Common Design Missteps

March 3, 2022
Architectural Design Review

Common Design Missteps

Jerry Phillips, RA
Our Vision...

- The State Construction Office is in a unique position of reviewing many diverse North Carolina construction projects and we have the time to focus intensely on a wide array of State Building Code and construction related issues. Our plan review process uses this broad body of knowledge to assist each project in becoming as successful as possible! For very large and complex projects it is typically a good idea to set up early meetings with the State Construction office to go over the key Building Code issues as they are being integrated into design decisions. Think of us as a resource and let us know how we can better serve you, our client!
The primary purpose of the required Appendix B is to concisely illustrate how a proposed project meets the NC State Building Code.

- This document becomes the starting point for all my plan reviews.
- Typically, new projects have better Appendix B’s. Existing projects often have improperly completed or incomplete Appendix B’s.
- This document, if properly completed, becomes an extremely important document for managing a building from cradle to grave and can serve as a tool to reduce the degradation of life safety systems over the life span of a building.
- All shareholders in a project should be well educated in the purpose and value of this document!
- Properly executed, it makes our job easier, and therefore expedites the review process.
• We experience the most issues with incomplete information on projects involving existing buildings.
• While we understand that certain parts of the Appendix B are not applicable, we still need any information that is relative to the scope of work!
• Even simple demolition and limited Level I Alterations typically impact wall, floor, and/or ceiling assemblies. As such, all contractors must know which assemblies are or which are not fire or smoke rated!

2022 State Construction Conference
• The primary purpose of the Life Safety Plan and sometimes the Life Safety Section is to graphically illustrate how a building is properly designed to meet the NC State Building Code requirements for egress from all parts of a building to the required exits.

• All spaces must be labeled for their use and occupant loads. Exit paths are then clearly shown including required fire-ratings, exit signage, door widths, corridor widths, stair widths, and even panic devices where required etc.

• If the plan is properly created, it can assist project engineers in making their job easier and more accurate because all parties can look at this plan and know various space occupant loads and how occupants could be using the various exits paths. This could impact everything from HVAC design heating and cooling loads to placement of emergency exit lighting and exit signs.

• The Life Safety Plan if done correctly can then become the basis upon which Emergency Evacuation Floor Plans can be created for posting in each building.

• When clearly shown and labeled, it again makes our job easier, and therefore expedites plan review!
Life Safety Plan

Load Factor
- 5.00 SF
- 15.00 SF
- 60.00 SF
- 100.00 SF
- 200.00 SF
- 300.00 SF

AREA/OCCUPANCY SCHEDULE - LEVEL 01

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Area Function</th>
<th>Area</th>
<th>Load Factor</th>
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<tr>
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<td>81.6' x 4'</td>
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<tr>
<td>EVENT DINING</td>
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Grand total: 20
Common Project Code issues...

• The following slides illustrate just a few of the types of construction concerns we see and building code issues we help identify and resolve...
Complexity & Simplification

- Sometimes it is possible to re-think a problem and look at it from a different perspective and achieve a better simpler solution.

- A change from separated Mixed Use to non-separated mixed use had a major impact on this project!
By the architect’s decision to change from separated mixed use to non-separated mixed use, a fire wall and many fire rated assemblies were eliminated. Of course, this was not a simple change, but it made both the construction and plan review so much simpler and faster for all involved!
In today's world almost all projects are complex! This is an example of a project that includes multiple high rises, mixed uses, a complex site and complex geometries rotated upon each other. While interesting in concept, as much simplification as possible, especially early in a project is highly recommended!
Complexity & Apparent Contradiction

- Two critical 2018 NC State Building Code Sections:

  **1020.6 Corridor Continuity.**

  Fire-resistance-rated corridors shall be continuous from the point of entry to an exit, and shall not be interrupted by intervening rooms. Where the path of egress travel within a fire-resistance-rated corridor to the exit includes travel along unenclosed exit access stairways or ramps, the fire-resistance rating shall be continuous for the length of the stairway or ramp and for the length of the connecting corridor on the adjacent floor leading to the exit.

  **Exceptions:**
  1. Foyers, lobbies or reception rooms constructed as required for corridors shall not be construed as intervening rooms.
  2. Enclosed elevator lobbies as permitted by Item 1 of Section 1016.2 shall not be construed as intervening rooms.
  3. A toilet room, as defined by the North Carolina Plumbing Code, that meets all of the following requirements may be included as part of the rated corridor enclosure:
     3.1 The toilet room shall be separated from the remainder of the building by fire-resistant rated construction meeting the same requirements as the corridor construction.
     3.2 No other rooms are open off of the toilet room.
     3.3 No gas or electric appliances other than electric point-of-use water heaters and hand dryers are located in the toilet room; and
     3.4 The toilet room is not used for any other purpose.

  **1016.2 Egress through Intervening Spaces.**

  Egress through intervening spaces shall comply with this section.

  1. Exit access through an enclosed elevator lobby is permitted. Access to not less than one of the required exits shall be provided without travel through the enclosed elevator lobbies required by Section 3006. Where the path of exit access travel passes through an enclosed elevator lobby, the level of protection required for the enclosed elevator lobby is not required to be extended to the exit unless direct access to an exit is required by other sections of this code.

  2. Egress from a room or space shall not pass through adjoining or intervening rooms or areas, except where such adjoining rooms or areas and the area served are accessory to one or the other, are not a Group H occupancy and provide a discernible path of egress travel to an exit.

     **Exception: Means of egress** are not prohibited through adjoining or intervening rooms or spaces in a Group H, S or F occupancy where the adjoining or intervening rooms or spaces are the same or a lesser hazard occupancy group.

  3. An exit access shall not pass through a room that can be locked to prevent egress.

  4. Means of egress from dwelling units or sleeping areas shall not lead through other sleeping areas, toilet rooms or bathrooms.

  5. Egress shall not pass through kitchens, storage rooms, closets or spaces used for similar purposes.
The solution for this dormitory was to:
- Allow one exit to pass through an elevator lobby and the other exit to be fully continuous.
- Provide multiple doors to achieve exit passage where at least one door swings with the flow of travel.
- Isolate the center kitchen area from the exit path with a fire rated barrier.
Complexity & Apparent Contradiction

• The 2015 International Building Code Commentary:

• Diagrams that clarify this apparent Code Contradiction and create certain design opportunities as shown in many dormitory designs.
Civil/Structural Design Review

Common Design Missteps

Md Aviquzzaman, PE
Introduction:

• Fire protection for Structural Supports
• Floodplain Development Permits
• Eccentricity
• Delegated Design
Fire protection for Structural Supports
Fire protection for Structural Supports

- Architects determine the fire requirements for structural members in the Appendix B.
- What falls on structural engineer’s shoulder?
- Deep Understanding of the UL (Underwriters Laboratories) standards.
The structural Engineer of Record must review and understand the requirements of the third-party listings.

Third-party listings will help avoid gaps and omissions in the overall building design; like limiting beam spacings and deck gauge.

UL listing indicating that deck spans are limited for “unrestrained assembly ratings”.

The **Unrestrained Assembly Rating** is equal to the Unrestrained Beam Rating for a max of 3 Hr. and is limited to the following units and limitations:

(a) 1-1/2 in. deep, 24 or 36 in. wide, 22 MSG or thicker fluted with clear spans not more than 7 ft 8 in.
(b) 1-1/2 in. deep, 24 or 36 in. wide, 20 MSG or thicker fluted with clear spans not more than 8 ft 8 in.
(c) 1-1/2 in. deep, 24 or 36 in. wide, 16 MSG or thicker fluted and 18/18 MSG or thicker cellular with clear spans not more than 9 ft 11 in.
(d) 3 in. deep, 36 in. wide, 18 MSG or thicker fluted and 24 in. wide, 20/18 MSG or thicker cellular with clear spans not more than 13 ft 2 in.
Part 703.2.3 of the NCBC: Fire-resistance-rated assemblies tested under ASTM E119 or UL 263 shall not be considered to be retrained unless evidence satisfactory to the building official is furnished by the registered design professional showing that the construction qualifies for a restrained classification in accordance with ASTM E119 or UL 263. Restrained construction shall be identified on the construction documents.

- Include the “restrained” or “unrestrained” language in Section 078100 (Applied Fireproofing) of the project specification to avoid confusion and construction disputes

- Unrestrained assemblies require greater applied fireproofing thicknesses than restrained
**Fire Protection of Structural Steel**

- An example of UL listing for a composite floor assembly
- The circled note indicates the design was evaluated using a load design method other than limit states design

**Design No. D916**
December 10, 2021

- Restrained Assembly Ratings — 3/4, 1, 1-1/2, 2 or 3 Hr. (See Items 1, 6, 7, 8 and 11)
- Unrestrained Assembly Rating — 3 Hr. (See Items 3, 4 and 4A)
- Unrestrained Beam Rating — 1, 1-1/2, 2 and 3 Hr.

- This design was evaluated using a load design method other than the Limit States Design Method. For jurisdictions employing the Limit States Design Method, such as Canada, a load restriction factor shall be used — See Guide BS5950 or AS5100.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

**Design No. D982**
October 21, 2016

- Restrained Assembly Rating - 2 Hr.
- Unrestrained Assembly Rating - 2 Hr.
- Unrestrained Beam Rating - 3 Hr.

- Loading Determined by Allowable Stress Design Method or Load and Resistance Factor Design Method published by the American Institute of Steel Construction, or in accordance with the relevant Limit State Design provisions of Part 4 of the National Building Code of Canada.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

- Another example UL listing
- The circled note indicates that loading was determined by allowable stress design method or load and resistance factor design method

- Differing testing conditions affect the steel design in certain situations.
Fire Protection of Structural Steel

• AISC, AISI and UL conducted a collaborative study several years ago where restrained and unrestrained assemblies, historically tested using working stress methods, where reevaluated using limit states procedures, or in other words, AISC’s LRFD and post-2005 ASD.

• Beams evaluated using ASD & LRFD can endure higher loads than those originally assumed by the UL tests.

• In order to ensure performance in harmony with the original listing, it was determined that the load capacity of certain beams must be reduced.
Load restriction factors for steel beams need not be applied to any UL Design that is based upon strength calculated using the 2005 or 2010 AISC Specification.

Load restriction factors for steel beams need not be applied to any other UL Design if an unrestrained beam rating is used.

Load restriction factors for steel beams need not be applied to any other UL Design if a 1-hour restrained beam rating is used.

When using a UL Design for which none of the foregoing conditions applies, a load restriction factor of 0.9 is applicable for both composite design and non-composite design in U.S. practice.
Part 707.5 of the NCBC state that fire barrier walls shall be supported by construction having an equivalent fire-resistance rating.

For Example: If a fire rated mechanical room or assembly is on third floor and architects specified 2-hr fire rated enclosure that means, all steel framing (beams, girders, and columns) directly supporting the room must achieve a 2-hour rating for their entire length.

The plans must define the extents of protection. There are times when this information is best shown on the structural drawings.
Executive Order 123 identifies the State Construction Office as the AHJ for Floodplain permitting.

Permitting Instructions found at https://ncadmin.nc.gov/businesses/construction/forms-documents

Two types of flood permits:
- Temporary flood plain permit
- Final flood plain permit
Floodplain Development Permits

- The Temporary Permit allows the project to go to bid but construction of the project should not begin until the Floodplain Development Permit Application is fully approved.

- Hard copies or electronic submittals accepted
Floodplain Development Permits

• Floodplain Development Permit Form
  • Should be submitted with CD
• Supporting Documents
  • Flood Insurance Rate Map (FIRM)
  • Site Plan showing extents of floodplain and note declaring involvement
  • Pertinent drawings and calculations
Floodplain Development Permits

• Considerations not covered by EO123:
  • ASCE24-14 Flood Design Class 4 – BFE +2ft or DFE, or 500-year flood elevation, whichever is higher.
  • Non-encroachment Zones – Portion of the floodplain where development may be prohibited due to its effects on the conveyance of discharge.
    • 44 CFR 60.3(c)(10) – “Required until a regulatory floodway is designated, that non new construction, substantial improvements, or other development shall be permitted within Zones A1-30 and AE on the community’s FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.
Floodplain Development Permits

- Considerations not covered by EO123:
  - LiMWA – Limit of Moderate Wave Action: IBC and ASCE24 require specific structural checks in Coastal A Zones.
Eccentricity

• Eccentricity on foundation – Specially for PEMB
  • Usually footing design doesn’t consider eccentricity in the calculation
Eccentricity

• In PEMB the foundation and superstructure are designed separately, sometimes what causes **significant eccentricity** on footing.

• As a result, **partial settlement and cracks** in the foundation **walls** occur.
Delegated Design

- **Memorandum 01262022** is available on the SCO website.
- **List of delegated systems** which can be delegated without question.
- Other systems are acceptable upon approval.
- **Delegated design** is not a complete delegation of responsibility.
- Shoring systems can be delegated, the EOR must define the need.
Mechanical, Energy, and Fire Protection Design Review

Common Design Missteps

Tom Galdi, PE
# Paths to Energy Code Compliance

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<tr>
<td>2018 NCECC</td>
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<td>ASHRAE 90.1-2013</td>
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<td>Comcheck</td>
<td>ASHRAE 90.1-2016 or ICC 2015</td>
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<tr>
<td>(401.2 other)</td>
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G.S. 143-135.37 Sustainable Energy Efficient Bldgs

- 30% Less Energy than ASHRAE 90.1-2004 Baseline.

- Amended for ‘Net Savings Required’ as determined by The Department.
ASHRAE

2004

4.5%

2007

18.2%

2010

7.6%

2013

27.8% less than 2004

ICC

2004

2009

2012

2015

NC

2012

2018

NC DOA
Where Are We With This?

HAND IN OR SUBMIT WHAT YOU DID DO, AND IT WILL BE OKAY.
Use ASHRAE 90.1-2013 as a compliance path.

- If performance path is used (Appendix G or ECB), submit compliance forms from the User’s manual that demonstrates compliance and where proposed design does not meet prescriptive requirements.
Fire Damper Access

“Approved Means of Access Large enough to permit inspection and maintenance”
Current ICC Wording

Fire and smoke dampers shall be provided with an approved means of access that is large enough to permit inspection and maintenance of the damper and its operating parts. Dampers equipped with fusible links, internal operators or both shall be provided with an access door that is not less than 12 inches (305 mm) square or provided with a removable duct section.

From 2021 ICC
Can exempt FD's in many situations in sprinklered bldgs. Use appropriate penetration detail.
Seismic for MEP and FP
SEISMIC DESIGN CATEGORY

• SDC
  • ‘A’ – Seismic Restraints Not Required
  • ‘B’ – Seismic Restraints Not Required
  • ‘C’ – Seismic Design Needed for Systems/Equipment Importance Factor > 1
  • ‘D’ – Seismic Design Needed
Importance Factor = 1.0 – Exempt from seismic design package
Importance Factor = 1.5 – Seismic design package required

- Sprinkler systems
- Systems and Equipment with hazardous materials
- Systems in critical facilities (Hospitals, Emergency Response Operations etc.)
Obtain the services of an engineer licensed in the state of North Carolina to design seismic restraint systems and methods of anchorage to building structure. This shall include preparation of a quality assurance plan that includes special inspections per 1705.12 of the NC Building Code.

- Delegated Designs do not abdicate D.O.R. of overall responsibility
Sprinkler System Design in NC is delegated to the Fire Sprinkler Contractor. This work is still under the Designer of Record who is expected to verify installation per approved design drawings.
Sprinkler Seismic Bracing Issues

• Frequent Installation Findings:
  • Missing flexible couplings at locations required by NFPA 13.
  • Annular space missing around pipes at locations prescribed by NFPA 13.
  • Brace locations do not match shop drawings.
  • Brace angle does not match shop drawings.
  • Hanger retaining straps not installed.
  • Number of crimps on cable system not per manufacture specifications.
Standpipes to be Flow Tested

250 GPM per Outlet

100 psig

Witness by SCO and DOR

Automatic Standpipe (high rise) - can’t use pumper truck

Manual Standpipe – supply can be portable pump or pumper truck.
Electrical Design Review

Common Design Missteps

Joshua Sartin, PE and Isaac Loydpierson, PE
Emergency Lighting

• Normal Power
  • NCSBC 1008.2 – The means of egress serving a room or space shall be illuminated at all times that the room or space is occupied
  • NCSBC 1008.2.1 – “The means of egress illumination shall not be less than 1 footcandle (11 lux) at the walking surface.”

• NCSBC 1008.3.1, 1008.3.2, 1008.3.3 requires Emergency Illumination in the listed areas regardless if the space is unoccupied. Automatic lighting controls shall not prevent emergency power from illuminating fixtures.
Emergency Lighting

- **NEC 700.16(B)** – Failure of any illumination source cannot leave an area in complete darkness.

- **NEC 700.17** – No single branch circuit failure shall leave an area in complete darkness.

*Not all acceptable solutions are shown*
Panel Labeling

- **NEC 408.4(A)** – The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others.
Panel Labeling

- Require Available Fault Current to be field marked on
  - All switchgear, switchboards, and panelboards (NEC 408.6)
  - Service equipment (NEC 110.24)
  - Elevator control panels (NEC 620.54(D)(2))
  - Motor control centers (NEC 430.99)
  - Industrial machinery (NEC 670.5)
  - Automatic transfer switches (NEC 700.5(E), 701.5(D), 702.5 (C))
Panel Labeling

- Must include:
  - Source of supply (NEC 408.4(B))
  - Panel Voltage
  - Arc flash hazard warning (NEC 110.16(A))
Service Disconnect Labeling

• Multiple Service Sources
  • Identify alternative sources per NEC 700.7(A), 701.7(A), 702.7(A).

• Identify all other service locations per NEC 230.2(E) and 225.37
Existing Loads

- 2019 State Construction Manual Section 507 (C)(7)(i)(3) requires electrical drawings to show estimated load summary, connected loads, demand loads, and demand factors on DD submittals and after.

- If load is added, provide calculated or measured loads for existing and calculated load for new.

- If new breakers are added confirm physical space is available within existing panels. New breakers must match existing AIC ratings of existing panels.
## Existing Loads

*Unacceptable (existing loads are not included in calculation)*

### Table

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<th>Description</th>
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<td>MC</td>
<td>(R) Receptacles</td>
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<td>4.32 kW 100% 4.32 kW</td>
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<td>0.10 kW 100% 0.10 kW</td>
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<td>Kitchen Equip</td>
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**Total:** 4.32 kW 100% 4.32 kW

**Notes:**
- **Phase A:** 0.700 kW 118.9 A 6.0 AMP
- **Phase B:** 1.600 kW 118.9 A 6.0 AMP
- **Phase C:** 1.980 kW 118.9 A 6.0 AMP
Existing Loads

- Acceptable

### Existing Panel HRD-9 Load Summary

**Load Removed by This Project:**
- EX. Water Heater WH-1: 504 VA

**Total Load Removed:** 504 VA

**Load Added by This Project:**
- (6) New Water Heaters: 6 @ 200 VA

**Total Load Added:** 1200 VA

**Net Load Added for This Project:** 696 VA (1.9A)

**Per Record Drawings and Field Investigation,**
70A/3P MCB Panel HRD-9 Connected Load Is 13.9A,
New Connected Load Increases to 15.8A at 208V/3-Phase.

100A/3P MCB Panel HRC Feeds HRD, and Connected Load is 30.5A.
New Connected Load Increases to 32.4A at 208V/3-Phase.

Removal of Tank Circulator RCP-2 Reduces 600A MCC4D Connected Load by 1.5A @ 480V/3-Phase.

### 1 Phase 3 Wire Flush Mounted

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<table>
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**Total Connected KVA:** 12.7

**Demand KVA:** 6.3

**Panel RMS Sym. Amps:** 22,000

**Demand Amps:** 29.3

* Refer to Dwelling Load Demand Calc
Residence Hall Smoke Detection

- SCO Fire Alarm Guidelines have been updated, reference Part 3 (9)(e).
- Any initiation device in common areas actuates the building-wide alarm.
- One initiation device in sleeping or dwelling unit shall actuate the alarm within that unit (sleeping room(s) and associated suite, pre-signal the FACP, and transmit alarm signal to supervising station to dispatch the Fire Department.
- More than one initiation device in any sleeping or dwelling unit (within the same unit or another) shall actuate the building-wide alarm.
- Low frequency sounder bases are required in all sleeping areas (NFPA 72 18.4.5.3).
NC General Statutes 66-23 thru 25 requires all electrical materials, devices, appliances, and equipment to be evaluated for safety and suitability for intended use.

Products must be listed and labeled by an NC DOI approved third-party testing agency.

NEC 110.3(B) requires using equipment in accordance with the instructions of the listing.

https://www.ncosfm.gov/codes/state-electrical-division/qualified-testing-laboratories

2022 State Construction Conference
Referenced Standards

• NCSBC (or NCBC) – 2018 North Carolina State Building Code
• NEC – 2020 National Electric Code (NFPA 70)
• NFPA 72 – 2013 edition of NFPA 72
• SCO Fire Alarm Guidelines – 2020 State Construction Office Fire Alarm Guidelines and Policies (RV1)
• ICC – International Code Council
• AISC – American Institute of Steel Construction
• AISI – American Iron and Steel Institute
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