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Taking control of controls

BY **JEREMY WINDLE**

COMING FROM AN ENTERTAINMENT BACKGROUND, transitioning to lighting for architecture can be difficult for a person. It's like speaking a new language. Though the technology is familiar, the tools we use and the way we document our design are significantly different.

The good news for us theatre-types is that energy code requirements are making architectural lighting controls more flexible, helping meet our expectations as lighting designers, with increased functionality to create scenes and ambiance for different times of day or occasions and animate the space.

While controls are good, it's easy to fall down the lighting controls rabbit hole on your projects. If you approach an architectural lighting design project like a theatre production, you can quickly get derailed trying to understand what the control systems can do, document circuiting, DMX512 addresses, and more. Unlike a theatre production, architectural lighting design passes through many hands on the way to completion, so it's important to step back and re-evaluate how we approach lighting controls.

In this article, we'll review a different approach to lighting controls that will inform your design from the beginning and evolve over the course of the design phase into the final construction documents and into commissioning.

Basis of Design

The Basis of Design (BOD) is a dull text document, but it's a powerful tool that lets the lighting designer concentrate on the design and control circuiting, while ensuring that these technical puzzle pieces are incorporated into the project. The BOD, or a version of it, should appear in your final design documents.

The BOD captures the lighting and control requirements for each room or room type, and will evolve with the project. It's a good way to track lighting coordination items and make sure they make it into the design. The BOD should include lighting and control devices, illumination targets, and any automation requirements. For example:

RM 101 – Lobby

- Lighting Zones – separate control
  - General downlighting
  - Downlights at elevators
  - Pendants at lobby table
  - Tapelight at security desk
- Provide Time of Day (T.O.D.) clock presets: Morning, Evening, Night, Clear (1 hour override, restore to current T.O.D. preset)
- Provide (1) min. 4-button wall station or equal for manual recall of presets. Locate at security desk.
  - Top and bottom presets must also act as raise / lower when held.
  - Provide custom engraving: "Morning," "Evening," "Night," and "Overnight"
    - Locate button station in nearby electrical or janitor closet.
- Provide daylighting sensors. Maintain min. 15 fc at floor.
- Provide occupancy sensors, quantity as required. Lights to 100% during overnight hours; off after 20 mins.
  - Occupancy sensor data shall be available over BACnet
- Timeclock events:
  - 6:00: 5 min. fade to preset 1 "Daytime"
  - Sunset -30min: 5 min. fade to preset 2 "Evening"
  - Sunset +60min: 5 min. fade to preset 3 "Night"
  - 22:00: 5 min. fade to preset 4 "Overnight"
- Provide (1) Ethernet programming jack, min. Cat5 homerun to lighting control processor.
  - Commission to meet energy code requirements.

Repeat the process for each room or room type for your project. And it's okay to have one entry that covers similar areas, such as private offices, for example.

While developing your Basis of Design, it is important to meet with the owner and architect and ask lots of exciting questions to inform your control decisions like:

- Does the owner have a control system preference?
- Does the landlord have a control system requirement that the owner has to adhere to? (Most landlords will want their tenants on the same control system as the rest of the building to take advantage of building automation systems.)
- Do conference rooms have AV systems that will need to interface with the lighting controls? Would the owner like 4-scene presets in these rooms? What protocol is used to communicate between the systems?
- Does the design require any color changing fixtures?
- Are there other operational requirements such as time of day events that need to be considered?
- Do you have a favorite kind of cheese? (Not relevant to the BOD, but always a good question to ask someone.)
- Will the lighting control system be on the

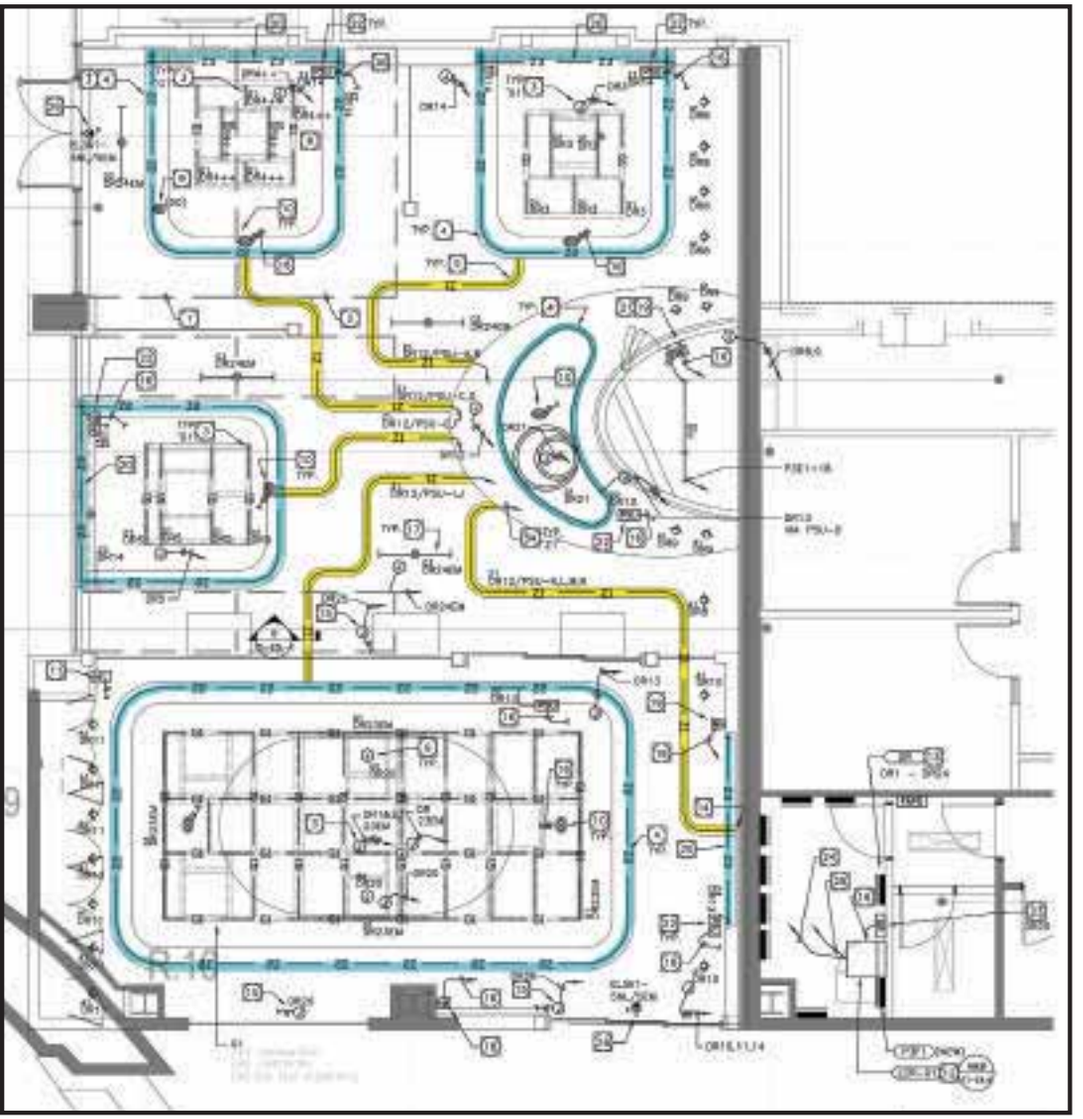


Figure 1 – This sample project featured conventional architectural lighting as well as 4-channel RGBW ceiling and wall cove lighting, shown in blue, and color changing backlit ceiling channels with both RGB and dynamic white LED nodes shown in yellow. The nodes were designed at 4" on center to animate the slots. A lighting systems integrator procured all intelligent lighting and the control system to ensure they were commissioned to work together.

building automation system (BAS)?

• Is a BACnet interface required?

Once your Basis of Design is completed, but before you begin your lighting control documentation, consider what your requirements really are, and how much you will need to document the controls on your plans. Your project will probably fall into one of three categories:

Basic projects, such as offices, classrooms, or exterior lighting may be handed off to the electrical engineer with little more than the lighting plans, fixture schedule, and a Basis of Design document as a guide for the controls. If the lighting designer has no strong opinions on how the fixtures are controlled, such as lighting in an open office, the engineer can proceed with zoning the controls to meet energy code requirements. Your Basis of Design will inform that engineer and lighting controls manufacturer of any requirements you have, such as 4-scene presets at the conference room, for example.

Intermediate projects, such as hospitality, restaurant, and retail are more involved, and you will want to take the time to document some or all of the lighting controls for these types of projects. For these projects, you will want to turn your BOD into a Lighting Control Intent document to capture all the control requirements. You may also want an equipment schedule to capture the control stations and further define what they do. Using these documents, the electrical engineer will be able to maintain your control zone intent while circuiting the fixtures for code compliance.

Advanced projects, such as theatres, theme parks, and casinos are the most complicated, requiring extensive documentation including fixture and equipment schedules, Lighting Control Intent documents, possibly even a complete lighting control riser diagram. These projects often use intelligent fixtures and control systems from different manufacturers, so it will also likely require a lighting systems integrator to ensure the success of the project.

A lighting systems integrator (LSI) is a contractor specializing in advanced lighting control systems. They are typically sub-contracted under the electrical contractor, and ensure that all fixtures and systems are provided and installed correctly, regardless of manufacturer. The LSI will be responsible for generating installation shop drawings of the control system for the installing contractor, and provide installation supervision for the electrical contractor, and final test and adjust onsite. When working on these advanced projects, it is important to inform the client that these services are required, and carefully write your specifications to include these services.

When an advanced project lighting design is handed over to the electrical engineer, the LSI and lighting designer will need to interface with the electrical engineer to ensure that their plan documentation refers to the LSI shop drawings for final control system documentation. It's easy for scope gaps to

occur at this stage of the design.

On all of these projects, the Basis of Design and Lighting Control Intent documents can work together to effectively communicate how the lighting control system is to be commissioned.

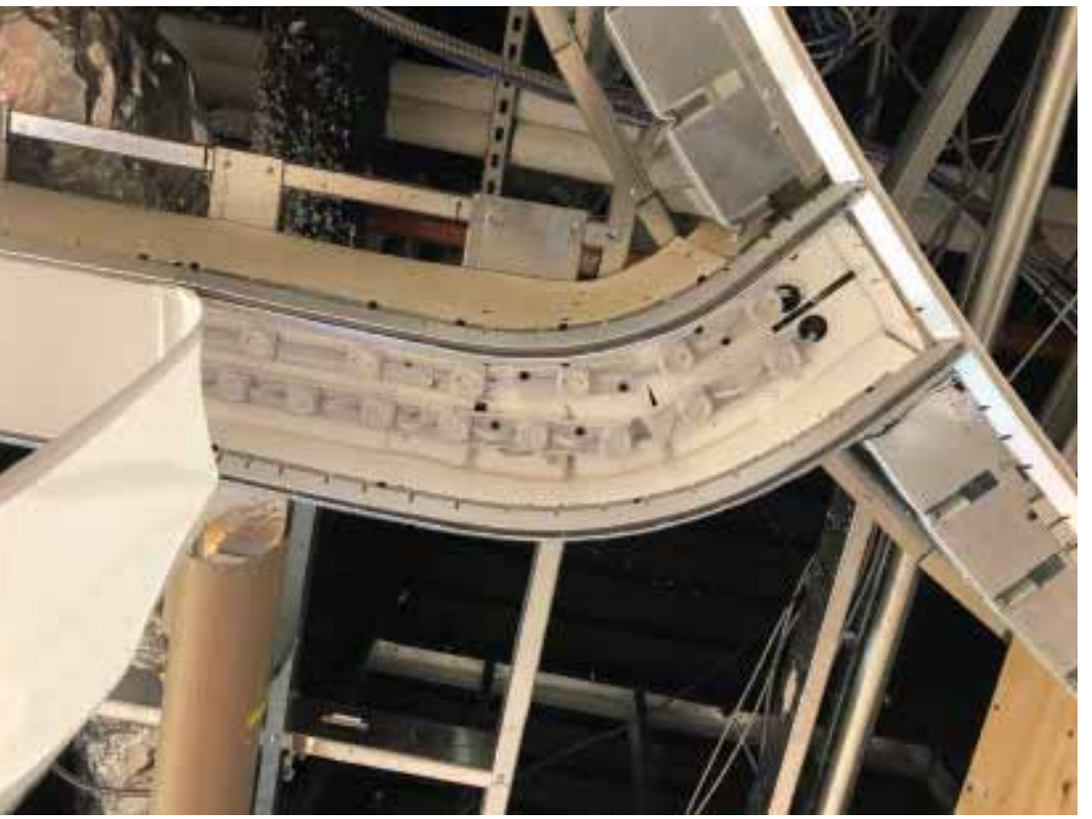


Figure 2 – The lighting control design included enough channel capacity to handle the individual node addressing, but during installation, the owner decided to change the lighting to 3" on center for increased brightness. The lighting systems integrator updated the control channels and added an additional processor to handle the extra channel requirements.

Where do I start?

The good news is that your Basis of Design is finished, so you can use it as a roadmap as you move right into production.

Lighting plans

The lighting plans generated will be handed off to the electrical engineer to become a part of the building plans that are submitted for permit. We have found that the lighting designer's plans should not be submitted to the municipal building department's plan check because they are not stamped by a professional engineer, and this causes confusion at the plan check office. The lighting designs are a fantastic reference for the contractor, though, so they should be issued to the field as additional reference information.

If working on an intermediate or advanced project, you want to be sure that the lighting control "zones" are shown on the plans. We have found that the best method is to standardize on a numbering scheme. For example, we tend to use 4-digits in our control zone assignments so 1000-series control zones are on level 1. The 2000-series control zones are on level

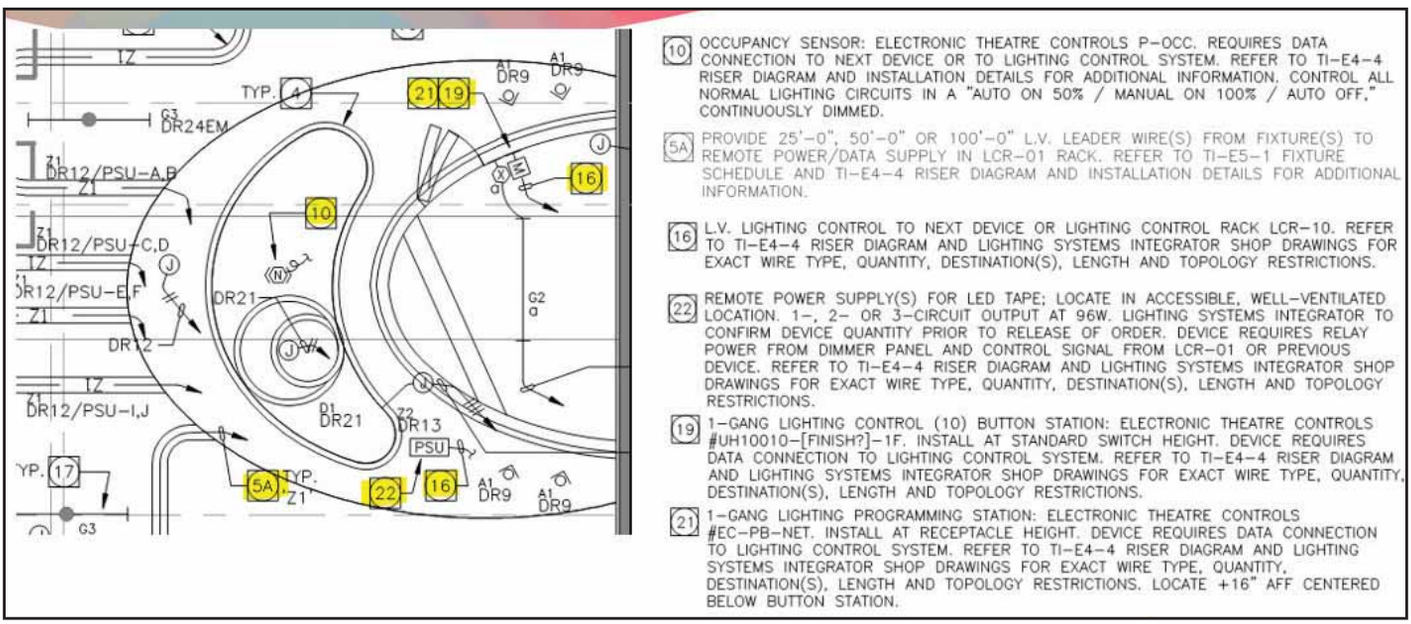


Figure 3 – A sample of the lighting plans showing extensive keynotes to communicate the design intent. In this project, sensor part numbers are listed in our keynotes.

— Z1 —	Z1	COLOR KINETICS IW STRING: 501-000016-00 RGB STRING: 101-000077-02 25FT LEADER: 108-000045-00 50FT LEADER: 108-000045-01 100FT LEADER: 108-000045-02 MTNG TRACK, WHITE: 101-000057-00 POWER SUPPLY:TBD PROVIDED BY QUALIFIED LIGHTING SYSTEMS INTEGRATOR AS PART OF AN ENGINEERED, NETWORKED LIGHTING CONTROL SYSTEM.	LED	RGB & DYN. WHITE	6|6/FT	LIGHTING ASSEMBLY TO BE COMPRISED OF (1) STRING OF DYNAMIC WHITE LED'S 4" O.C. AND (1) STRING OF RGB LED'S 4" O.C.; INSTALLED SIDE BY SIDE. PROVIDE WITH LEADER WIRES AND MOUNTING TRACK AS REQUIRED. PROVIDE REMOTE DATA ENABLERS AS INDICATED ON LIGHTING SYSTEMS INTEGRATOR SHOP DRAWINGS.	INSTALL FIXTURE IN BARRISOL CEILING "TRACES." REQUIRES COMPLETE MOCKUP WITH FIXTURE AND SPECIFIED MATERIAL. FIXTURE REQUIRES POWER FROM RELAY VIA REMOTE POWER SUPPLY(S). POWER SUPPLY(S) REQUIRE NETWORK DATA FROM LIGHTING CONTROL SYSTEM. REFER TO LIGHTING SYSTEMS INTEGRATOR SHOP DRAWINGS FOR ADDITIONAL INFORMATION.
— Z2 —	Z2	OPTIC ARTS LED TAPE: FLEXSTP-20-RGBW30-24-50-[LEGTH?]-[15FT LEADER] ADHESIVE TAPE: AS REQUIRED MOUNTING CLIP: FLEXMNT.SIL.INT STRAIN RELIEF: FLEX.ZIP DMX POWER SUPPLY: Q-TRAN QTM-eLED-[100, 200 OR 300W]-UNV/24+DMX-BK PROVIDED BY QUALIFIED LIGHTING SYSTEMS INTEGRATOR AS PART OF AN ENGINEERED, NETWORKED LIGHTING CONTROL SYSTEM.	LED	RGBW	5|4.4/FT	SURFACE MOUNT TAPELIGHT FOR USE WITH 5-WATT, 205-LUMEN PER FOOT RGBW LED. TAPE LIGHT PROVIDED WITH EXTENDED 15'-0" LENGTH LEADER WIRE. PROVIDE COMPLETE WITH HIGH STRENGTH ADHESIVE TAPE. MECHANICALLY SECURE WITH MOUNTING CLIPS AND STRAIN RELIEF CLIP. PROVIDE REMOTE POWER SUPPLY AS REQUIRED.	INSTALL TAPELIGHT IN CONCEALED CEILING COVES. REFER TO ARCHITECTURAL PLANS AND DETAILS. MAX 21'-0" LED LENGTH PER 96W DRIVER OUTPUT. FIXTURE REQUIRES REMOTE DMX DRIVER IN ACCESSIBLE, WELL-VENTILATED LOCATION. DRIVER LOCATION AND QUANTITY TO BE CONFIRMED BY CONTRACTOR. MANUFACTURER TO PROVIDE TYPICAL OR CUSTOM SHOP DRAWINGS FOR INSTALLATION. TERMINATE DMX SIGNAL AT LAST POWER SUPPLY.
— Z3 —	Z3	OPTIC ARTS LED TAPE: FLEXSTP-20-RGBW30-24-50-[LEGTH?]-[15FT LEADER] ADHESIVE TAPE: AS REQUIRED MOUNTING CLIP: FLEXMNT.SIL.INT STRAIN RELIEF: FLEX.ZIP DMX POWER SUPPLY: (1) 96w OUTPUT: PROVIDED BY QUALIFIED LIGHTING SYSTEMS INTEGRATOR AS PART OF AN ENGINEERED, NETWORKED LIGHTING CONTROL SYSTEM.	LED	RGBW	5|4.4/FT	SURFACE MOUNT TAPELIGHT FOR USE WITH 5-WATT, 205-LUMEN PER FOOT RGBW LED. TAPE LIGHT PROVIDED WITH EXTENDED 15'-0" LENGTH LEADER WIRE. PROVIDE COMPLETE WITH HIGH STRENGTH ADHESIVE TAPE. MECHANICALLY SECURE WITH MOUNTING CLIPS AND STRAIN RELIEF CLIP. PROVIDE REMOTE POWER SUPPLY AS INDICATED ON LIGHTING SYSTEMS INTEGRATOR SHOP DRAWINGS.	INSTALL TAPELIGHT IN CONCEALED WALL CHANNELES, CONTINUOUSLY AROUND PERIMETER OF WALL POCKET. REFER TO ARCHITECTURAL PLANS AND DETAILS. FIXTURE REQUIRES REMOTE DMX DRIVER IN ACCESSIBLE, WELL-VENTILATED LOCATION. DRIVER LOCATION AND QUANTITY TO BE CONFIRMED BY CONTRACTOR. MANUFACTURER TO PROVIDE TYPICAL OR CUSTOM SHOP DRAWINGS FOR INSTALLATION. TERMINATE DMX SIGNAL AT LAST POWER SUPPLY.

SEE GENERAL LIGHTING FIXTURE SCHEDULE NOTES FOR CRITICAL FIXTURE SPECIFICATION AND ORDERING INFORMATION.

LIGHTING SYSTEMS INTEGRATOR:
1. LIGHTING SYSTEMS INTEGRATOR SHALL PROVIDE ALL DIMMING CONTROL SYSTEM DEVICES.
2. LIGHTING SYSTEMS INTEGRATOR SHALL PROVIDE ALL INTELLIGENT, DMX-ADDRESSABLE LIGHT FIXTURES.
3. LIGHTING SYSTEMS INTEGRATOR SHALL COORDINATE INSTALLATION OF DIMMING AND CONTROL DEVICES, LUMINAIRES, AND ALL DATA, WITH ELECTRICAL CONTRACTOR.
4. LIGHTING SYSTEMS INTEGRATOR SHALL CONFIGURE AND PROGRAM LIGHTING CONTROL SYSTEM AS DIRECTED BY LIGHTING CONSULTANT AND OWNER.
5. LIGHTING SYSTEMS INTEGRATOR SHALL BE APPROVED BY LIGHTING CONSULTANT.
6. PRE-APPROVED LIGHTING SYSTEMS INTEGRATORS ARE.
   6.1. [redacted] LOS ANGELES
   CONTACT: [redacted]
   6.2. [redacted] | LOS ANGELES
   CONTACT: [redacted]S.COM

LIGHTING FIXTURE SCHEDULE (A)
scale: NONE

Figure 4 – The lighting fixture schedule lists the LED fixtures and accessories, to be provided by a "qualified lighting systems integrator as part of an engineered, networked lighting control system." Notes in the right column capture the data requirements.

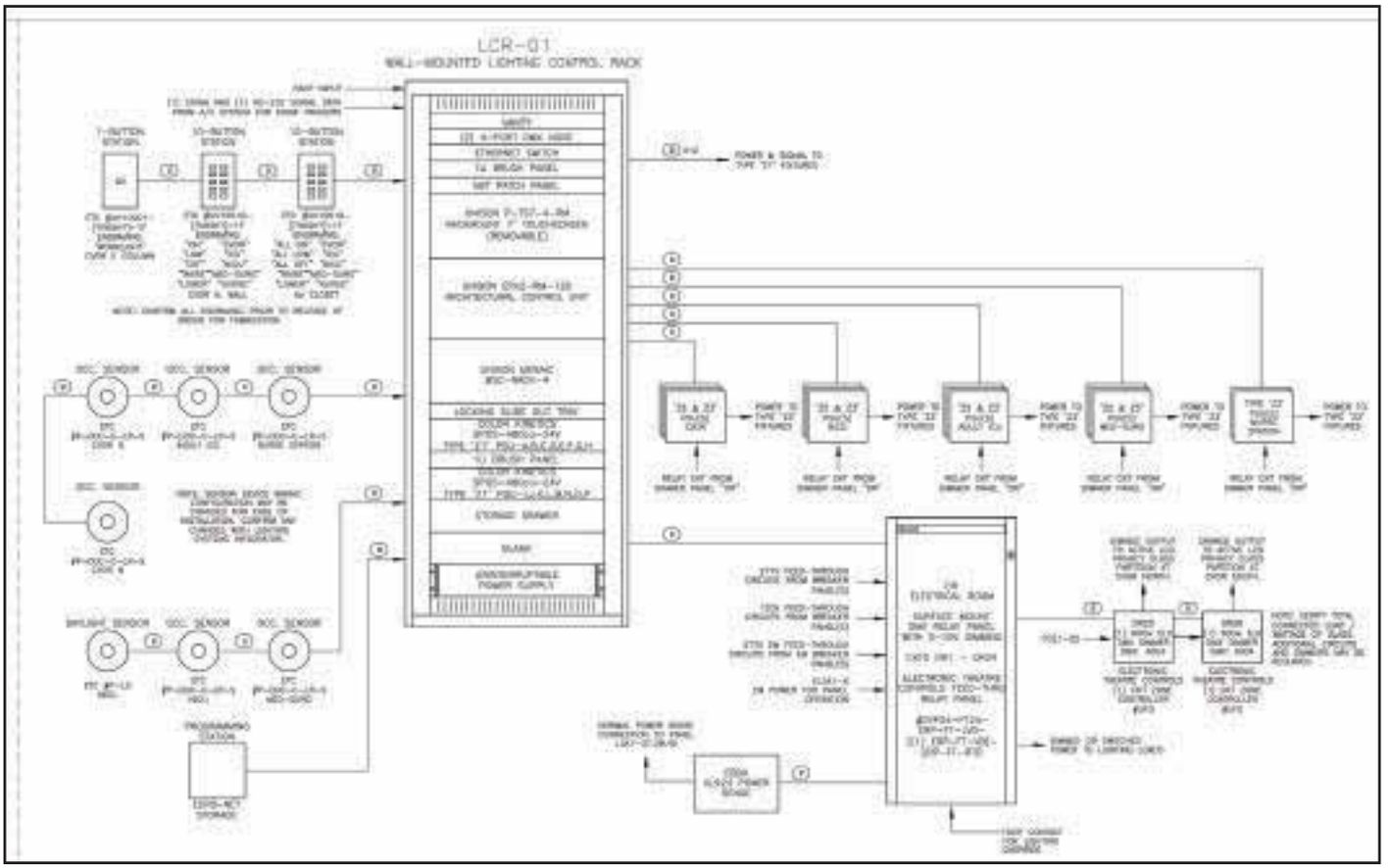
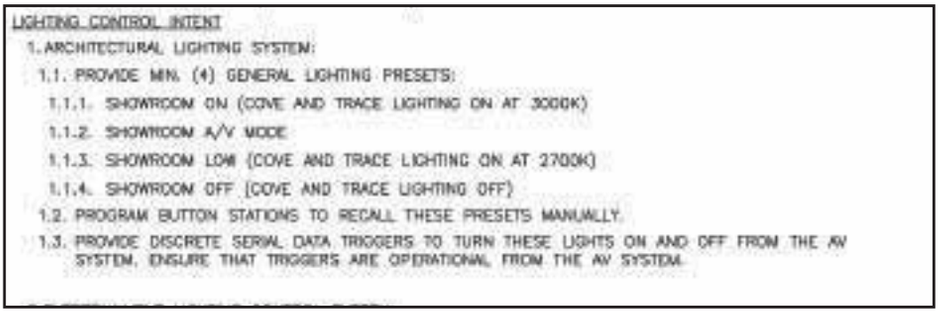


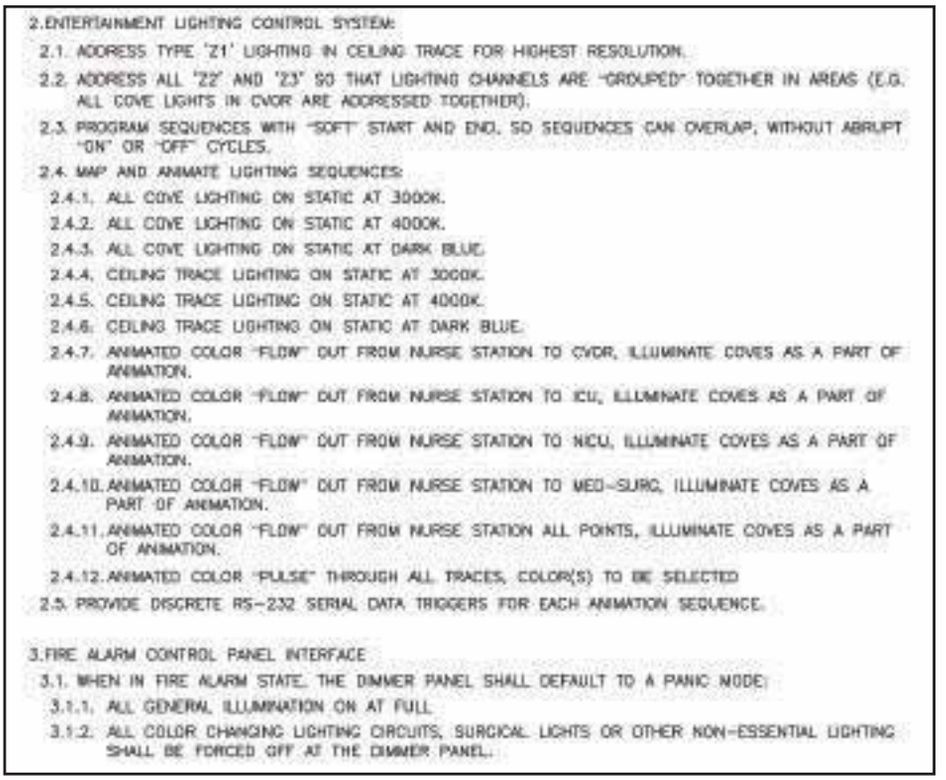
Figure 5 – Instead of a separate equipment schedule, all device part numbers and even custom button engraving are shown on the control riser diagram. The LSI based their shop drawings on this document. This project has both an architectural lighting controller to manage normal room lighting, including code-compliant daylighting and motion sensing, as well as a show controller that takes over when the space is used as a presentation showroom. The relay panel has a voltage separation barrier to control both normal and emergency lighting circuits.



LIGHTING CONTROL INTENT

1. ARCHITECTURAL LIGHTING SYSTEM:
   - 1.1. PROVIDE MIN. (4) GENERAL LIGHTING PRESETS:
     - 1.1.1. SHOWROOM ON (COVE AND TRACE LIGHTING ON AT 3000K)
     - 1.1.2. SHOWROOM A/V MODE
     - 1.1.3. SHOWROOM LOW (COVE AND TRACE LIGHTING ON AT 2700K)
     - 1.1.4. SHOWROOM OFF (COVE AND TRACE LIGHTING OFF)
   - 1.2. PROGRAM BUTTON STATIONS TO RECALL THESE PRESETS MANUALLY.
   - 1.3. PROVIDE DISCRETE SERIAL DATA TRIGGERS TO TURN THESE LIGHTS ON AND OFF FROM THE AV SYSTEM. ENSURE THAT TRIGGERS ARE OPERATIONAL FROM THE AV SYSTEM.

Figure 6 – Lighting Control Intent, Architectural. The BOD was distilled down to the basic requirements for static lighting presets to be programmed on the architectural lighting controller. These presets can also be recalled from the button stations, the AV system, or the show lighting controller.



2. ENTERTAINMENT LIGHTING CONTROL SYSTEM:
   - 2.1. ADDRESS TYPE 'Z1' LIGHTING IN CEILING TRACE FOR HIGHEST RESOLUTION.
   - 2.2. ADDRESS ALL 'Z2' AND 'Z3' SO THAT LIGHTING CHANNELS ARE "GROUPED" TOGETHER IN AREAS (E.G. ALL COVE LIGHTS IN CVOR ARE ADDRESSED TOGETHER).
   - 2.3. PROGRAM SEQUENCES WITH "SOFT" START AND END, SO SEQUENCES CAN OVERLAP, WITHOUT ABRUPT "ON" OR "OFF" CYCLES.
   - 2.4. MAP AND ANIMATE LIGHTING SEQUENCES:
     - 2.4.1. ALL COVE LIGHTING ON STATIC AT 3000K.
     - 2.4.2. ALL COVE LIGHTING ON STATIC AT 4000K.
     - 2.4.3. ALL COVE LIGHTING ON STATIC AT DARK BLUE.
     - 2.4.4. CEILING TRACE LIGHTING ON STATIC AT 3000K.
     - 2.4.5. CEILING TRACE LIGHTING ON STATIC AT 4000K.
     - 2.4.6. CEILING TRACE LIGHTING ON STATIC AT DARK BLUE.
     - 2.4.7. ANIMATED COLOR "FLOW" OUT FROM NURSE STATION TO CVOR, ILLUMINATE COVES AS A PART OF ANIMATION.
     - 2.4.8. ANIMATED COLOR "FLOW" OUT FROM NURSE STATION TO ICU, ILLUMINATE COVES AS A PART OF ANIMATION.
     - 2.4.9. ANIMATED COLOR "FLOW" OUT FROM NURSE STATION TO NICU, ILLUMINATE COVES AS A PART OF ANIMATION.
     - 2.4.10. ANIMATED COLOR "FLOW" OUT FROM NURSE STATION TO MED-SURG, ILLUMINATE COVES AS A PART OF ANIMATION.
     - 2.4.11. ANIMATED COLOR "FLOW" OUT FROM NURSE STATION ALL POINTS, ILLUMINATE COVES AS A PART OF ANIMATION.
     - 2.4.12. ANIMATED COLOR "PULSE" THROUGH ALL TRACES, COLOR(S) TO BE SELECTED
   - 2.5. PROVIDE DISCRETE RS-232 SERIAL DATA TRIGGERS FOR EACH ANIMATION SEQUENCE.

3. FIRE ALARM CONTROL PANEL INTERFACE
   - 3.1. WHEN IN FIRE ALARM STATE, THE DIMMER PANEL SHALL DEFAULT TO A PANIC MODE:
     - 3.1.1. ALL GENERAL ILLUMINATION ON AT FULL
     - 3.1.2. ALL COLOR CHANGING LIGHTING CIRCUITS, SURGICAL LIGHTS OR OTHER NON-ESSENTIAL LIGHTING SHALL BE FORCED OFF AT THE DIMMER PANEL.

Figure 7 – Lighting Control Intent – Show. The Control intent starts to read more like a narrative as we describe how the different lighting sequences are to be programmed on the show controller. All sequences and transitions are programmed to be recalled from the AV controller as a part of the showroom AV presentations.

2, and so on. Always leave yourself a couple spare control zones in each room, in case you have to add a zone later.

If you're using DMX-controlled fixtures, be sure to note the DMX cabling between fixtures on your plans, as well as the homeruns to the lighting control system. This is also a good time to call the electrical engineer and review the data wiring requirement with them so they understand what needs to be noted on the engineering plans.

Once the lighting and control zones are on the plan, reference your BOD and start roughing in the lighting controls. Once the lighting and control zones are on the plan, reference your BOD and start roughing in the lighting controls. If you have a few control sensors and button stations, you can add keynotes or a simple device legend to your plans to call out the device type and information. If you have a lot of control devices, you may want to create an equipment schedule. We'll cover this a little later.

Lighting fixture schedule

The fixture schedule is used to compile all the information for each fixture, including the fixture type, manufacturer, catalog number, control type, lamp type, and wattage. The engineer will use this information to circuit the fixtures and fill in any energy code compliance forms. The lighting control system manufacturers will use this information to configure their system to control the specified fixtures.

If this is an advanced project, make sure that the requirement for DMX wiring is noted in the fixture schedule for each DMX fixture type. It's also a good idea to try to note that these fixtures are to be **"provided by the lighting systems integrator as part of an engineering lighting control system."** Most contractors, vendors, or rep agencies won't try to break apart an engineered system, so this helps ensure these fixtures are procured by the LSI.

Most LSIs will prep, address, and label these fixtures in the shop before shipping them to the job site. This is helpful because any fixture issue is discovered before it's delivered to the job site, saving time troubleshooting fixtures in the field.

Equipment schedule

The equipment schedule is where you can capture all the catalog information and details of your lighting control equipment, including button stations, programming ports, data outputs, and more. Relevant information to include would be device type, location, description, catalog information, and notes about what system it connects to. On basic and intermediate projects, it's okay to reference generic lighting controls without manufacturer or part numbers, or simply name a single manufacturer as the Basis of Design for your control system. This will give the contractor

and owner some flexibility in shopping the control system for the best price, while ensuring that the controls meet the performance criteria outlined in your Lighting Control Intent.

If you're working on an advanced project, and you're comfortable with generating lighting control risers, you can add these to your equipment schedules. Clearly note which parts of the system are to be provided and installed by a qualified lighting systems integrator as part of an engineering lighting control system.

Lighting Control Intent

Also referred to as a "Control Narrative" or "Sequence of Operations" the Lighting Control Intent is the final evolution of your Basis of Design. It should be sorted by control zone, and include relevant information for each zone, including location, purpose, fixture type and quantity, total connected wattage, control type, and any additional notes. Lighting control type is typically 0-10 V or electronic low voltage (ELV), but may also include DALI or DMX512.

The electrical engineer will use this document to validate the circuiting indicated on the plans and connect the fixtures. The lighting controls manufacturer will use this to pre-configure the system.

Take advantage of a notes column to point out relevant information, such as which zones require remote transformers or drivers, or which zones require DMX data.

Try not to repeat information on the schedule that is shown on the plans, it is always easier to make any changes in one location only.

If you know what scene presets you might be using, now's a good time to rough in some programming levels, too. This will save you time during commissioning by allowing the programmers to rough in your scenes prior to your arrival onsite.

On basic and intermediate projects using standard architectural lighting control systems, the BOD or Control Intent will ensure that the selected architectural lighting control system will perform as expected. The lighting controls manufacturer or programmers cannot claim that they were never informed of any complex control or programming requirements.

When we're working on an advanced project, I prefer to generate a Lighting Control Intent and a lighting control riser diagram to ensure that I've captured all control points and fixtures in my documents. I don't hesitate to write an additional narrative describing how the building is to operate over the course of the day, or describe all the animated color changing sequences that are required.

Don't get stuck in the weeds defining starting addresses for each fixture. Simply make sure to have enough data ports and addresses for the system, and the LSI will work through these details with you during the construction process.

When the LSI finally does receive the project, they can review the riser and the BOD and understand exactly what the design intent is. They'll usually have suggestions to improve the lighting control system or save costs—changes we can review and approve during the shop drawing process.

Be sure to include the Lighting Fixture Schedule, Equipment Schedules, and Control Intent in your contract documents to ensure that the lighting system will meet your expectations.

Conclusion

As the project moves into construction, all of the information we provided in the design documents should minimize questions from the field. By using the Basis of Design document to inform our design process, we methodically captured all the lighting requirements of each room before beginning the design. By evolving this into our Control Intent, we ensure that the lighting control system will perform to meet everyone's expectations. ■

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