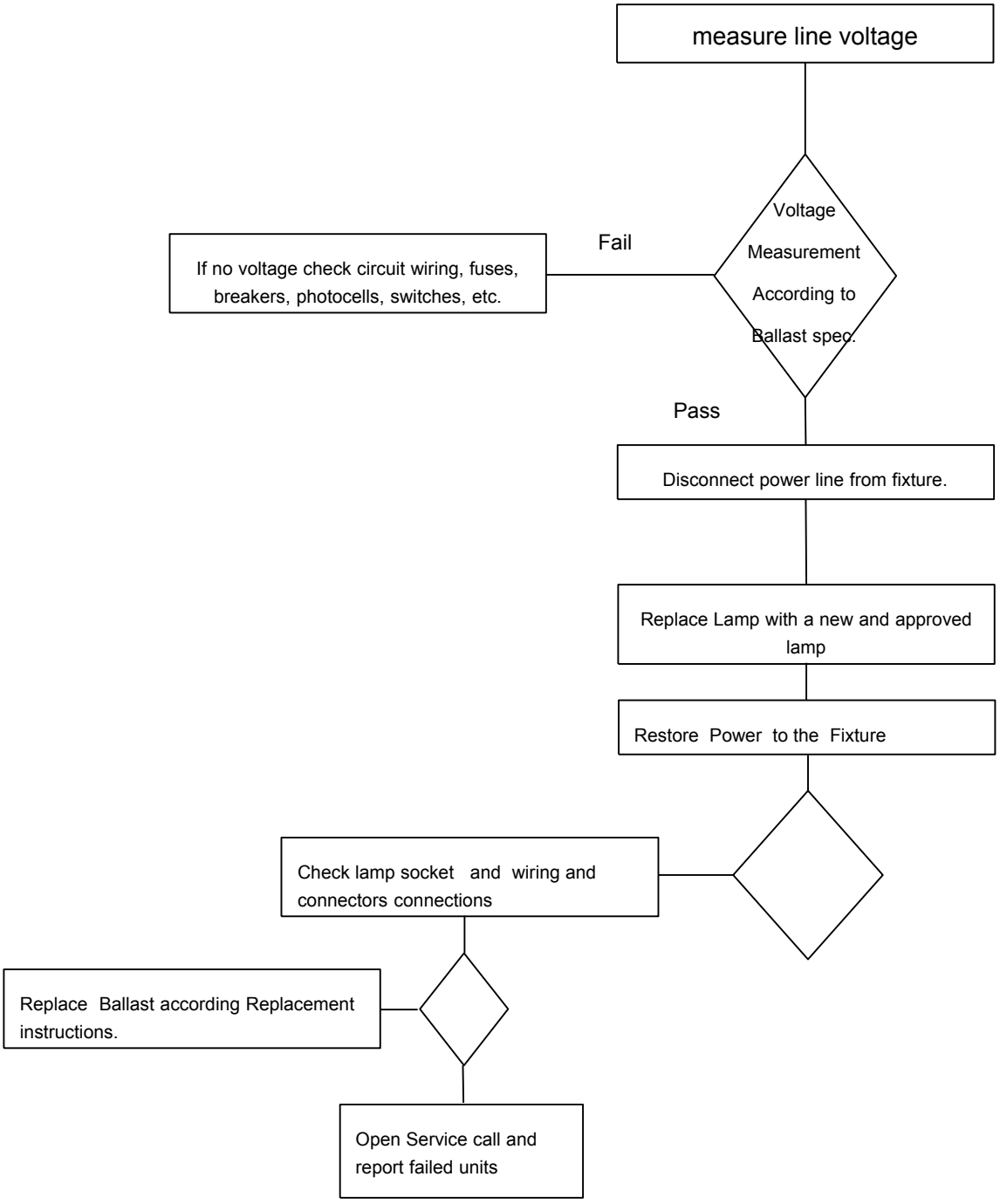
Manufacturer	Model Number
ViewPoint	PIP-300EB Motion sensor
Lutron	MW -LC-2 Motion and light controller
SensorSwitch	CMR-10-ADC-LT Motion sensor

Chapter 7: Troubleshooting

Always follow these safety rules when working with your lighting fixtures:

- Disconnect the Smart Electronic Ballast from mains power before checking the lamp.
- To reset the Smart Electronic Ballast, disconnect it from mains power for at least 10 seconds.
- Do not try to open the Smart Electronic Ballast. It contains no user-serviceable parts.

Note: The MADLI digital control and management system includes full maintenance and diagnostics functionality. See the MADLI Installation and Control Manual for more details.


measure line voltage
Voltage Measurement According to Ballast spec.
Fail
If no voltage check circuit wiring, fuses, breakers, photocells, switches, etc.
Pass
Disconnect power line from fixture.
Replace Lamp with a new and approved lamp
Restore Power to the Fixture
Check lamp socket and wiring and connectors connections
Replace Ballast according Replacement instructions.
Open Service call and report failed units

About Metrolight

Metrolight is dedicated to enabling improved efficiency in commercial lighting systems. We pride ourselves on our personal attention to every client and our can-do approach to meeting all lighting requirements.

Company Profile

Metrolight was founded in 1996. Our mission is to produce cutting edge energy-saving HID lighting solutions.

In order to design the ground breaking Smart Electronic Ballast series of microprocessor controlled ballasts we brought together a wealth of expertise in HID lamp physics, power electronics, software and communications. The result is a revolutionary family of HID electronic ballasts from 20W up to 1000W and an accompanying array of solutions for communication, monitoring and control of lighting installations.

Metrolight intelligent ballasts enable dramatic energy savings and are helping customers operate lighting networks more cost effectively in thousands of installations around the globe.

Contact Details

World Wide Web:

www.metrolight.com

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Israel	USA
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Appendix

Warranty and Liability

LIMITED WARRANTY; LIMITATIONS OF LIABILITY

(a) METROLIGHT warrants to the original purchaser ("BUYER") that the electronic ballasts and accessories sold by METROLIGHT to BUYER (the "Equipment") shall be free from defects in material and workmanship for 12 months from date of shipment from Metrolight to BUYER, (the "Warranty Period"). The Warranty Period will be extended to up to 36 month period, according to the provisions as specified in section (e) below. This Warranty shall survive a one time transfer and the transferee This Warranty provided hereunder shall not apply unless (1) METROLIGHT has received, prior to the end of the Warranty Period written notice regarding a defective part of an item of Equipment in accordance with the provisions of this Warranty, (2) BUYER has afforded METROLIGHT prompt and reasonable opportunity to inspect any part as to which any such claim is being made, (3) BUYER has shipped the item of Equipment, freight pre-paid, to METROLIGHT or its authorized repair agent after receiving prior approval from METROLIGHT to do so, and (4) the relevant part of the Equipment has been stored, shipped, handled, installed, tested, operated and maintained by BUYER in accordance with the Equipment's manual and any other written instructions as may be updated by METROLIGHT.

(b) This Warranty does not include damage to the Equipment or any parts thereof resulting (i) from a cause other than a defect or malfunction or (ii) from the performance of any repairs, modifications or alterations by any person other than METROLIGHT or (iii) from wrong use, misuse, neglect use, power or air conditioning failure or other hazard, or any unreasonable use or (iv) from acts of God or force majeure (including, without limitations, floods, accidents, fires, lightings or acts of war etc.)

(c) This Warranty does not include any damage to any equipment, lamps, light fixtures, electrical cables and connectors etc. in which the Equipment was used or to which the Equipment was connected.

(d) This Warranty is not applicable to any piece of Equipment which is not installed and operated in accordance with the current edition of The National Electric Code (NEC), the Standards for Safety of Underwriters' Laboratory, Inc. (UL), the Standards for the American National Standards Institute (ANSI) and with METROLIGHT instructions and guidelines, as they may be updated from time to time.

(e) This 12 month Warranty is conditioned upon the Equipment operating at a maximum TC point not exceeding the rated TC temperature specified for the particular Equipment in Metrolight's data sheet, or Equipment label.

The above 12 month Warranty Period can be extended to a maximum of 36 month under the following conditions:

1. If the Equipment was operating at a maximum TC point equal or below 80^0 Warranty Period is extended to 24 month period.

2. If the Equipment was operating at a maximum TC point equal or below 75^0 Warranty Period is extended to 36 month period.

This Warranty does not cover any ballast which is installed in a lamp other than the type of lamp indicated on

the Equipment label, or any other lamp which is approved in writing by Metrolight. This Warranty does not cover software incorporated in the Equipment or included in program diskettes purchased either from Metrolight or from third party vendors in conjunction with the Equipment. The Warranty covering such software, if any, is included in the software licenses accompanying the Equipment.

(f) METROLIGHT shall not be liable for any claims, damages, losses and expenses, including attorneys' fees, arising out of or resulting from the Equipment, any bodily injury, sickness, disease or death of any person, or injury or destruction of any personal property.

(g) Should METROLIGHT determine, in its sole and absolute discretion, that any part of an item of Equipment is defective due to faulty materials or workmanship, METROLIGHT shall at its sole option and at its expense, either repair or replace such part and return the repaired/replaced part to BUYER. Any replaced or repaired item shall be covered for the remainder of the original Warranty Period. Removal, installation and reinstallation costs are not covered by this Warranty.

(h) IN ORDER TO SUBMIT A CLAIM PURSUANT TO THIS WARRANTY:

1. The BUYER must contact METROLIGHT in writing, which shall detail the following:

2. Model Number

3. Manufacturing Date Code/Serial Number

4. Date of Installation

5. Description of malfunction

6. (2) Upon receipt of the claim, METROLIGHT will send the BUYER shipping instructions.

7. (3) Upon receipt of the shipping instructions, the BUYER must ship the relevant part, at its expense, to METROLIGHT.

8. (4) Should METROLIGHT determine, according to section b of this Warranty that the part should be either repaired or replaced METROLIGHT will send at its expense the repaired or replaced part to the Buyer.

(i) ONE TIME TRANSFER – The Buyer may make a one-time transfer of this Warranty to another person or entity (the "End Buyer") provided however, that the Buyer shall serve as the contact person with respect to this Warranty and under no circumstances Metrolight shall be obligated to perform its obligations hereunder vis-à-vis the End Buyer. This transfer of this Warranty is subject to the following conditions: (i) at the time of the purchase by the End Buyer, the Buyer has been entitled to the Warranty hereunder and; (ii) the End User have purchased the Equipment directly from the Buyer and the End Buyer have provided METROLIGHT with a written evidence of such direct sale.

(j) THE FOREGOING WARRANTY IS THE SOLE AND EXCLUSIVE WARRANTY REGARDING THE EQUIPMENT AND PERFORMANCE THEREOF. THERE ARE NO OTHER WARRANTIES (INCLUDING WITHOUT LIMITATION WARRANTIES FOR CONSUMABLES AND OTHER SUPPLIES), OR GUARANTEES, EXPRESS OR IMPLIED WITH RESPECT TO THE EQUIPMENT. THE IMPLLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, STATUTORY OR OTHERWISE, ARE EXPRESSLY EXCLUDED AND HEREBY WAIVED BY THE BUYER. IN NO EVENT SHALL THERE BE ANY LIABILITY TO

METROLIGHT OR ANY OTHER PERSON OR ENTITY, WHETHER ARISING IN CONTRACT, TORT, NEGLIGENCE OF ANY DEGREE, STRICT LIABILITY OR OTHERWISE, WITH RESPECT TO THE EQUIPMENT OR ANY PART THEREOF DELIVERED HEREUNDER OR WITH RESPECT TO ANY NON-CONFORMANCE OR DEFECT IN ANY SUCH EQUIPMENT OR ANY PART THEREOF DELIVERED HEREUNDER, INCLUDING BUT NOT LIMITED TO ANY LIABILITY FOR ANY INDIRECT, CONSEQUENTIAL, INCIDENTAL OR SPECIAL, PUNITIVE OR EXEMPLARY DAMAGES AND/OR LOSSES (INCLUDING LOSS OF USE, REVENUE, AND/OR PROFITS) SUSTAINED OR INCURRED REGARDLESS WHETHER OR NOT SUCH DAMAGES WERE FORESEEN OR UNFORESEEN. IN ANY EVENT, THE MAXIMUM EXTENT OF LIABILITY OF METROLIGHT HEREUNDER FOR A PARTICULAR CLAIM SHALL NOT, UNDER ANY CIRCUMSTANCES, EXCEED THE PURCHASE PRICE ACTUALLY RECEIVED BY METROLIGHT FOR THE SPECIFIC PIECE OF EQUIPMENT PURCHSED FROM METROLIGHT GIVING RISE TO THE CLAIM.

Appendix C

specifications:

Lamp Compatibility List Metrolight Smart Electronic Ballast for HID™

This document lists the lamps that have been tested and approved by Metrolight as compatible with our Smart Electronic Ballasts for HID™. Metrolight is constantly testing new lamps for compatibility with the Smart Electronic Ballast. For the latest list of approved lamps, please visit our website, www.metrolight.com. For additional help, or for information about a lamp that is not listed here, please contact Metrolight customer support.

Please Note:

1. Only lamps that have been approved by Metrolight should be used with the Smart Electronic Ballasts.
2. Using lamps that have not been approved or recommended by Metrolight might void the ballast warranty.
3. Metrolight warrants the ballast performance when used with the lamps listed in this document but does not warrant the lamp itself.
4. Metrolight warrants the ballast performance when used with the lamps approved by lamp manufacturers. The lamp performance is warranted by the lamp manufacturer.

20-39W Ballast

The following types of lamps are suitable for use with the 20-39W Smart Electronic Ballasts:

20W	Ceramic	MH, M156
39W	Ceramic	MH, M130

Approved Lamps

The following lamps have been tested and approved by Metrolight.

* Lamps approved and warranted by lamp manufacturer

	Po	am	Type
GE	39W*	CMH-39	Ceramic
	35W*	CMH-35	Ceramic
	20W*	CMH-20 85101 CMH20MR16/830/SP 85110 CMH20MR16/830/FL 97638 CMH20MR16/830/WFL 29485 CMH20PAR20/SP 29486 CMH20PAR20/FL 29487 CMH20PAR30/SP10 29488 CMH20PAR30/SP15 29489 CMH20PAR30/FL25 29703 CMH20/T/U/830/G12 85086 CMH20/TC/U/830/GU6.5 92696 CMH20/TC/U/830/G8.5	Ceramic
Philips	39W	CDM-T 39W, CDM35/PAR20	Ceramic
	39W	CDM-TC 39W	Ceramic
	20W	CDM-TC 20W	Ceramic

50-150W Ballast

The following types of lamps are suitable for use with the 50W – 150W Smart Electronic Ballasts:

150W	Ceramic HPS	MH M81 M102 S56
100W	Ceramic	MH M90 M91 M92
70W	Ceramic, Quartz HPS	MH M98 HPS S88
50W	Ceramic, Quartz, White Son	MH M110

Approved Lamps

The following lamps have been tested and approved by Metrolight:

*Lamps approved and warranted by lamp manufacturer

	Po	am	Type
EIKO	70W	MH70/B34	Ceramic
GE	150W*	CMH150/T/UVC	Ceramic
	100W*	MVR100U/MED	Ceramic
	70W*	CMH70/T/UVC	Ceramic
Sylvania (OSI)	150W	MCP150/U/MED/830	Ceramic
	100W	MCP100/U/MED/830	Ceramic
	70W	MCP70/U/MED/830	Ceramic
Philips	150W	CDM-T 150W/830	Ceramic
	100W	MHC100/U	Ceramic
	70W	CDM-T 70W	Ceramic
Venture	50W	MH 50W/.. MP 50W/..	Quartz
	70W	MH 70W/.. MP 70W/..	Quartz
	100W	MH 100W/.. MP 100W/..	Quartz
	150W	MH 150W/.. MP 150W/..	Quartz

250-450W Ballast

The following types of lamps are suitable for use with the 250W – 450W Smart Electronic Ballasts:

250W	Pulse start HPS	MH M138 M80 S50
320W	Pulse start	MH M132
350W	Pulse start HPS	MH M131 S129
400W	Pulse start HPS	MH M135 S51
450W	Pulse start HPS	MH M135 S51

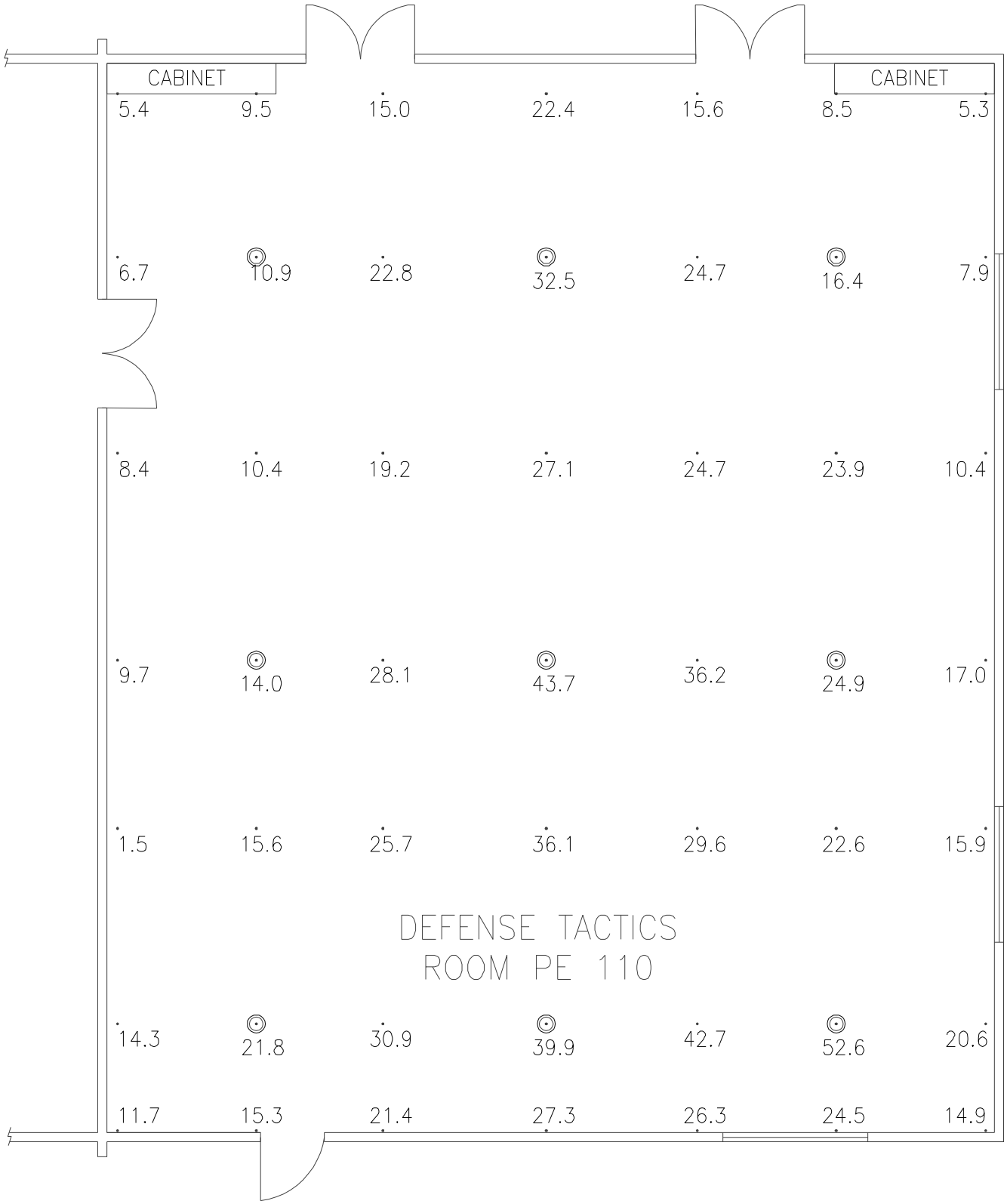
Approved Lamps

The following lamps have been tested and approved by Metrolight:

* Lamps approved and warranted by lamp manufacturer

EIKO	400W	MH400/U/T46	Pulse Start
GE	400W	MPR400/ MPR350/ MPR320/ MPR250/	Pulse Start
Sylvania (OSI)	175W	MP175/…	Pulse Start
	200W	MP200/…..	Pulse Start
	250W	M250/PS/BU	Pulse Start
	320W*	M320/PS/BU	Pulse Start
	350W*	M350/PS/BU	Pulse Start
	400W	M400/PS/BU	Pulse Start
	250W	MCP250/PS/BU	Ceramic
	320W	MCP320/PS/BU	Ceramic
Osram	250W	HCI-T 250/.., HQI-E/P 250/D, HQI-T 250/D	Ceramic Quartz
	400W	HQI-T 400/N, HQI-BT 400/D, HQI-E/P 400/D	Quartz
Philips	250W	MS250/BU/PS, HPI-T Plus 250	Pulse Start
	320W	MS320/BU/PS	Pulse Start
	350W	MS350/BU/PS	Pulse Start
	400W	MS400/BU/PS, HPI-T Plus 400	Pulse Start
Venture	175W	HIPE175/C/V…, MP 175W/BU/UVS/PS/740	Pulse Start
	200W	HIPE200/C/V…., MP 200W/BU/UVS/PS, MP 200W/C/BU/UVS/PS/737, MP 200W/BU/UVS/PS/740	Pulse Start
	250W	HIPE250/C/V…, MP 250W/BU/UVS/PS, MP 250W/C/BU/UVS/PS/737, MP 250W/BU/UVS/PS/740	Pulse Start
	320W	HIPE320/C/V…, MP320W/V/EL/UVS/PS/740, MP 320W/C/V/EL/UVS/PS/737, MP 320W/BU/EL/UVS/PS/950, MP 320W/C/BU/EL/UVS/PS/950	Pulse Start
	350W*	HIPE350/C/V…, MP 350W/BU/UVS/PS, MP 350W/V/EL/UVS/PS/740, MP 350W/C/V/EL/UVS/PS/737, MP 350W/BU/EL/UVS/PS/950, MP 350W/C/BU/EL/UVS/PS/950	Pulse Start
	400W*	HIPE400/…, MP 400W/BU/UVS/PS, MP 400W/V/EL/UVS/PS/740, MP 400W//C/V/EL/UVS/PS/737, MP 400W/BU/EL/UVS/PS/950, MP 400W/C/BU/EL/UVS/PS/950	Pulse Start
	450W	MP 450W/BU/EL/UVS/PS/740, MP 450W/C/BU/EL/UVS/PS/737	

Appendix D



VALUES ARE Fc READINGS TAKEN WITH A MINOLTA MN: TL-1, SN: 00515492

SCALE: 1/8" = 1'-0"

SALAS O'BRIEN
ENGINEERS, INC.
305 South 11th Street
San Jose, CA 95112-2218
436 14th Street, Suite 915
Oakland, CA 94612-2725
498 Foam Street
Monterey, CA 93940-1410
(408) 282-1500
FAX: (408) 297-2995
www.salasobrien.com

PG&E

EMERGING TECHNOLOGY (ET)

LIGHTING FLOOR PLAN - PE 110

DATE: 10/16/07

JOB # 06267

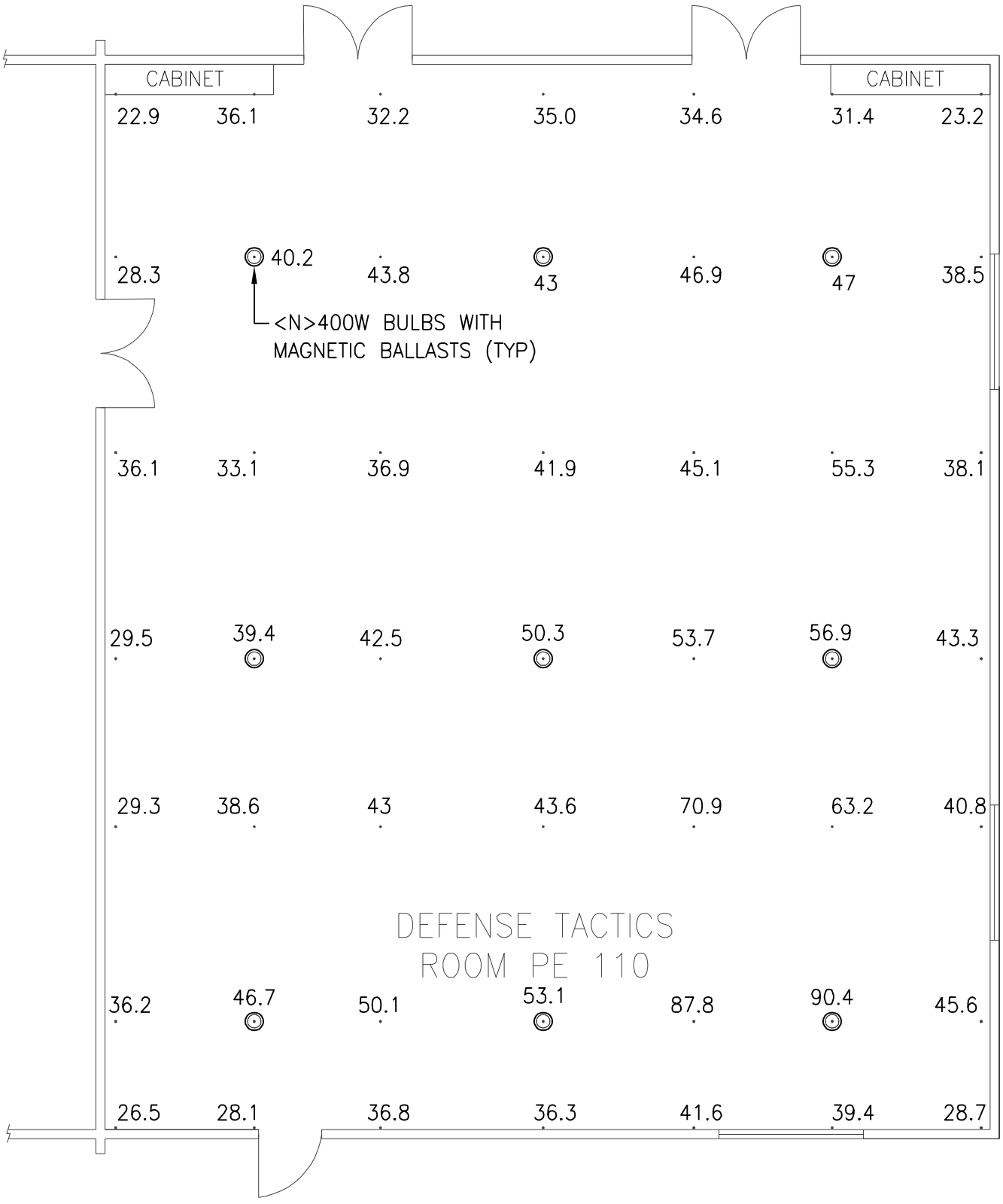
MOD DWG:

SK-1

SHT OF X

6267SK-1.DWG

Appendix E



VALUES ARE Fc READINGS TAKEN WITH A MINOLTA MN: TL-1, SN: 00515492

SCALE: 1/8" = 1'-0"

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www.salasobrien.com

PG&E

EMERGING TECHNOLOGY (ET)

LIGHTING FLOOR PLAN - PE 110 - NEW

DATE: 10/16/07

JOB # 06267

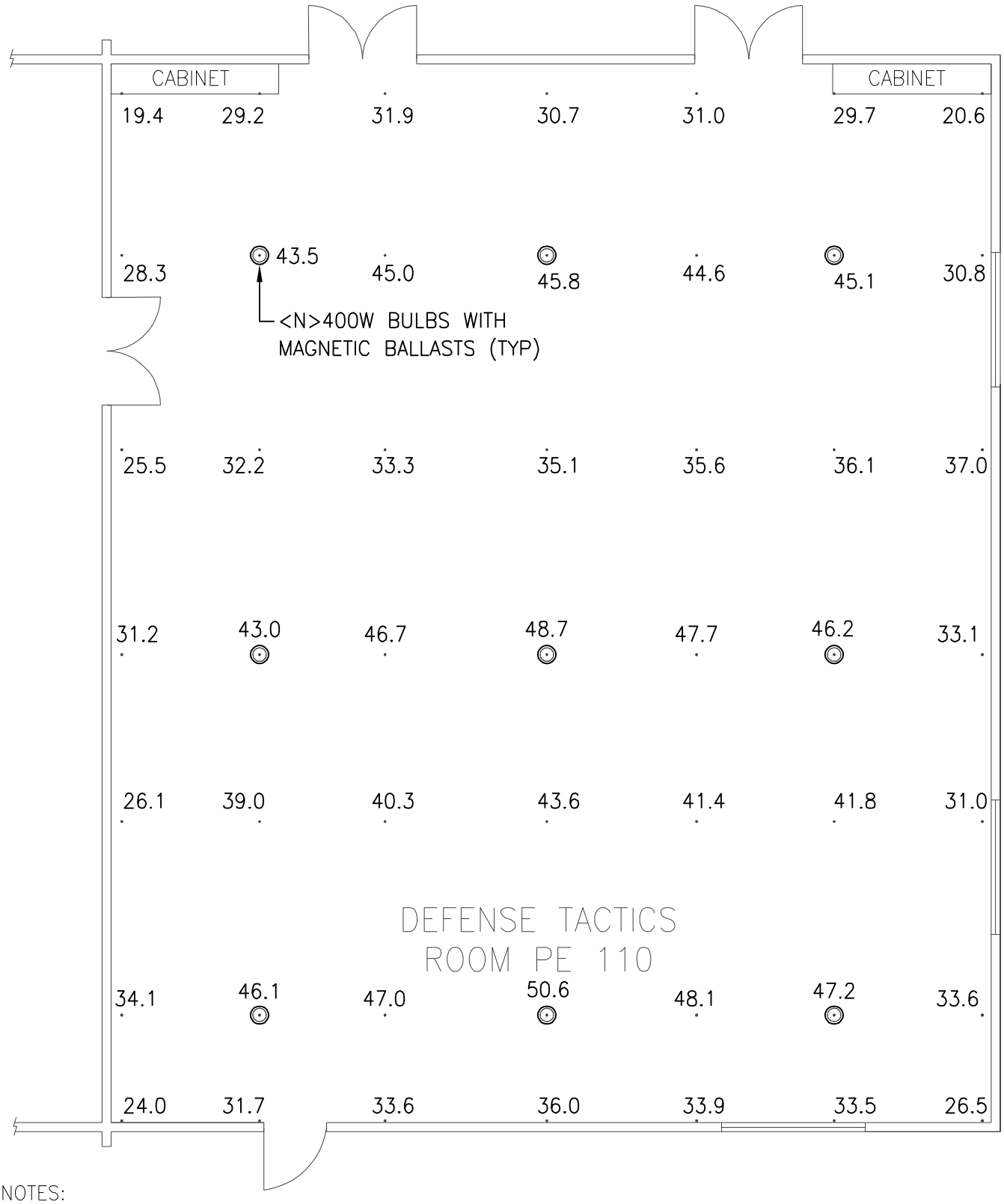
MOD DWG:

SK-2

SHT OF X

6267SK-2.DWG

Appendix F



NOTES:

1. Fc READINGS TAKEN WITH THE WINDOWS COVERED TO REDUCE LIGHT INTERRUPTION FROM OUTSIDE.
2. BASELINE READINGS W/NEW 400W BULBS.

VALUES ARE Fc READINGS TAKEN WITH A MINOLTA MN: TL-1, SN: 00515492

SCALE: 1/8" = 1'-0"

SALAS O'BRIEN
ENGINEERS, INC.
305 South 11th Street
San Jose, CA 95112-2218
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EMERGING TECHNOLOGY (ET)

FLOOR PLAN- NEW W/COVERED WINDOWS

DATE: 10/29/07

JOB # 06267

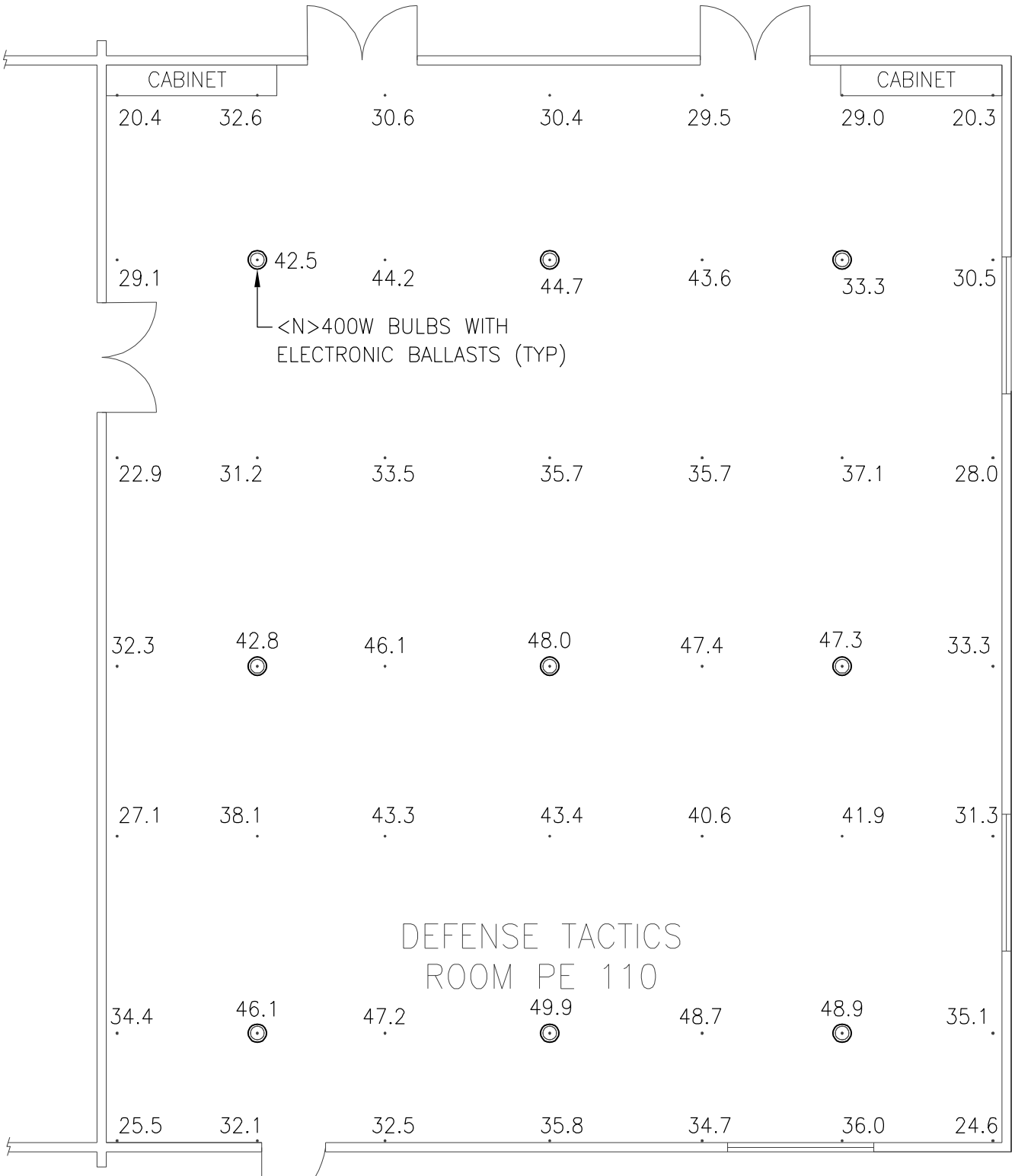
MOD DWG:

SK-3

SHT OF X

6267SK-3.DWG

Appendix G



NOTES:

1. POST INSTALLATION FOOTCANDLE READINGS...WITH WINDOWS COVERED.
2. READINGS TAKEN AT 42"AFF.
3. POST INSTALLATION READINGS WITH NEW 400W BULBS.

VALUES ARE Fc READINGS TAKEN WITH A MINOLTA MN: TL-1, SN: 00515492

SCALE: 1/8" = 1'-0"

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EMERGING TECHNOLOGY (ET)

LIGHTING FLOOR PLAN - PE 110

DATE: 12/04/07

JOB # 06267

MOD DWG:

SK-4

SHT X OF X

6267SK-4.DWG

Appendix H

J-Box for balllast

49.6 dB | 45.5 dB

52.1 dB

Bottom	n/a	dB
Left	49.6	dB
Top	n/a	dB
Right	45.5	dB
Below	52.1	dB
Avg.	**49.1**	**dB**

Magnetic Ballast Sound readings

With existing 400 W bulbs

J-Box for balllast

44.7 dB

46.3 dB | 43.5 dB

45.2 dB

47.5 dB

Bottom	45.2	dB
Left	46.3	dB
Top	44.7	dB
Right	43.5	dB
Below	47.5	dB
Avg.	**45.4**	**dB**

Magnetic Ballast Sound readings

Avg Decrease in Sound Level = **3.6** **dB**

7.39%

With new 400 W bulbs

38.0 dB

36.7 dB | 35.0 dB

34.6 dB

36.2 dB

Bottom	34.6	dB
Left	36.7	dB
Top	38	dB
Right	35	dB
Below	36.2	dB
Avg.	**36.1**	**dB**

Electronic Ballast Sound readings

Avg Decrease in Sound Level = **9.3** **dB**

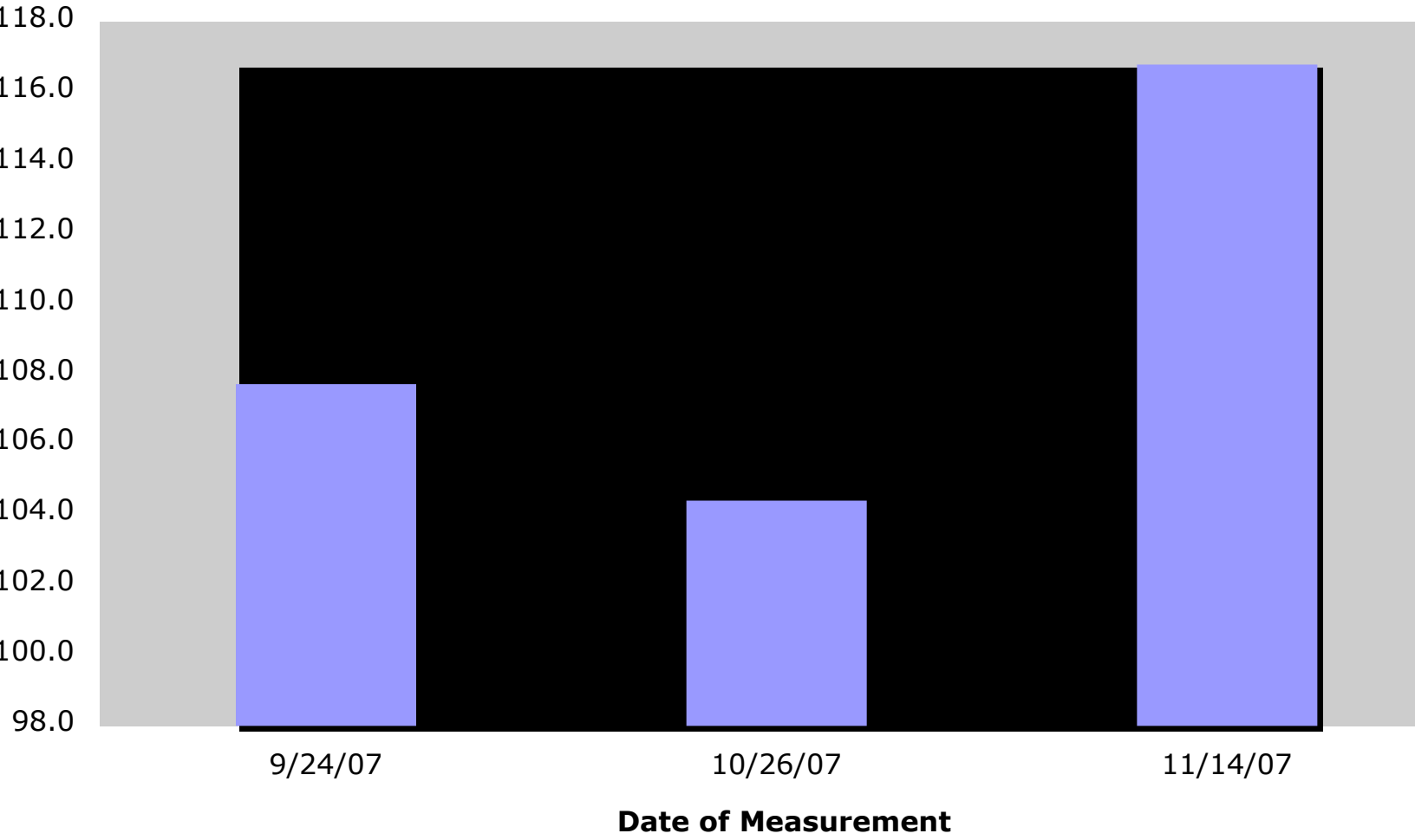
20.6%

Overall Avg Decrease in Sound Level = **13.0** **dB**

26.4%

Appendix I

Fixture Temperature at 4" away from HID Bulb



Appendix J

PACIFIC GAS ELECTRIC COMPANY
EMERGING TECHNOLOGIES PROGRAM

LARGE MANUFACTURING PLANT
FREMONT CALIFORNIA

COST SAVING CALCULATIONS

Lighting Description

Using Existing Magnetic Ballast, 400 Watts, Metal Halide Lamps

Existing Bulb:	400	W
Existing Magnetic Ballast:	68	W
Total Fixture:	468	W
Estimated (Calculated) Power Demand for 9 fixtures:	4212	W
Total Measured Power Demand for 9 fixtures:	3.400	kW

Using MetroLight Electronic Ballast, 400 Watts, Metal Halide Lamps

Replacement Bulb:	400	W
New Electronic Ballast:	40	W
Total Fixture:	440	W
Estimated (Calculated) Power Demand for 9 fixtures:	3960	W
Total Measured Power Demand for 9 fixtures:	3.050	kW

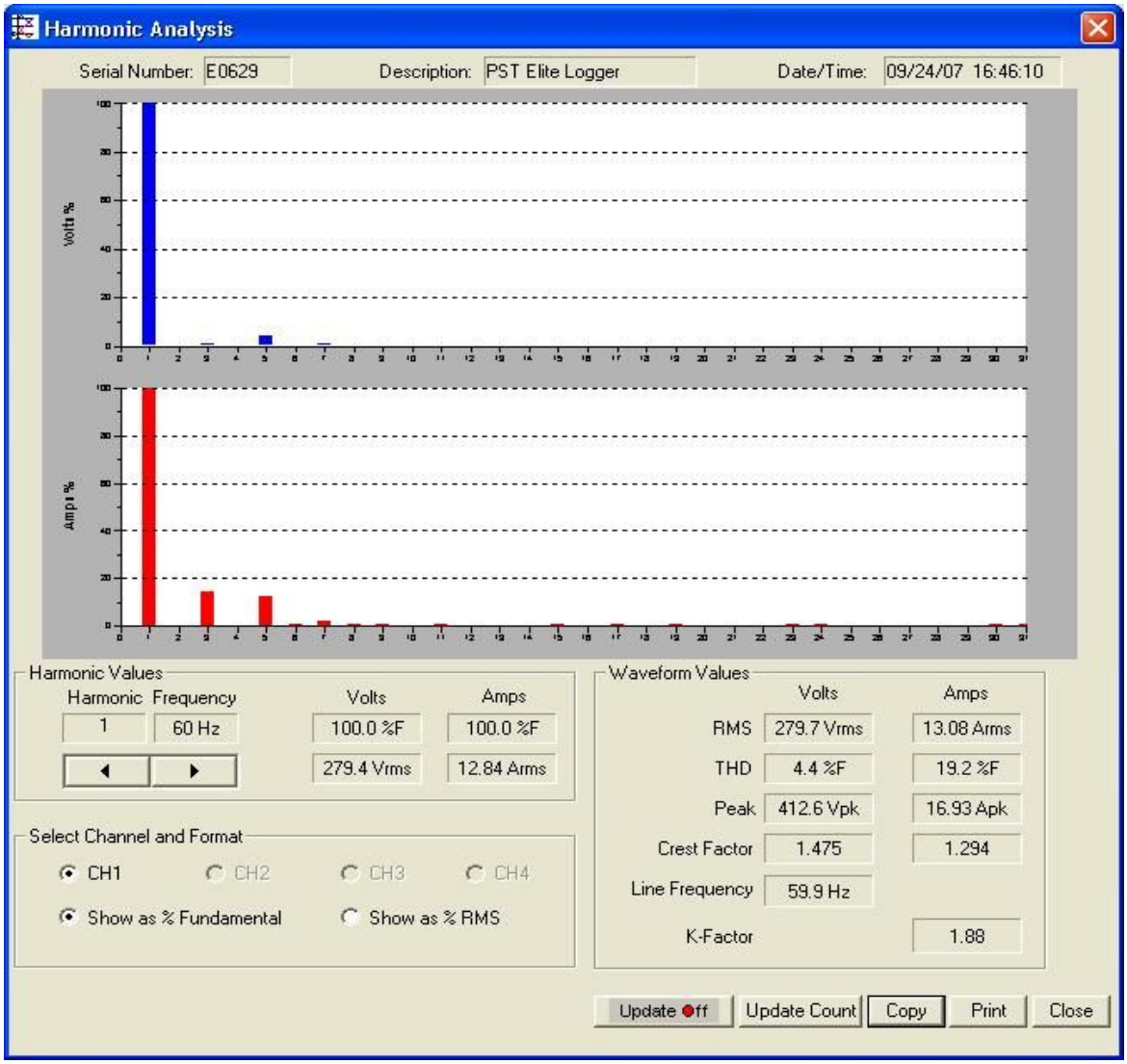
No. of Hours Used (assume 16 hrs/weekday, lights are ON) 16 Hours

Comparison in Yearly Usage

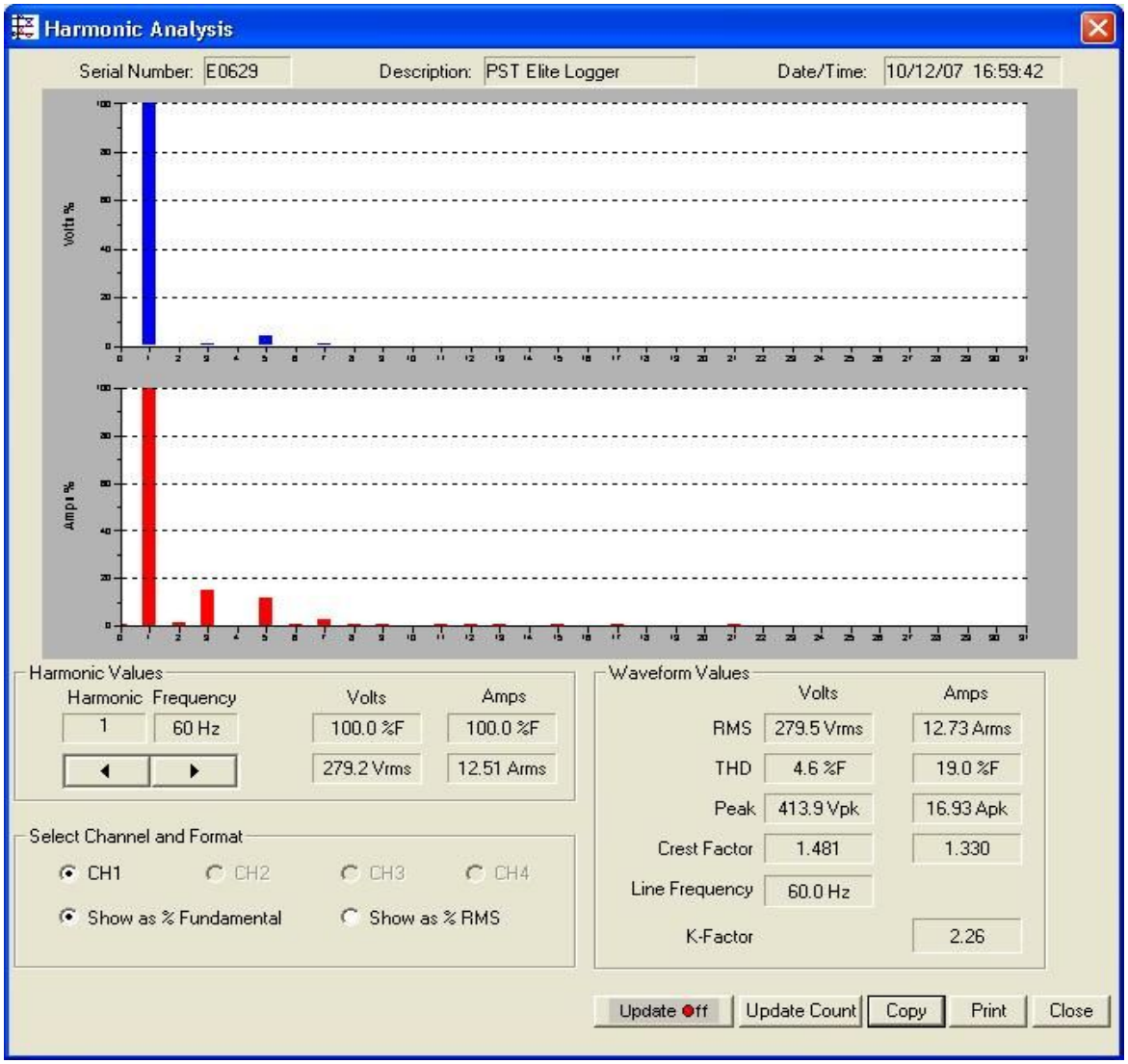
	Magnetic	Electronic	Savings
Consumed Power (kW)	3.400	3.050	0.350
Number of Daily Operational Hours (hr)	16	16	
Subtotal (kWh)	54.4	48.8	5.6
Number of Operational Days in a Year	260	260	
Subtotal (kWh - year)	14144	12688	1456
Cost per kWh ($)	$0.120	$0.120	
Power Cost Per Year	$1,697	$1,523	$175

TOTAL SAVINGS PER YEAR		
$175		$19 per fixture
0.35	kW	0.039 kW/fixture
1456	kWh	162 kWh/fixture

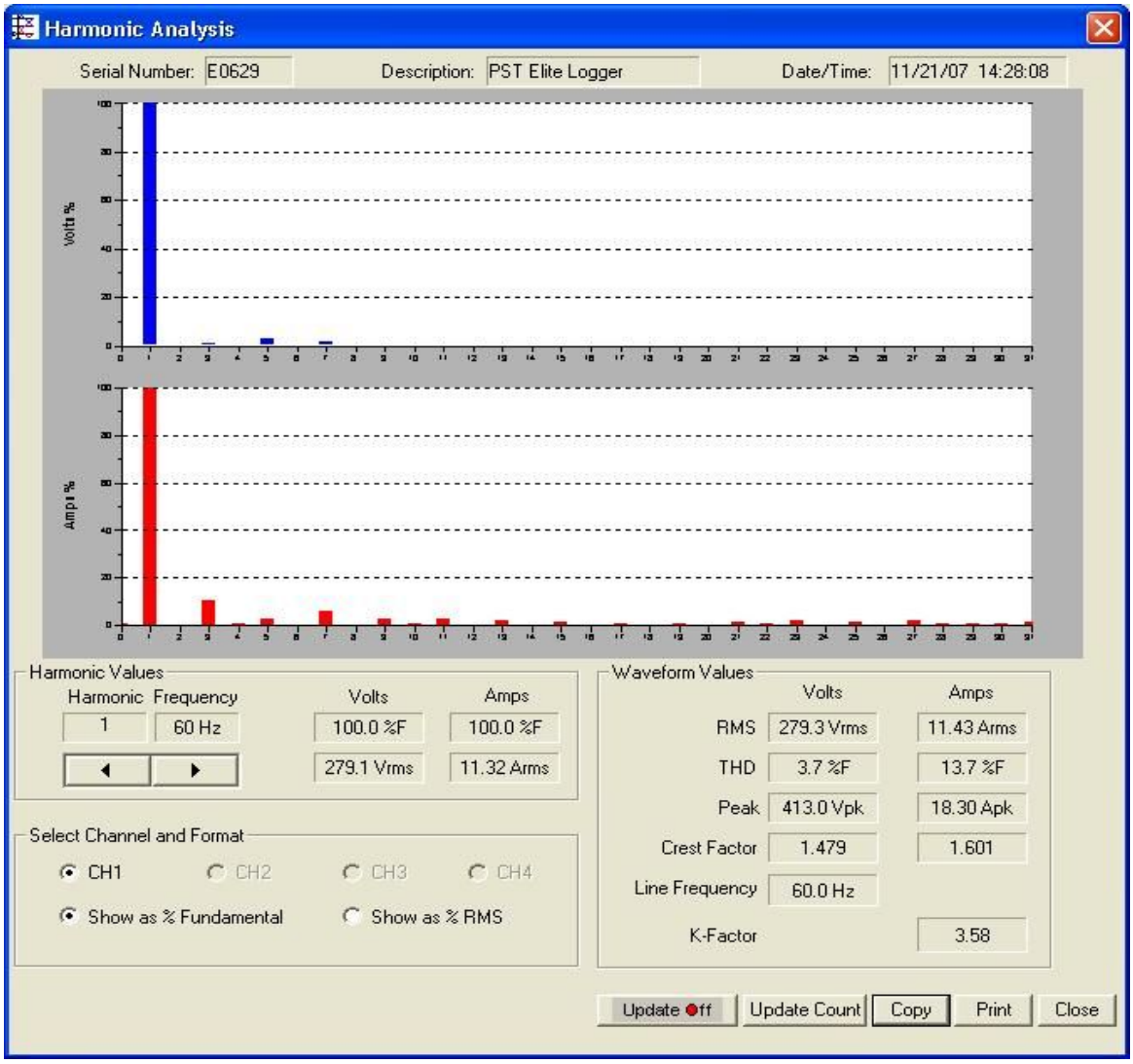
Appendix K



PRE-INSTALLATION CASE
WITH OLD 400 W BULBS AND MAGNETIC BALLASTS



PRE-INSTALLATION CASE
WITH NEW 400 W BULBS AND MAGNETIC BALLASTS



POST-INSTALLATION CASE
WITH 400 W BULBS AND ELECTRONIC BALLASTS

Appendix L

Appendix M

COST SAVINGS CALCULATION
DUE TO EFFECT OF LUMENS DEPRECIATION

From previous calculation in Appendix J:

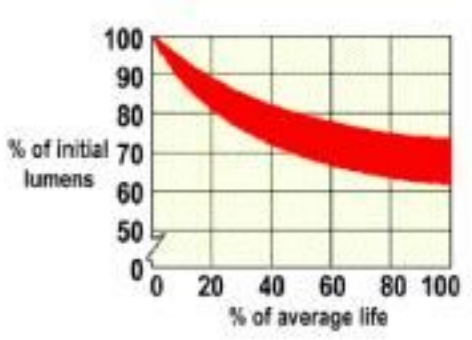
Using Existing Magnetic Ballast, 400 Watts, Metal Halide Lamps

Total Measured Power Demand for 9 fixtures: 3.400 kW

Also, at est. 16 hrs/day and 260 days/yr: 14144 kWh/yr

Existing fixtures are estimated to be at 100% of it's average useful life.

For magnetic HID ballasts:



Estimated depreciation over 100% of average lifetime: 32%
Estimated depreciation over 50% of average lifetime: 25%

Using MetroLight Electronic Ballast, 400 Watts, Metal Halide Lamps

Total Measured Power Demand for 9 fixtures: 3.050 kW

Also, at est. 16 hrs/day and 260 days/yr: 12688 kWh/yr

Estimated depreciation over 100% of average lifetime: 10%
Estimated depreciation over 50% of average lifetime: 8%

Therefore, difference between lumen depreciation between the magnetic and electronic cases is the % that the electronic ballasts can be "tuned down" and still achieve the same lumen output as the original existing magnetic ballast installation: 17%

Using MetroLight Electronic Ballast, 400 Watts, Metal Halide Lamps - TUNED DOWN

Estimated (Calculated) Power Demand for 9 fixtures: 2.526 kW (based on EB-fitted measured power demand data above)

Also, at est. 16 hrs/day and 260 days/yr: 10507 kWh/yr

Therefore, estimated savings

due to Lumen Depreciation:	***2181***	***kWh/yr***
Estimated savings per fixture:	***242***	***kWh/yr***

Assuming cost per kWh at $0.120/kWh/yr: ***$261.69***

$29.08 ***per fixture***

TOTALS with ENERGY SAVINGS CALC in APPENDIX J:

Total Savings:	***3637***	***kWh/yr***
	404	***kWh/yr/fixture***
Total Cost Savings:	***$436***	
	$48	***per fixture***