Fire-Resistance,

Tony Crimi, AC Consulting Solutions
Bill Koffel, Koffel Associates
Bill McHugh, NFCA Technical Director
Rich Walke, CTI, consultant to NFCA

Info@NFCA-Online.org

National Fireproofing Contractors Association

NFCA FREE
Webinar Series

Learn –
Network Grow

Thanks Members…

- NFCA Contractors
- NFCA Associates
- NFCA Manufacturers

Thanks 2025 NFCA Board of Directors

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What Does NFCA Provide?

National Fireproofing Contractors Association

- **Fireproofing Education & Exams**
  - World-Class SFRM & IFRM Fireproofing Instruction
- **NFCA Contractor Accreditation Program for IFRM & SFRM**
  - Educated fireproofing Companies – UL QFCP
- **Week of Learning - Educational Conference**
  - Network with top Fireproofing Contractors, Manufacturers, Associates
  - A forum for suppliers and contractors to learn from one another

- **NFCA 100-400 Standards** for quality and life safety
- **NFCA Handbook of Fireproofing Knowledge**
- **NFCA Website** to find Fireproofing Leaders – www.NFCA-online.org
- **Technical expertise, Standards and Code development….**

What does NFCA Do?

- NFCA @ ASTM Task Groups - Fireproofing
- NFCA @ NFPA Fire Protection Features
- NFCA @ AISC, AISI, CSI/CSC
- NFCA @ National Codes, Canada – NBCC, NFCC
- NFCA @ American Institute of Steel Construction (AISC)
- Industry Articles
- NFCA @ SFPE/ASCE Meetings
- NFCA Committee ACTIONS
- NFCA International Efforts
  - Middle East
  - Mexico
  - India
  - More…

CSI NATIONAL CONFERENCE 2024

2024 INTERNATIONAL CODE COUNCIL CONFERENCE EXPO+HEARINGS

ASTM INTERNATIONAL

AMERICAN INSTITUTE OF STEEL CONSTRUCTION AISC FOUNDED 1921

NFPA

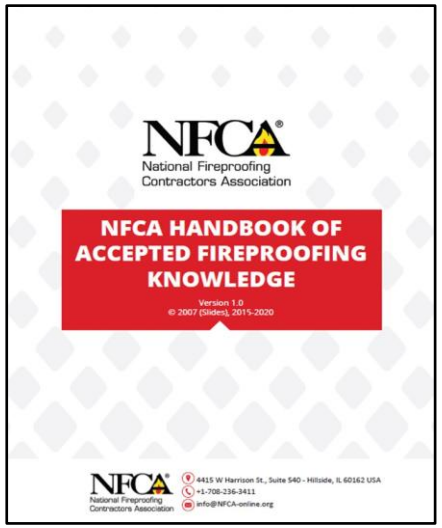
2027 Code Development Process (CDP) IBC, NFPA
2025/2030 CDP – NBCC, NFCC

Bill McHugh, Technical Director, NFCA
Rich Walke, Consultant to the NFCA

NFCA®
National Fireproofing Contractors Association

Contractor Qualifications – NFCA Contractor Accreditation Program (CAP)

- Contractor DRI's
- Inspection Agency Personnel
- Commitment to Fireproofing Installation
- NFCA Accreditation Seal - Registered mark



IFRM Accredited Contractor
NFCA®
National Fireproofing Contractors Association

SFRM Accredited Contractor
NFCA®
National Fireproofing Contractors Association

IFRM and SFRM Accredited Contractor
NFCA®
National Fireproofing Contractors Association

Contractor Qualifications – UL QFCP

- UL Qualified SFRM Fireproofing Contractors
  - NFCA Education
    - NFCA HAFK, DRI
    - UL Program Guide, Product iQ
  - NFCA SFRM Fireproofing Exam
  - Management System
  - UL Audits –
    - Office
    - Field

CERTIFIED
MANAGEMENT SYSTEM
QUALIFIED FIRESTOP CONTRACTOR

NFCA Educational Events

National Fireproofing Contractors Association

- NFCA/FCIA PasFiPro Canada Symposium
  - Members, Code Officials
- NFCA/FCIA PasFiPro Dubai, Doha
- NFCA @ Mexico LATAM/PCI
- NFCA's Week of Learning

NFCA – "Associate – Advocate" Fire & Life Safety

- Webinars, FSBI - Fire Safe Build India
- CSI – Construction Specifications Institute
- CSC – Construction Specifications Canada
- NFPA Expo & Committees
- ICC Expo & Hearings
- Dubai, UAE & Doha, Qatar
  & Riyadh, Saudi Arabia,
  Australia, New Zealand…
- ***Accreditation, Education, More…***

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Thanks for Attending!!!

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Glen Ellyn, IL 60137
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Fire-Resistance Basis – Rich & Tony

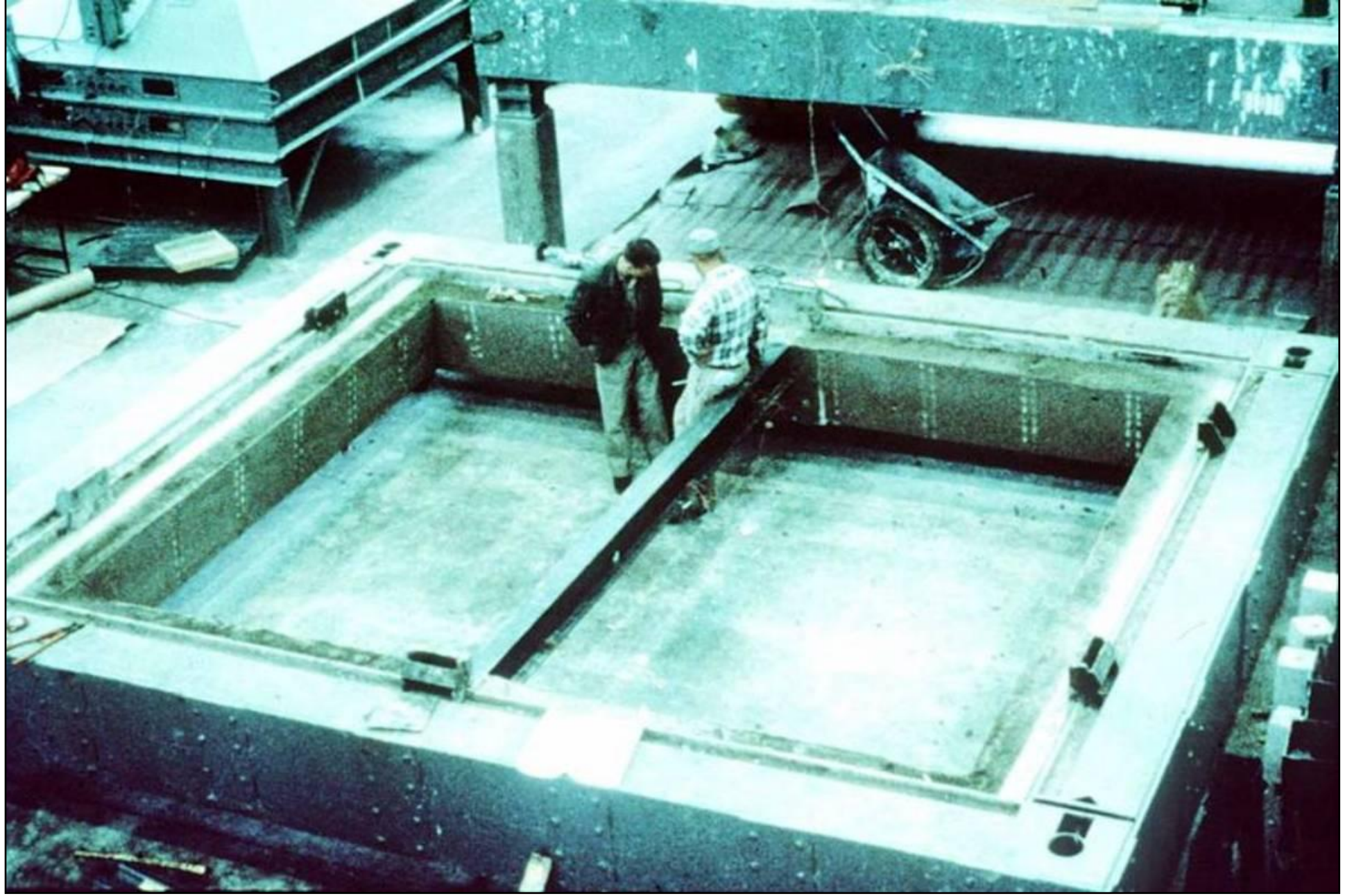
- How is Fire-Resistance Determined? Fire Test Standards
  - ASTM E119
  - UL 263
  - ULC-S101
  - ISO Standards
- Standard Time Temperature Curves, Worldwide
- Restrained/Unrestrained
- Loading – Fully? Partial? When and Where?

How is Fire Resistance Determined Standards

- US Based
  - ASTM E119
  - NFPA 251 (Withdrawn)
  - UL 263
- Canadian Based
  - ULC-S101

Floor/Ceiling or Roof/Ceilings

- Sample size – 180 sq ft / 12 ft
- Load applied – Per design



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Conditions of Acceptance
Floor/Ceilings or Roof/Ceilings

- Flame passage
- 250ºF / 325ºF
- Temperatures of supporting construction – Relates to Unrestrained Rating
- Support load – Relates to Restrained Rating

Time-Temperature Curves in World Wide Fire Test Standards

- Cellulosic
  - ASTM E119
  - UL 263
  - NFPA 251(withdrawn)
  - CAN/ULC-S101
  - BS 476 Cellulosic (ISO 834)
- Hydrocarbon
  - UL 1709
  - ASTM E1529

North American Based Cellulosic Fire Test Standards

- ASTM E119 / UL 263 / ULC-S101 represents a cellulosic fire
- Simulates a cellulosic fire in office buildings, hospitals, schools, etc.
- Furnace temperature reaches 2000°F over the course of 4 hours

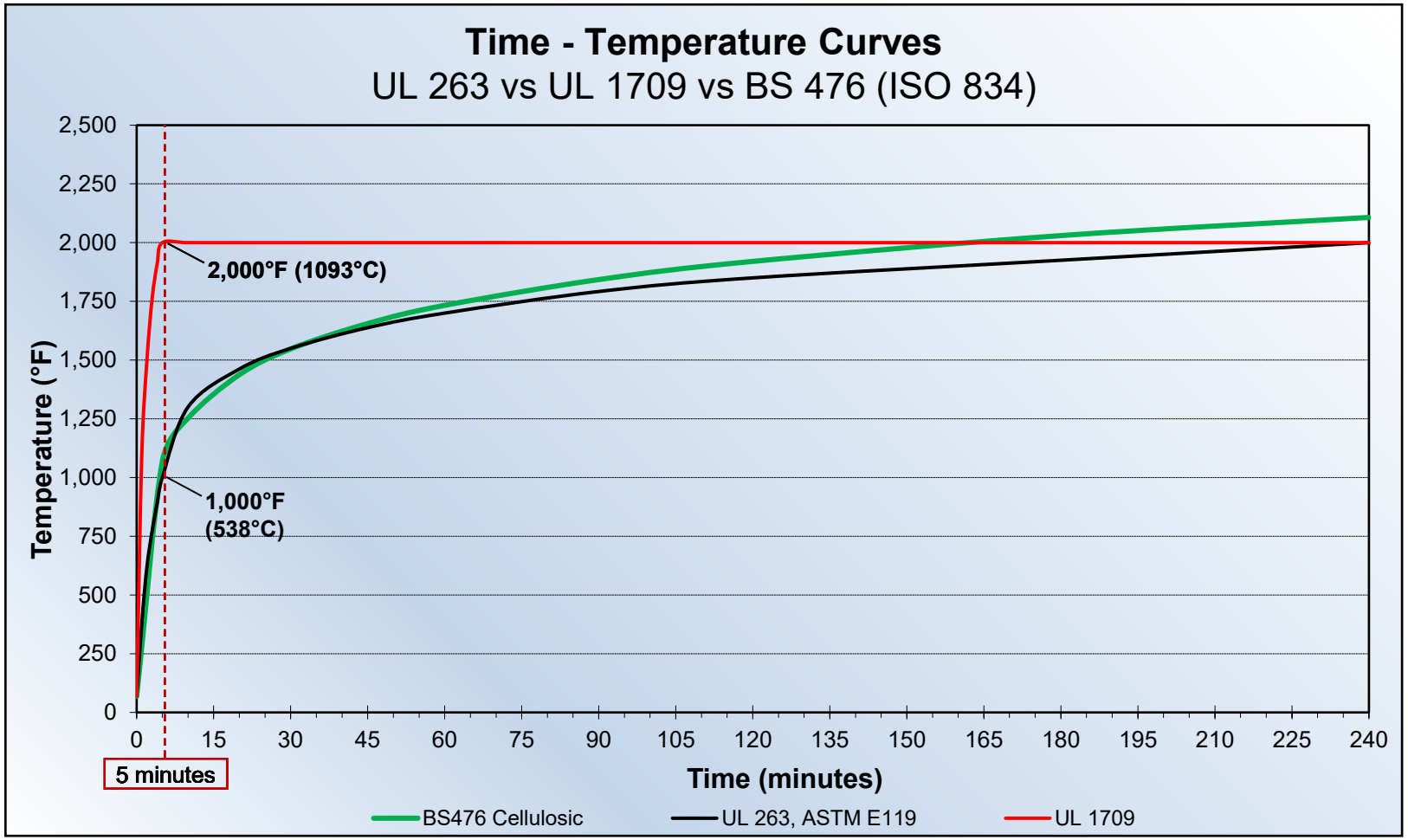
Non-North American Based Cellulosic Fire Test Standards

- BS 476 Cellulosic / ISO 834 represent a cellulosic fire
- Simulates a cellulosic fire in office buildings, hospitals, schools, etc.
- Furnace temperature reaches 1153°C (2106°F) over the course of 4 hours

North American Based Hydrocarbon Fire Test Standards

- UL 1709 (ASTM E1529) represents a rapid temperature rise hydrocarbon fire
- Simulates a hydrocarbon fire in refineries, petrochemical plants, etc.
- Furnace temperature reaches 2000°F in first 5 minutes and maintains this temperature throughout the duration of test

Global Time – Temperature Curves



UL 263 / ASTM E119
Cellulosic
- Office buildings
- Hospitals
- Schools

UL 1709 / ASTM E1529
Hydrocarbon
- Oil refineries
- Petrochemical plants

BS 476 / ISO 834
Cellulosic
- Office buildings
- Hospitals
- Schools

Restrained vs Unrestrained Ratings What's the Difference??

- Debate began in the 60's when it was observed that test assemblies maintained their structural integrity long after temperatures of the structural elements suggested the assemblies should have collapsed.
- Research ultimately suggested the restrained test condition was the reason.

Restrained vs Unrestrained Ratings What's the Difference??

- Standards writing organizations (ASTM, NFPA and UL) updated the fire resistance standards to differentiate restrained vs unrestrained ratings in the early 1970s.
  - ASTM E119 revised in 1971
  - UL 263 revised on January 15, 1971
- UL updated their designs to differentiate Restrained vs Unrestrained Ratings with the 1972 Fire Resistance Index (early name of Fire Resistance Directory).

Fire Test Methods

- ASTM E119, UL 263 & ULC-S101 – “Fire Tests of Building Construction and Materials”
  - Fire tests can be conducted either with the assembly restrained or unrestrained
  - Most tests are conducted with assembly restrained
  - Restrained test will generate a restrained assembly rating, an unrestrained assembly rating and an unrestrained beam rating. The unrestrained ratings are generally governed by the 1100°F / 1300°F average steel temperature limitations.

Fire Test Methods

- From restrained fire tests…
  - Conditions of acceptance for restrained rating
    - No flaming on unexposed side sufficient to ignite cotton waste
    - Max ave unexposed temp rise of 250°F and max individual unexposed temp rise of 325°F
    - Support applied load
    - Max ave beam temperature of 1100°F and max individual beam temperature of 1300°F for greater of 1 hr or 1/2 of rating period

Fire Test Methods

- From restrained fire tests…
  - Conditions of acceptance for unrestrained ratings
    - Essentially the same as for a restrained rating, except the beam limiting temperature criteria applies for the full rating period

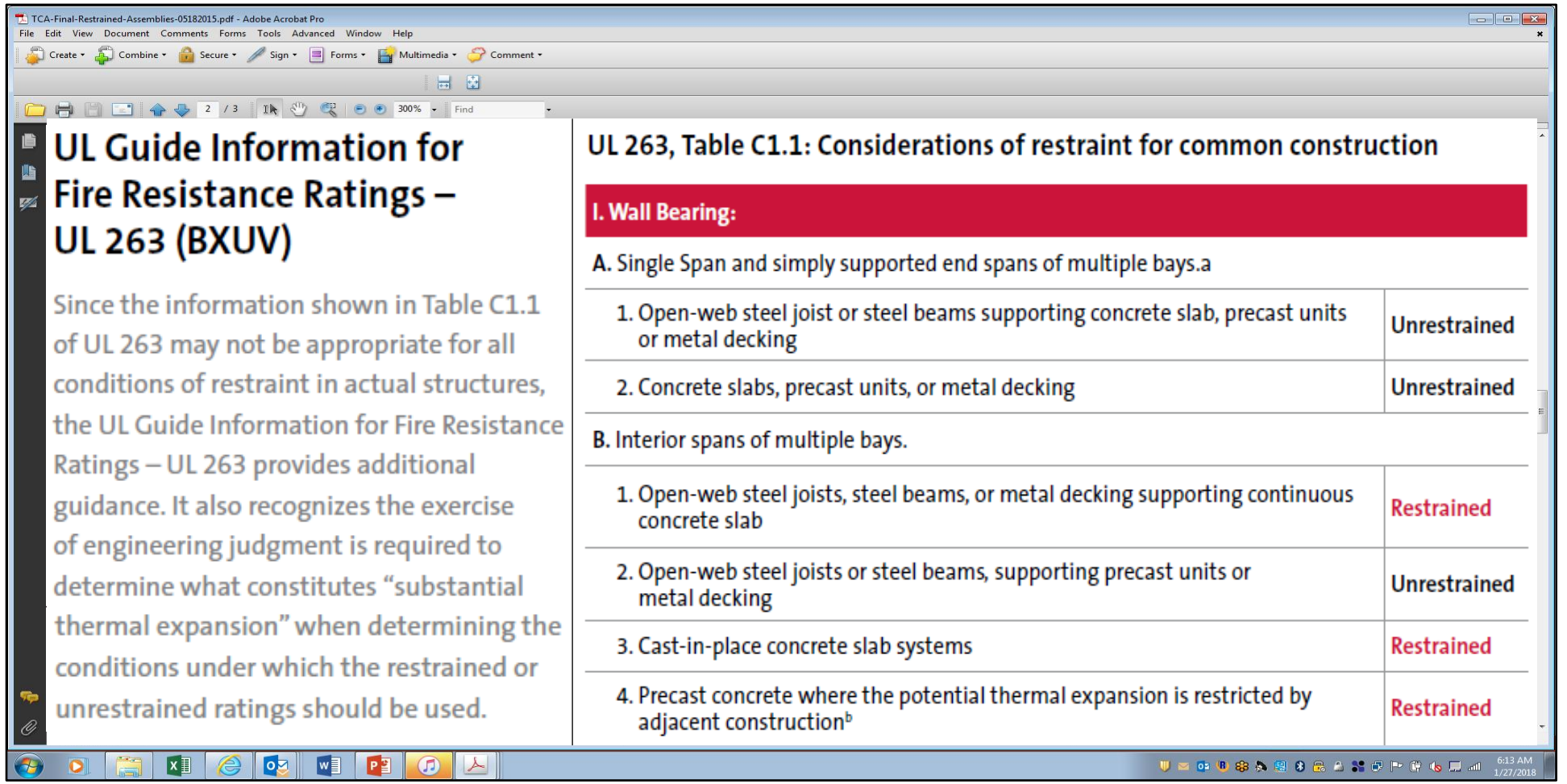
The Code Perspective

- **703.2.1.3 in the 2024 IBC – "Restrained classification.** Fire-resistance-rated assemblies tested under ASTM E119 or UL 263 shall not be considered to be restrained 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*."

Determining the Condition of Restraint in Buildings

- Two Methods of determining Restraint
  1. Appendices of ASTM E119 and UL 263 provide guidance for determining the condition of thermal restraint in buildings
     - CAN/ULC-S101 does not provides similar guidance
  2. Structural engineers can calculate the relative stiffness of the surrounding structure and compare it to the stiffness of the UL test frames
     - UL publishes the stiffness of the test frames as a point of comparison
       - GREATER STIFFNESS THAN THE UL TEST FRAME = RESTRAINED
       - LESS STIFFNESS = UNRESTRAINED

Appendices to the Standards



Stiffness of Test Frame

- Stiffness of UL test frames is 850,000 kip-in and 700,000 kip-in along the 14 ft and the 17 ft sides, respectively
- If the estimate stiffness exceeds these values then a case can be made that the assembly be considered thermally restrained

Partially Loaded Test Assemblies

- Both ASTM E119 and UL 263 allow assemblies to be loaded to something less than the full design capacity
- Section 10.3.1 of UL 263 permits an applied load less than the maximum. Such tests shall be identified in the test report as having been conducted under restricted-load conditions. The applied load, and the applied load expressed as a percentage of the maximum allowable design load, is to be included in the report.

Partially Loaded Test Assemblies

Good Idea?
Bad Idea?

Listing Below from a Nationally Recognized Test Laboratory

Unrestrained Beam
ASTM E119/UL 263
CAN/ULC-S101

Restricted Load: Maximum 75% of Design Load
Assembly Rating: Unrestrained, See Table…..

Safe?
Code Compliant?
Design Professional/AHJ Approval under IBC 104.11 (IBC 104.2.3 post 2024)

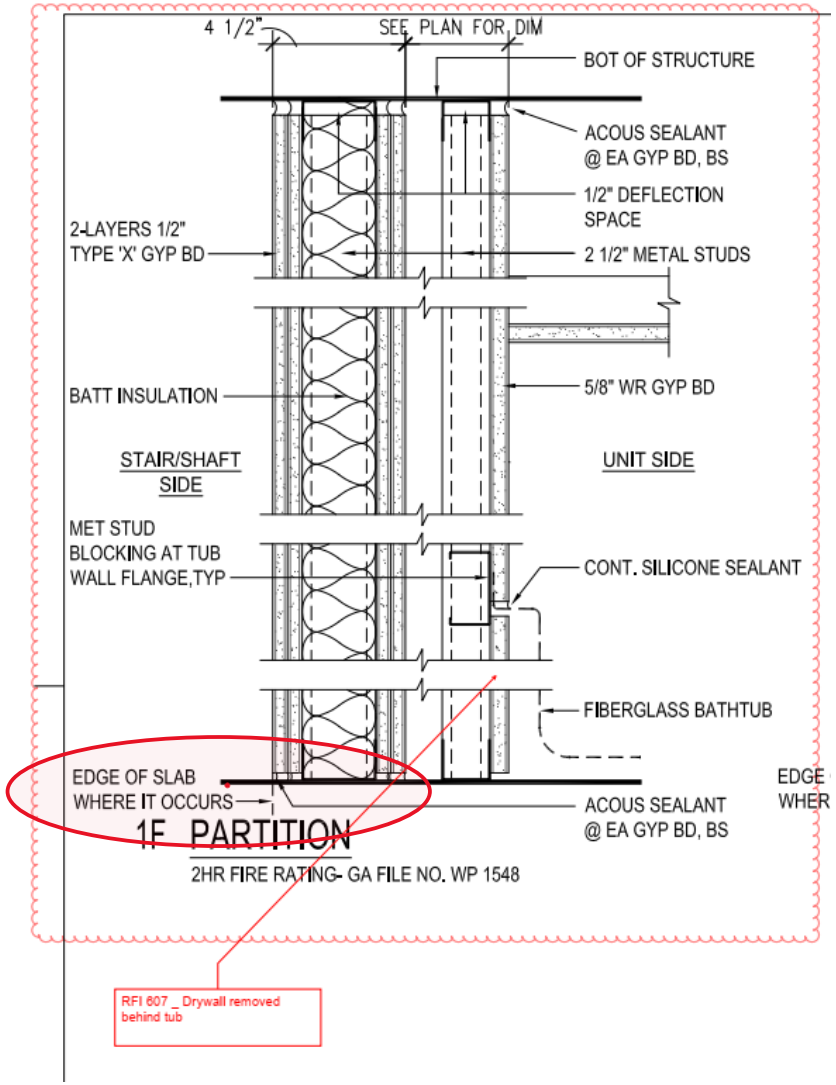
Fire-Resistance Continuity – Bill Koffel

- Fire-Resistance Continuity
  - Fundamental Requirement – In most cases, fire resistance-rated construction must be supported by construction having an equivalent or greater fire resistance rating

704.1.1 Supporting construction.
The *fire-resistance ratings* of supporting structural members and assemblies shall be not less than the ratings required for the fire-resistance-rated assemblies supported by the structural members.
Exception: Structural members and assemblies that support fire barriers, fire partitions, *smoke barriers* and horizontal assemblies as provided in Sections 707.5, 708.4, 709.4 and 711.2, respectively. (IBC 2024)

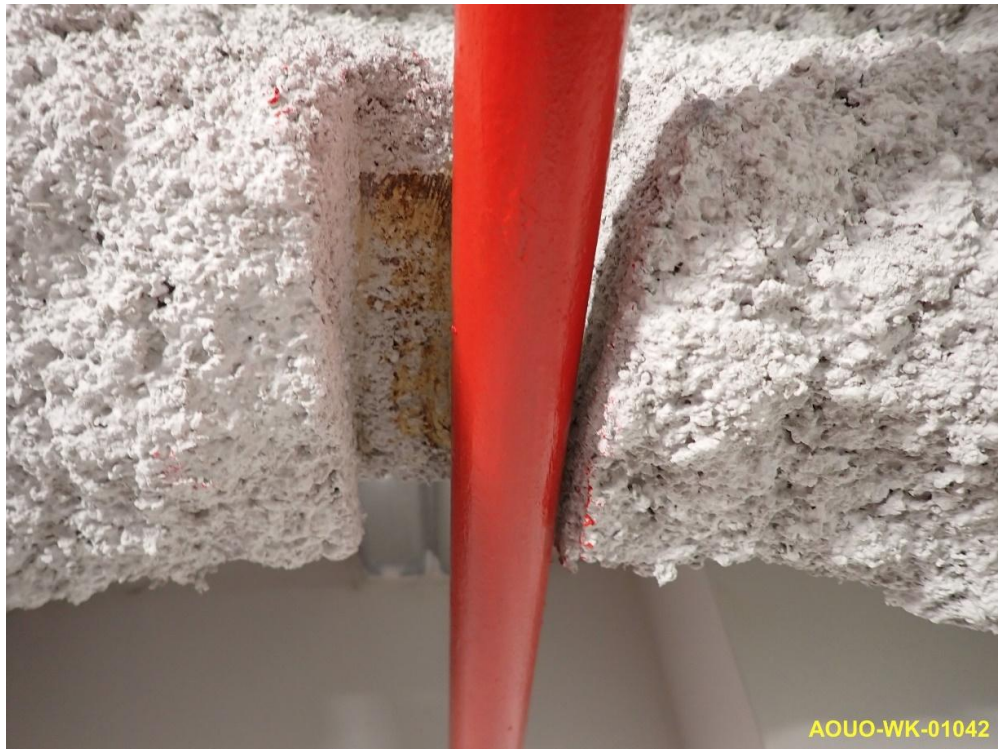
NFPA approach is different but similar in many respects

Fire Resistance Continuity Issues



Fire-Resistance Continuity Issues – Bill Koffel

- How far is far enough?
  - Entire horizontal assembly
  - One bay plus
  - One bay
  - It depends
    - Horizontal exit
    - Occupancy separation fire barrier
    - Structural analysis



Fire-Resistance Issues – Bill Koffel

Secondary Attachments

704.6.1 Secondary attachments to structural members.

Where primary and secondary structural steel members require fire protection, **secondary steel attachments to those structural members** shall be protected with the same fire-resistive material and thickness as required for the structural member. The protection shall extend away from the structural member a distance of not less than 12 inches (305 mm), or shall be applied to the entire length where the attachment is less than 12 inches (305 mm) long. Where an attachment is hollow and the ends are open, the fire-resistive material and thickness shall be applied to both exterior and interior of the hollow steel attachment. **(IBC 2021)**

704.5.1 Secondary attachments to structural members.

Where primary and secondary structural steel members require fire protection, **any additional structural steel members** having direct connection to the primary structural frame or secondary structural members shall be protected with the same fire-resistive material and thickness as required for the structural member. The protection shall extend away from the structural member a distance of not less than 12 inches (305 mm), or shall be applied to the entire length where the attachment is less than 12 inches (305 mm) long. Where an attachment is hollow and the ends are open, the fire-resistive material and thickness shall be applied to both exterior and interior of the hollow steel attachment. **(IBC 2024)**

Fire-Resistance Issues – Rich Walke

- Fire Resistance Continuity
  - Multiple materials, same structural building element? Mixing boards / SFRM / IFRM??
  - Can a wall be used on one side of column for fireproofing?
  - Bond Strength based on heights – Just those floors or whole building?
    - Occupiable floor or occupiable roof 0-75’ higher than lowest fire department access
    - 75’-420’
    - 420’ ++

Multiple Materials on Same Structural Building Element?

- Mixing Boards / SFRM / IFRM
  - Examples
    - Boards on beam, IFRM on columns, SFRM on deck, all on same structure, or
    - High-density SFRM on lower 8 ft column and low-density at higher elevations
  - UL's BXUV Guide Info, including the limitations on the use of the beam substitution equation, is silent on this concept
  - Manufacturers freely promote the concept
  - Good idea, bad idea?

Use of Wall on One Side of Column as Fireproofing?

- Hypothetical Scenario
  - Column is either in contact with a rated CMU wall, or located in close proximity to the wall obstructing the ability to protect the fourth side of the column. Can the wall be considered as part of the fire protection of the column?
  - Should testing of this type of construction be factored into ASTM E119 / UL 263

Bond Strength Based on Building Heights

- IBC Section 1705.6 (Special Inspections) states the bond strength of cured SFRM shall not be less than 150 psf
- IBC Table 403.2.3 (High-Rise Buildings) states the bond strength shall be min 430 psf for buildings up to 420 ft in height and min 1000 psf for buildings greater than 420 ft
- This sets up three tier approach

Height of Building	SFRM Minimum Bond Strength
Buildings up to 75 ft in height	150 psf
Buildings greater than 75 ft and up to 420 ft	430 psf
Buildings greater than 420 ft in height	1000 psf

Bond Strength Based on Building Heights

- Question:
  - For a “Super High-Rise” building greater than 420 ft in height must the entire building be protected with a material having a min bond strength of min 430 psf, or can the lowest 75 ft be be protected with a material having a min bond of 150 ft, the intermediate levels with a material having a min bond strength of 430 psf and the upper levels with a material having a min bond strength of 1000 psf?

Fire-Resistance Issues – Bill/Tony

- Fire-Resistance & Thermal Barriers
  - Fireproofing installed over Insulation for hourly ratings??
  - Insulation Installed over Fireproofing??
  - What's the proof?
  - ASTM E119/UL 263 Fire-Resistance testing? Not yet

- Fireproofing used as Thermal Barriers?
  - SFRM/IFRM?
  - Canada

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