# ADVANCED PHENOLIC COMPOSITE TRANSIT VEHICLE FLOOR SYSTEMS:

# A REVIEW OF USA ROLLING STOCK VEHICLE FLOOR FIRE PLATFORM TESTING AND RELATED PASSENGER SAFETY FIRE PROTECTION


OCTOBER 24, 2012

# Our Discussion Today:

- The Rolling Stock Floor Fire Platform Testing (ASTM E-119/NFPA 130) & Fire Materials Testing discussed and presented here today has originated from our work with actual passenger railcar floor projects that we have delivered to various global customers.
- All of the floor fire testing has been done under specific customer contracts, and all the actual ASTM E-119, ASTM E-162, ASTM E-662 & BSS 7239 tests were performed by independent outside accredited testing laboratories.

# Passengers Need Fire Safe Rolling Stock.

Superliner Car Fire Vehicle

Passenger Interior

Superliner Ceiling and
Related Interior Damage From Fire

Superliner
Interior Damage From Fire

***Worldwide Rolling Stock/Transit Authorities Are Growing More Concerned About Fire Safety…they want to make their cars much safer.***

# oway Fire in due to bway Car.

National Fire Protection Association NFPA 130, Standard for Fixed Guideway Transit & Passenger Rail Systems has been a benchmark in the United States providing the scope of a respected document that clearly covers life safety from a fire & fire protection requirement viewpoint. Full scale rolling stock/railcar floor fire platform testing is extremely important to truly validate passenger floor fire platform safety.



Without full scale floor platform fire endurance testing, our direct experience shows that carbuilders can make mistakes that may someday cause passenger injury from fire. The only true floor endurance validation of a modern day railcar floor assembly is through actual testing, not computer models or predictions. We will show you why our group feels so strongly about the need for NFPA 130 and all related flame, smoke and toxicity testing for flooring systems.

# ASTM E-119 Floor Fire Endurance Test Simulates a Fire Source Beneath The Passenger Railcar


**Thirty (30) Minute Duration is Intended to Allow for Fire Rescue of Trapped Passengers, Especially Within Tunnels**

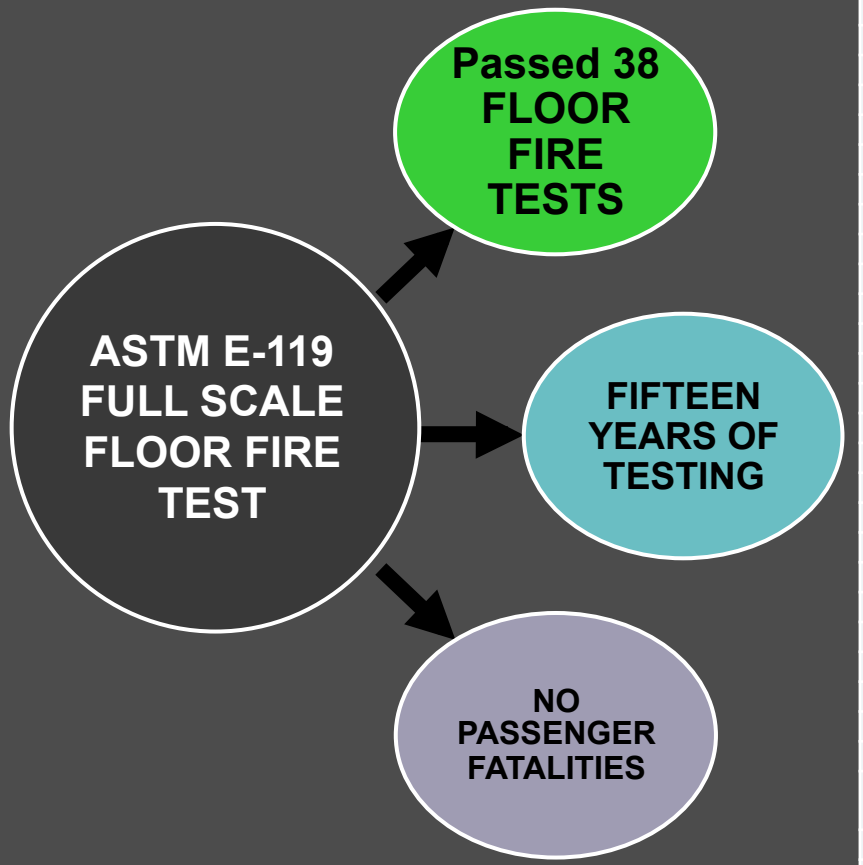
# Flame Spread, Smoke Density and Toxicity Testing Simulates Interior Car Fires.

Too much smoke causes poor interior visibility...difficult for passenger to egress.

High levels of Toxic Gas can kill people in minutes.

Rapid Flame Spread can cause death for passengers.

(SIMULATION)




ASTM E-119 (NFPA 130) FLOOR TEST RECORD

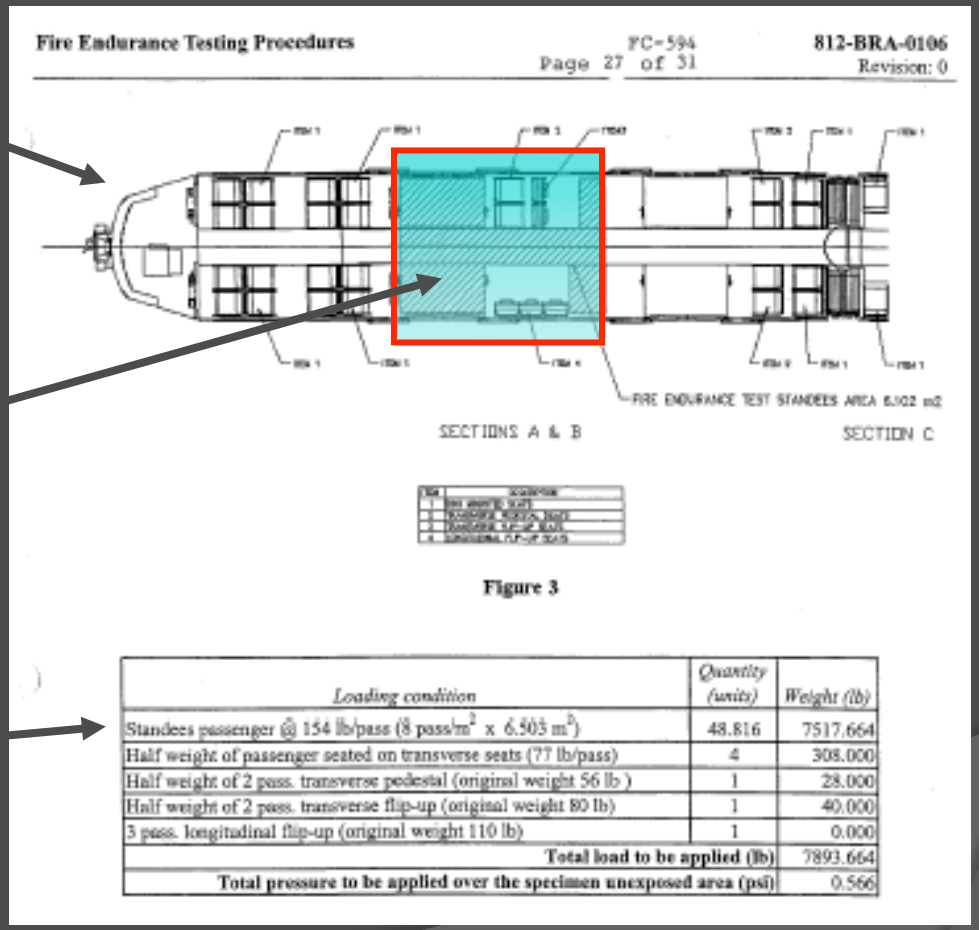
| TEST No. | YEAR TESTED | BUILDER | PROJECT |
|---|---|---|---|
| 1 | 1997 | Adtranz | SEPTA |
| 2 | 1999 | Siemens | Tren Urbano (Puerto Rico) |
| 3 | 2000 | Siemens | Denver V |
| 4 | 2001 | Bombardier | Hiawatha (Minneapolis) |
| 5 | 2002 | Siemens | Salt Lake City |
| 6 | 2003 | Alstom | WMATA 6000 |
| 7 | 2003 | Bombardier | Metro North |
| 8 | 2003 | Siemens | San Diego |
| 9 | 2004 | Colorado Railcar | SFRTA (South Florida) (bi-level) |
| 10 | 2004 | Siemens | Houston |
| 11 | 2005 | Bombardier | NJT-Bi Levels |
| 12 | 2005 | Nippon Sharyo | METRA Highliners (bi-level) |
| 13 | 2006 | Colorado Railcar | RMV (Northwest-USA) |
| 14 | 2006 | Kinkisharyo | Seattle, WA |
| 15 | 2006 | Changchun Railway | Beijing Metro & Beijing Airport |
| 16 | 2006 | Kinkisharyo | Phoenix, AZ |
| 17 | 2006 | Siemens | Denver VI |
| 18 | 2006 | Siemens | Charlotte |
| 19 | 2007 | Colorado Railcar | Tri-Met (Portland) Single Level DMU |
| 20 | 2007 | Hyundai-Rotem | SEPTA Silverliner V |
| 21 | 2007 | Nippon Sharyo | NICTD Highliners (bi-level) |
| 22 | 2007 | Siemens | Tri-Met (Portland) |
| 23 | 2008 | Alstom R-160 | NYCT R-160 (Option #1 ) |
| 24 | 2008 | Alstom R-160 | R-160 Project for NYCT |
| 25 | 2008 | Bombardier | NJT- Bi-Level Option Cars |
| 26 | 2008 | Bombardier | AMT Bi-Level Railcars |
| 27 | 2008 | Hyundai-Rotem | SCRRA (Los Angeles) |
| 28 | 2008 | Kawasaki | M-8 Vehicles |
| 29 | 2009 | BART | Overhaul of existing fleet flooring (multi-year project) |
| 30 | 2009 | Hyundai-Rotem | MBTA: OEM Bi-Levels |
| 31 | 2009 | Hyundai-Rotem | India - Bangalore |
| 32 | 2009 | Siemens | Salt Lake City IV Option Vehicles |
| 33 | 2009 | Siemens | Hampton Roads (Norfolk, VA) |
| 34 | 2009 | Siemens | Denver VII Option Vehicles |
| 35 | 2010 | BEML | India - Bangalore (consortium with Hyundai-Rotem) |
| 36 | 2011 | Siemens | San Diego |
| 37 | 2011 | United Streetcar | Portland and Tucson Streetcars |
| 38 | 2012 | Nippon Sharyo | SMART Project |

# ASTM E-119 Fire Endurance Test: Bombardier Hiawatha Floor Test (Minneapolis, MN)

**Test Requires Exact Carbody Underframe be simulated for the test.**

**Zone of railcar used for this test.**

**Passenger Load Density.**



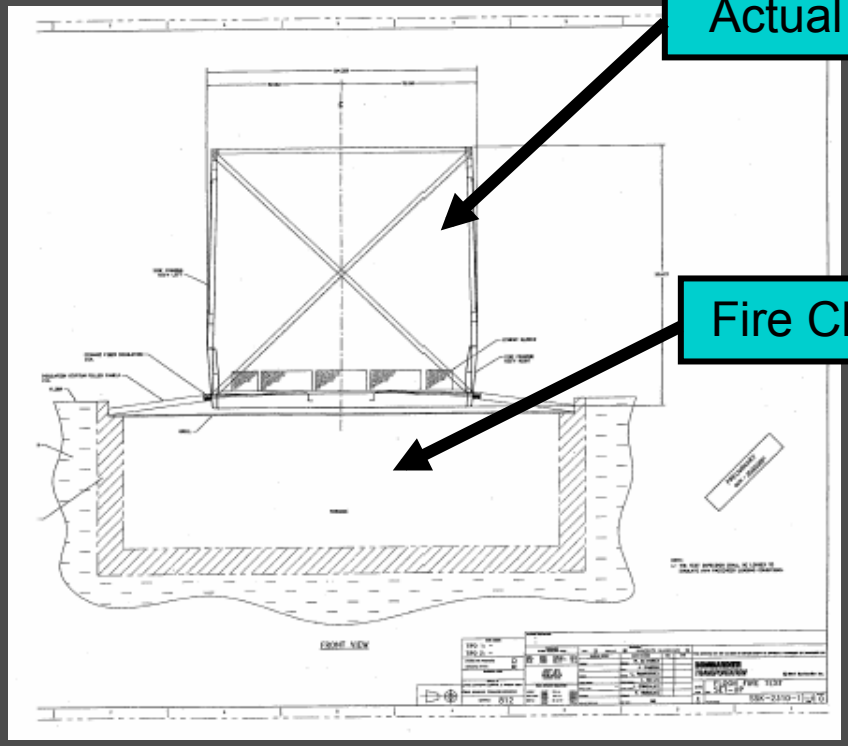
Fire Endurance Testing Procedures FC-594 812-BRA-0106
Page 27 of 31 Revision: 0

SECTIONS A & B SECTION C

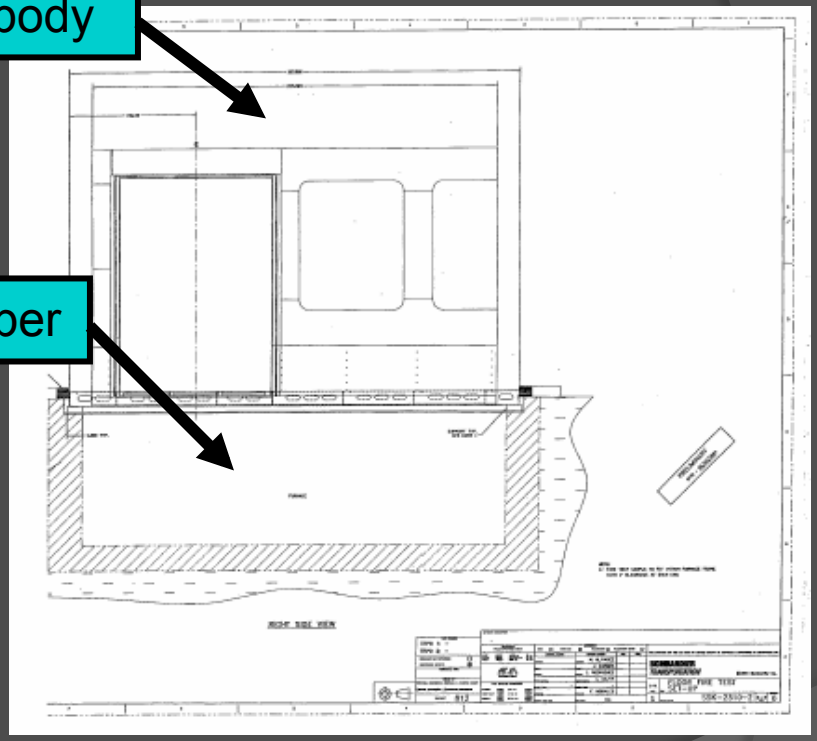
Figure 3

| *Loading condition* | *Quantity (units)* | *Weight (lb)* |
|---|---|---|
| Standees passenger @ 154 lb/pass (8 pass/m$^2$ x 6.503 m$^2$) | 48.816 | 7517.664 |
| Half weight of passenger seated on transverse seats (77 lb/pass) | 4 | 308.000 |
| Half weight of 2 pass. transverse pedestal (original weight 56 lb ) | 1 | 28.000 |
| Half weight of 2 pass. transverse flip-up (original weight 80 lb) | 1 | 40.000 |
| 3 pass. longitudinal flip-up (original weight 110 lb) | 1 | 0.000 |
| **Total load to be applied (lb)** | | 7893.664 |
| **Total pressure to be applied over the specimen unexposed area (psi)** | | 0.566 |


# ASTM E-119 Fire Endurance Test: Bombardier Hiawatha Floor Test (Minneapolis, MN)

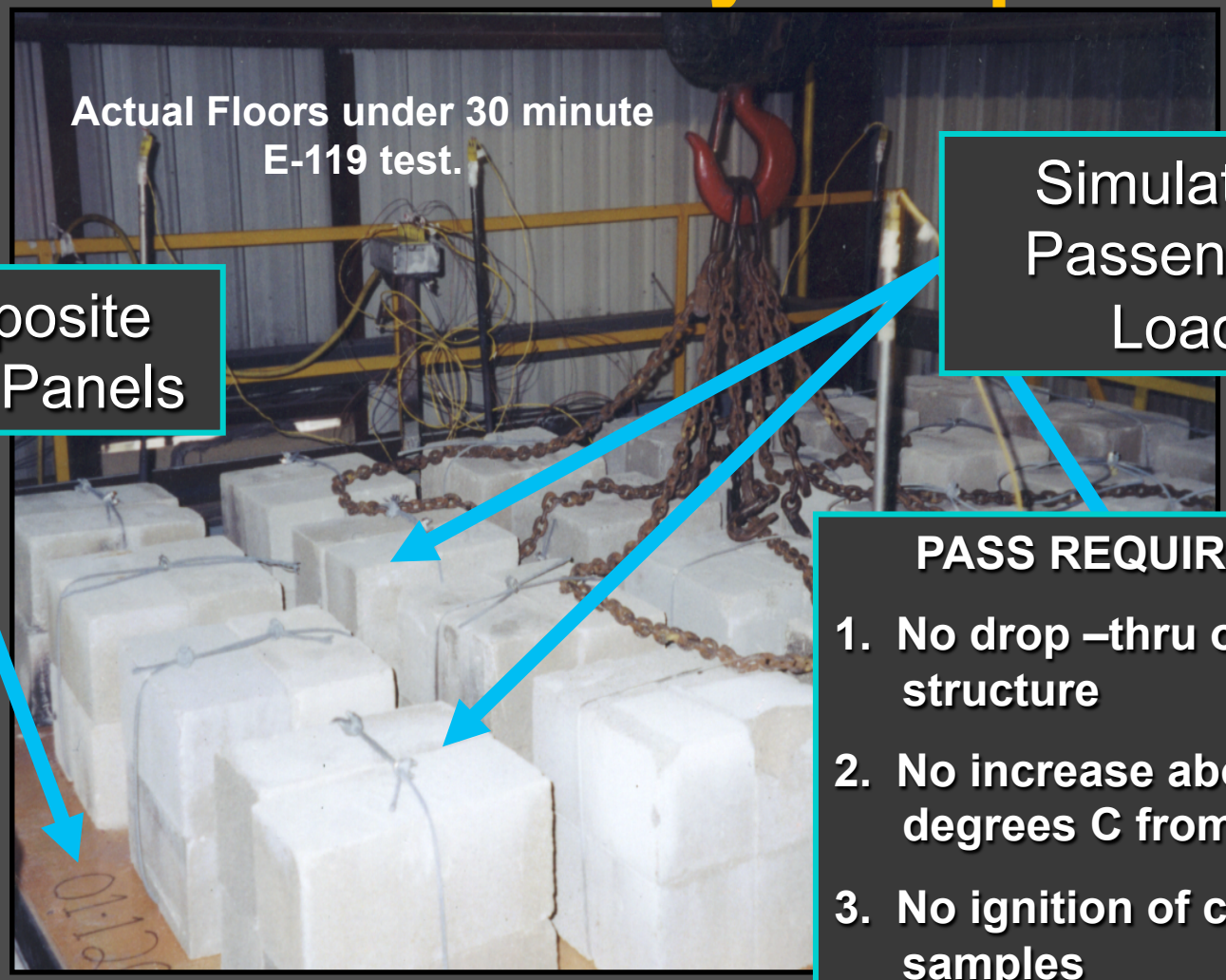



End View: Test Facility



Side View: Test Facility

# Tested Fire Safety Compliance:




Composite Floor Panels

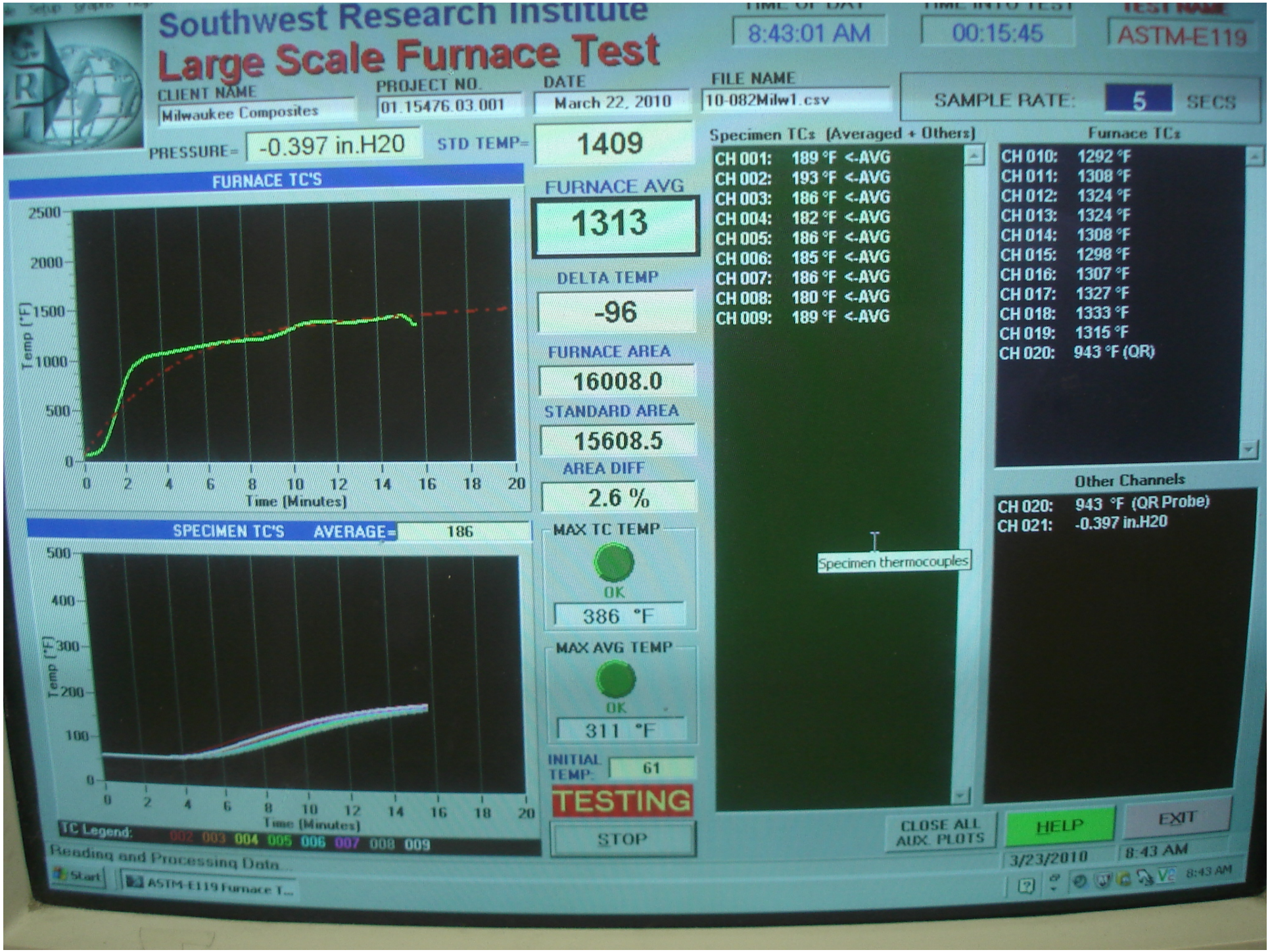
Simulated Passenger Load

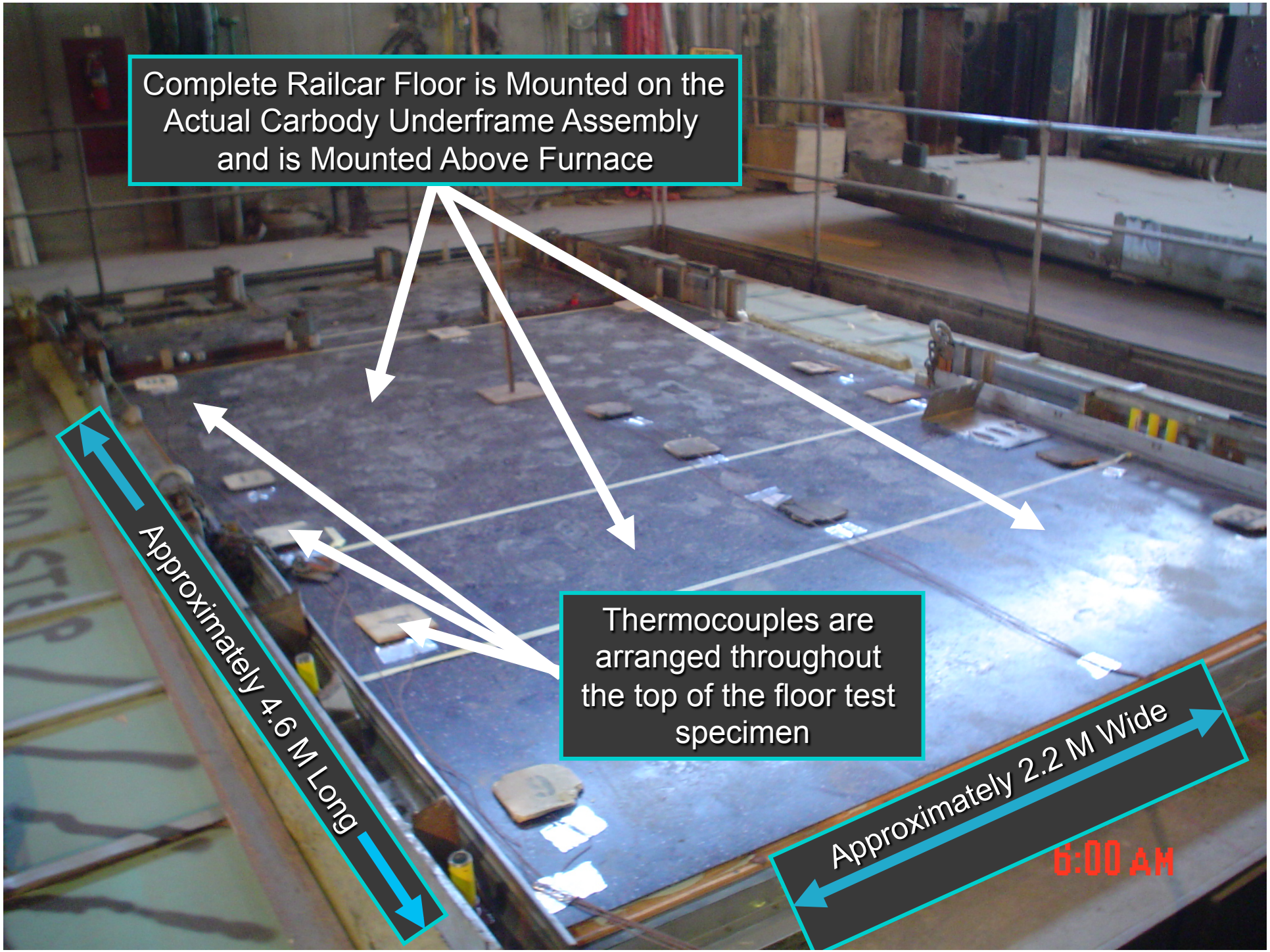
**PASS REQUIREMENTS:**

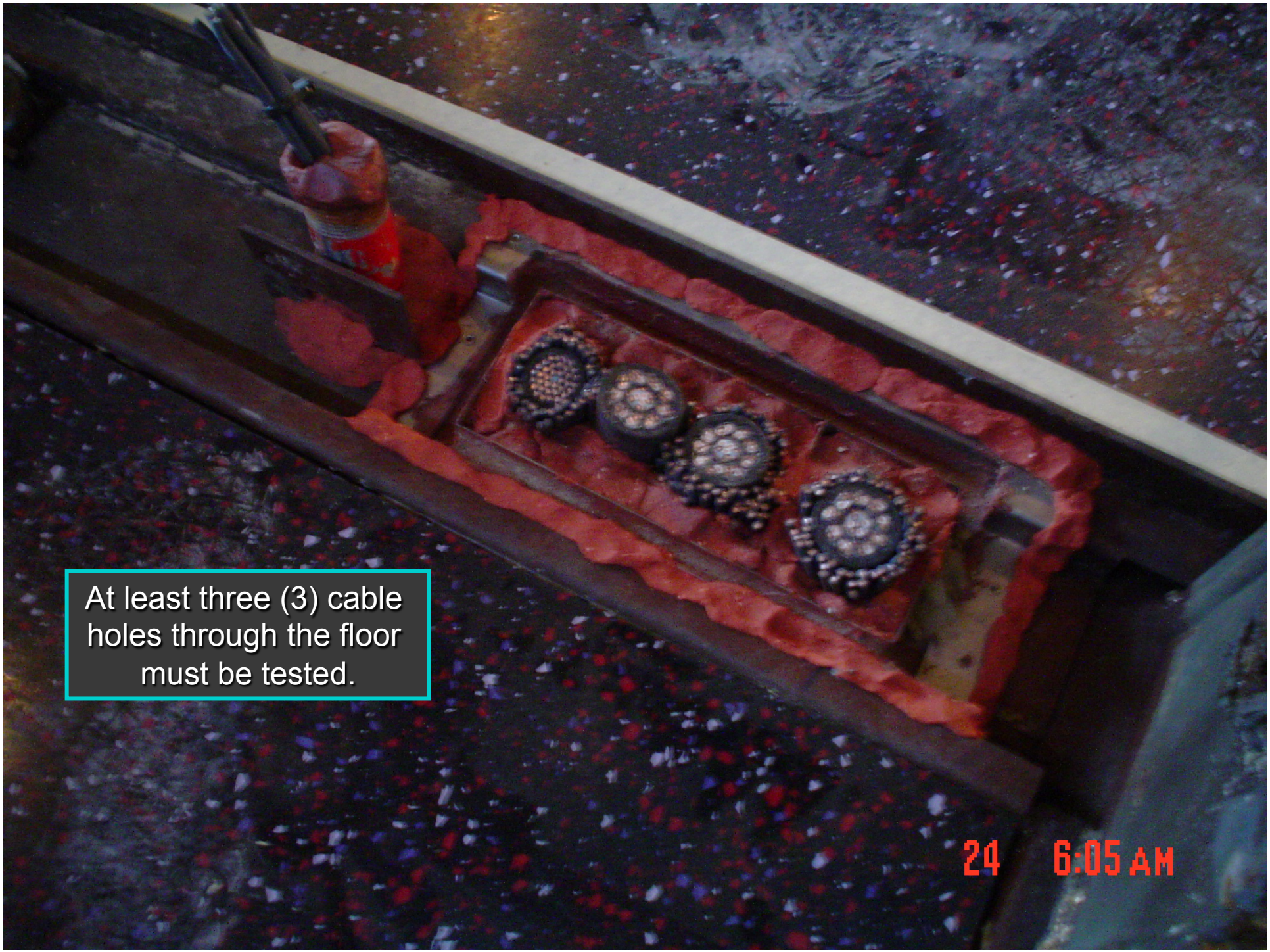
1. **No drop –thru of any floor structure**
2. **No increase above 135 degrees C from ambient.**
3. **No ignition of cotton cloth samples**
4. **No Flame-Thru's**


# Southwest Research NFPA 130/ASTM E-119 Floor Fire Test Cell

(SAN ANTONIO, TEXAS)


Southwest Research Institute
Large Scale Furnace Test
8:43:01 AM
00:15:45
ASTM-E119
CLIENT NAME
Milwaukee Composites
PROJECT NO.
01.15476.03.001
DATE
March 22, 2010
FILE NAME
10-082Milw1.csv
SAMPLE RATE:
5
SECS
PRESSURE=
-0.397 in.H20
STD TEMP=
1409
FURNACE TC'S
Temp (°F)
Time (Minutes)
FURNACE AVG
1313
DELTA TEMP
-96
FURNACE AREA
16008.0
STANDARD AREA
15608.5
AREA DIFF
2.6 %
SPECIMEN TC'S AVERAGE=
186
MAX TC TEMP
OK
386 °F
MAX AVG TEMP
OK
311 °F
INITIAL TEMP:
61
TESTING
STOP
TC Legend:
002 003 004 005 006 007 008 009
Specimen TCs (Averaged + Others)
CH 001: 189 °F <-AVG
CH 002: 193 °F <-AVG
CH 003: 186 °F <-AVG
CH 004: 182 °F <-AVG
CH 005: 186 °F <-AVG
CH 006: 185 °F <-AVG
CH 007: 186 °F <-AVG
CH 008: 180 °F <-AVG
CH 009: 189 °F <-AVG
Specimen thermocouples
Furnace TCs
CH 010: 1292 °F
CH 011: 1308 °F
CH 012: 1324 °F
CH 013: 1324 °F
CH 014: 1308 °F
CH 015: 1298 °F
CH 016: 1307 °F
CH 017: 1327 °F
CH 018: 1333 °F
CH 019: 1315 °F
CH 020: 943 °F (QR)
Other Channels
CH 020: 943 °F (QR Probe)
CH 021: -0.397 in.H20
CLOSE ALL AUX. PLOTS
HELP
EXIT
Reading and Processing Data...
Start
ASTM-E119 Furnace T...
3/23/2010
8:43 AM

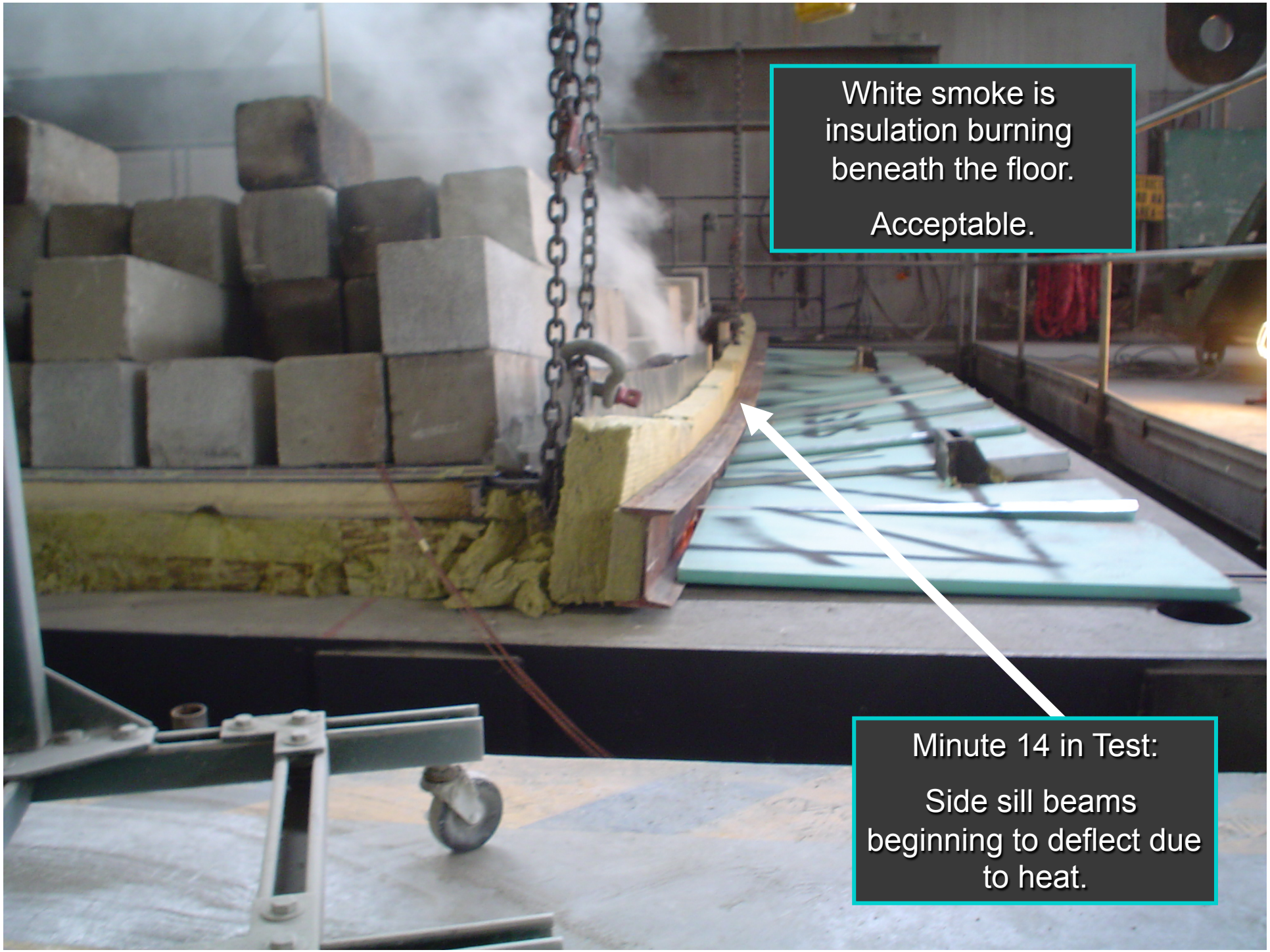

Complete Railcar Floor is Mounted on the Actual Carbody Underframe Assembly and is Mounted Above Furnace
Thermocouples are arranged throughout the top of the floor test specimen
Approximately 4.6 M Long
Approximately 2.2 M Wide
6:00 AM


At least three (3) cable holes through the floor must be tested.
24 6:05 AM

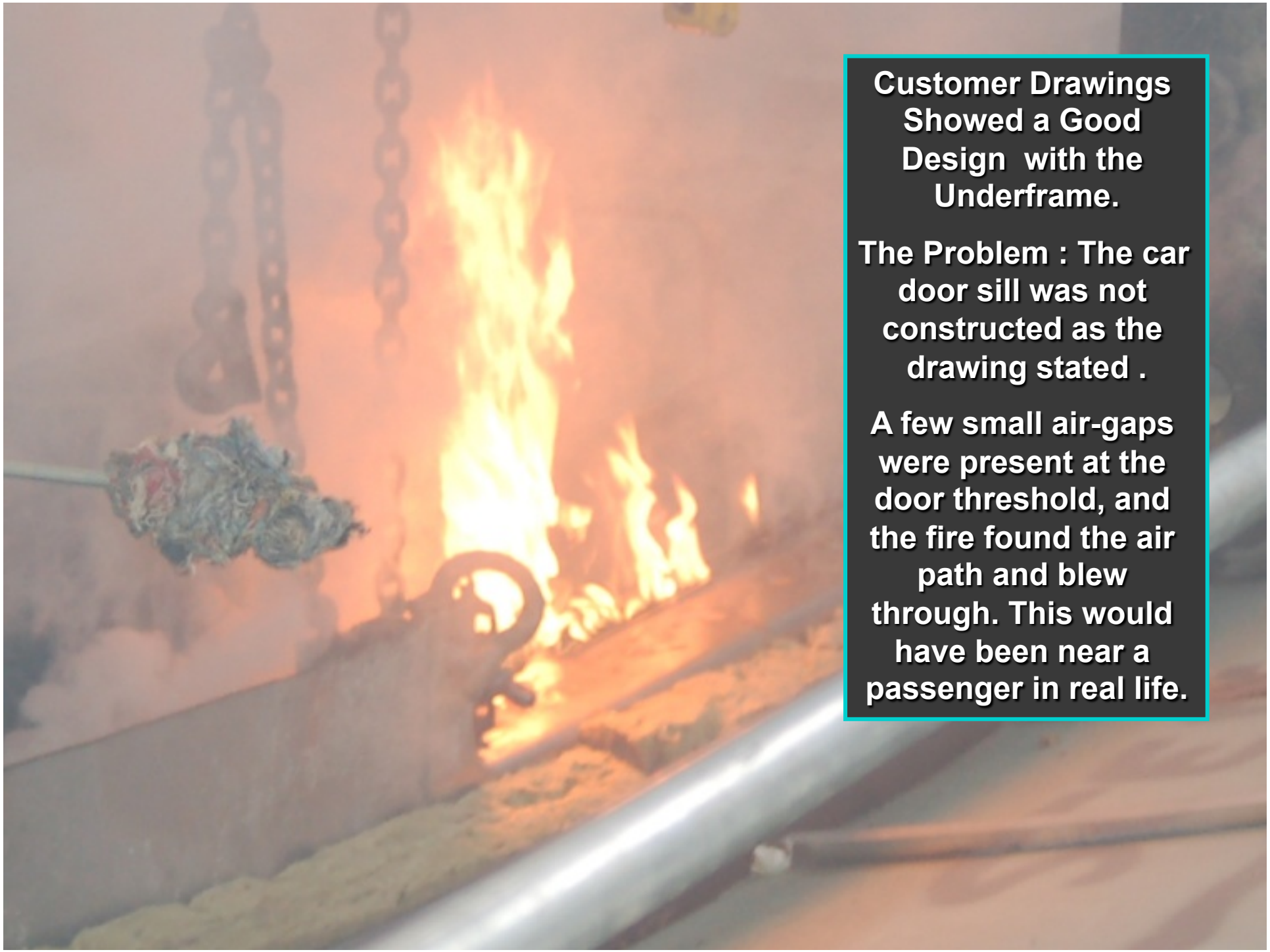

All floor loading specified by the transit agency must be simulated during the fire test. Cinder blocks are used to provide the loads at specific locations.
24 7:53 AM


27 1:02 PM


27 9:17 AM


White smoke is insulation burning beneath the floor.
Acceptable.
Minute 14 in Test:
Side sill beams beginning to deflect due to heat.

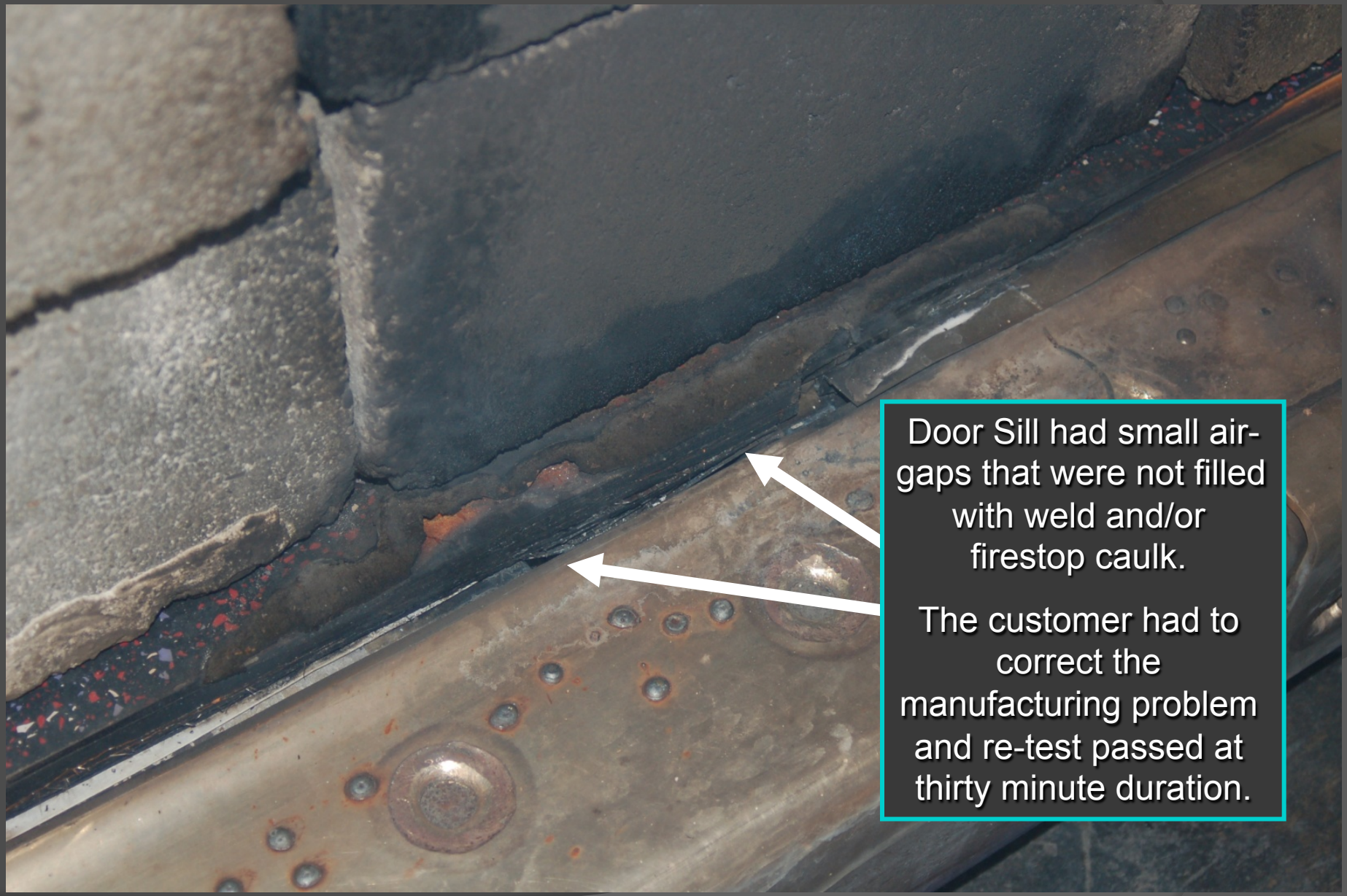

Minute 25 in Test:
Side sill beams seriously deflect due to heat.
This ASTM E-119 Test Passed at minute 30.
Furnace is extinguished at minute 30.
27 9:35 AM



Customer Drawings Showed a Good Design with the Underframe.

The Problem : The car door sill was not constructed as the drawing stated .

A few small air-gaps were present at the door threshold, and the fire found the air path and blew through. This would have been near a passenger in real life.


Door Sill had small air-gaps that were not filled with weld and/or firestop caulk.
The customer had to correct the manufacturing problem and re-test passed at thirty minute duration.

# ASTM E119 Timeline:

- Early 1900's was known as the C-19 Standard
- 1918: Adopted by American Society for Testing and Materials (ASTM)
- 1983: Required in Recommended Fire Safety Practices for Rail Transit Materials Selection (US DOT)
- 1983: Included in the new NFPA 130

# US Fire Standards Timeline:

- **1974: Guidelines for Flammability and Smoke Emission Specifications**
- **1979: Bay Area Rapid Transit (BART) Vehicle Tunnel Fire (January)**
- **1979: Urban Mass Transit Administration (UMTA) Publishes Recommended Fire Safety Practices for Rail Materials**
- **1983: NFPA 130 Standard for Fixed Guideway Transit Systems Published**
- **1984: *UMTA Fire Safety Practices for Rail Materials Published in Code of Federal Regulations for Rapid Transit and LRVs (49CFR 238)***

# 49 CFR 238.103 Background:

In 1984 the FRA issued passenger train fire safety guidelines that recommended the use of certain flammability and smoke emission test methods and performance criteria for intercity and commuter rail cars. Revised guidelines were issued in1989 that used terms and categories to more closely reflect passenger train design and furnishings. In 2002 these "guidelines" were issued as regulations in the Code of Federal Regulations 49 CFR Part 238.103 (See Appendix 5). ***These regulations now have the force of US law, and penalties are imposed for non compliance.***

# Code of USA Federal Regulations 49 CFR Part 238.103

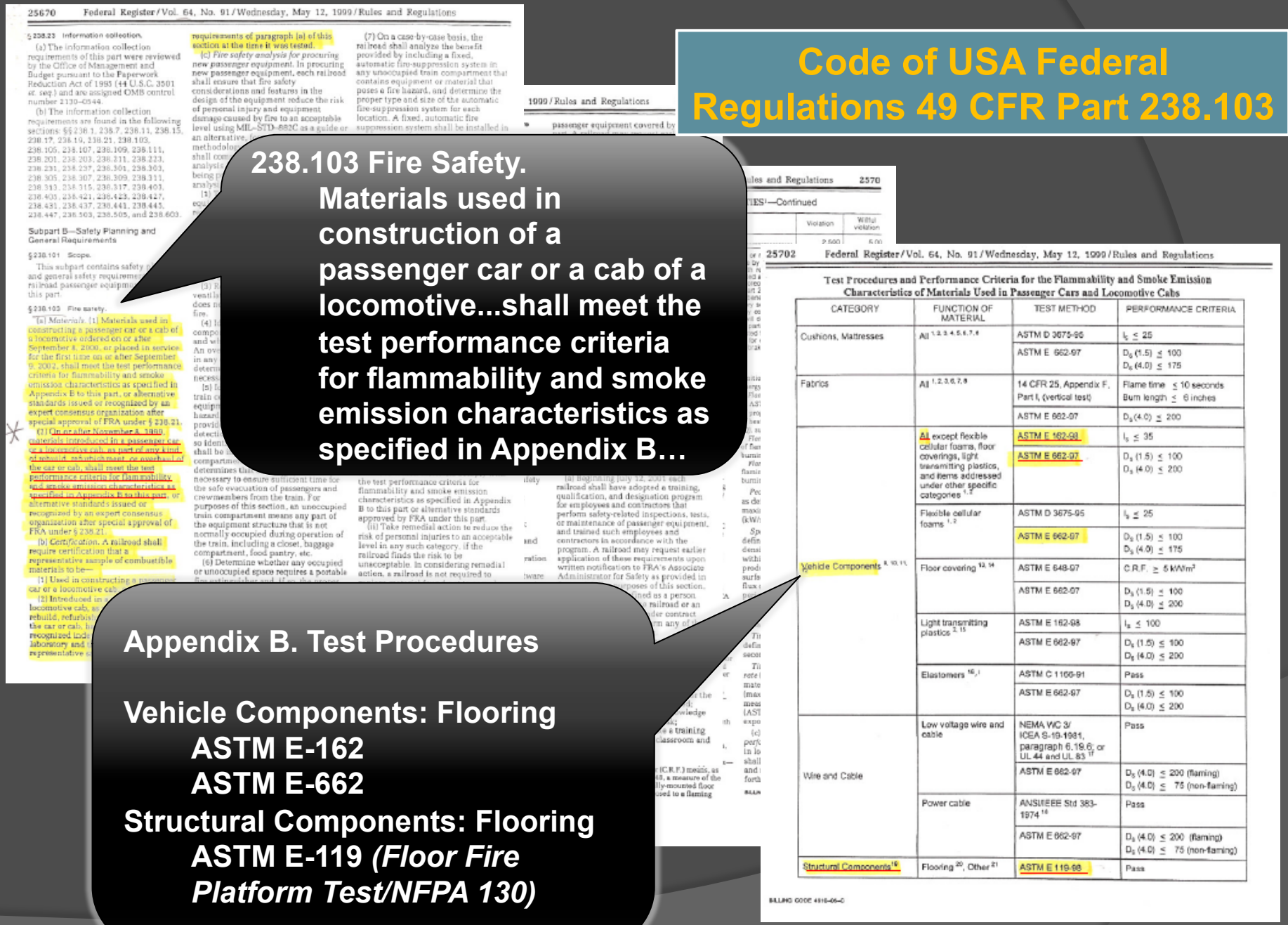
**238.103 Fire Safety.**

**Materials used in construction of a passenger car or a cab of a locomotive...shall meet the test performance criteria for flammability and smoke emission characteristics as specified in Appendix B…**

**Appendix B. Test Procedures**

**Vehicle Components: Flooring**
- **ASTM E-162**
- **ASTM E-662**

**Structural Components: Flooring**
- **ASTM E-119** ***(Floor Fire Platform Test/NFPA 130)***



# 49 CFR 238.103 Background

The regulation addresses flammability and smoke emissions performance for combustible materials in the interior and on the exterior of the car.

The regulation outlines five categories of materials and utilizes five ASTM test protocols for flammability, one ASTM test protocol for smoke emissions and one ASTM test protocol for structural integrity during a fire.

All test protocols are small scale tests with the exception of the structural integrity test which utilizes ASTM E119.

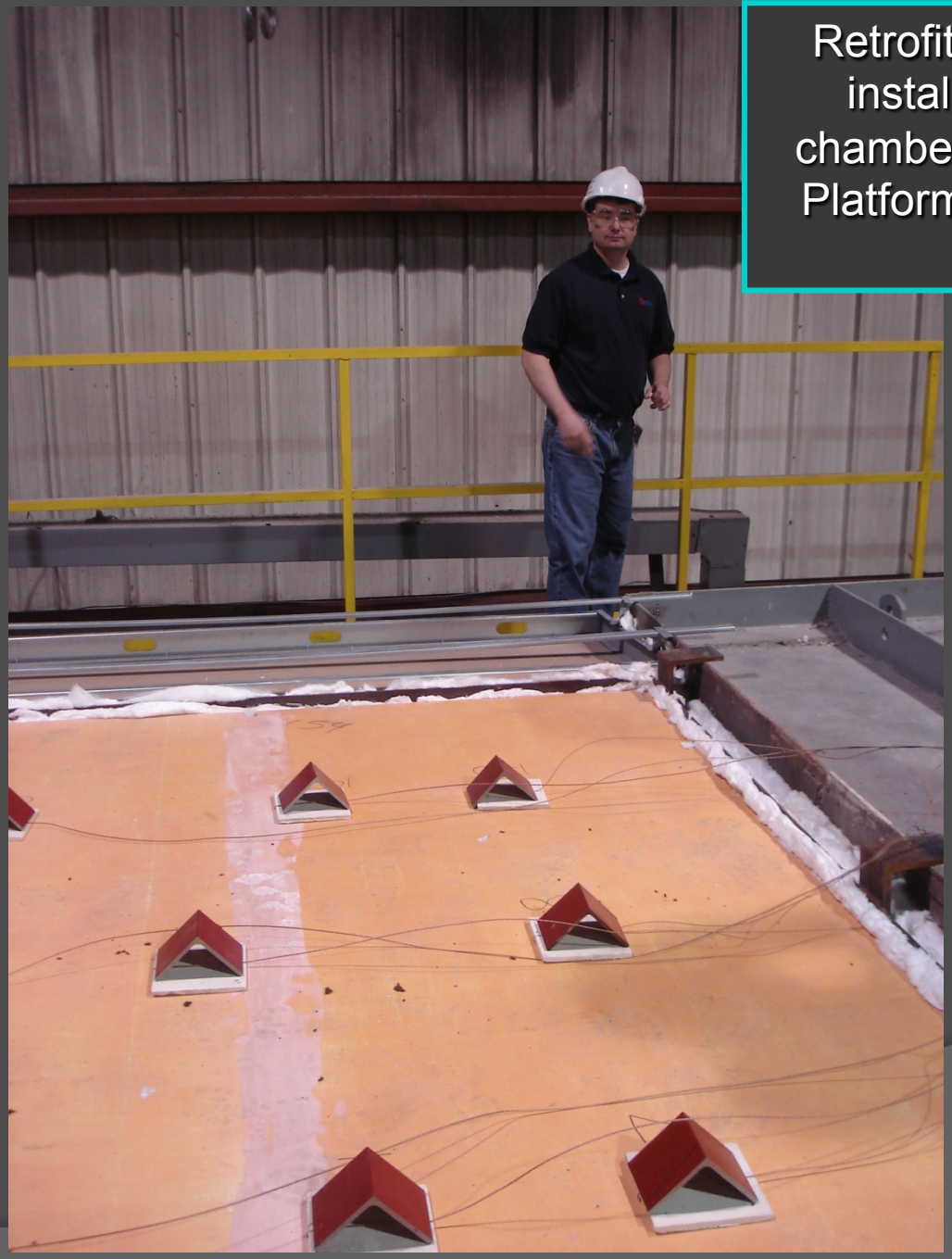
# Two Examples of USA Composite Floors That Required ASTM E-119 (30 minute burn test)


CHARLOTTE, NORTH CAROLINA

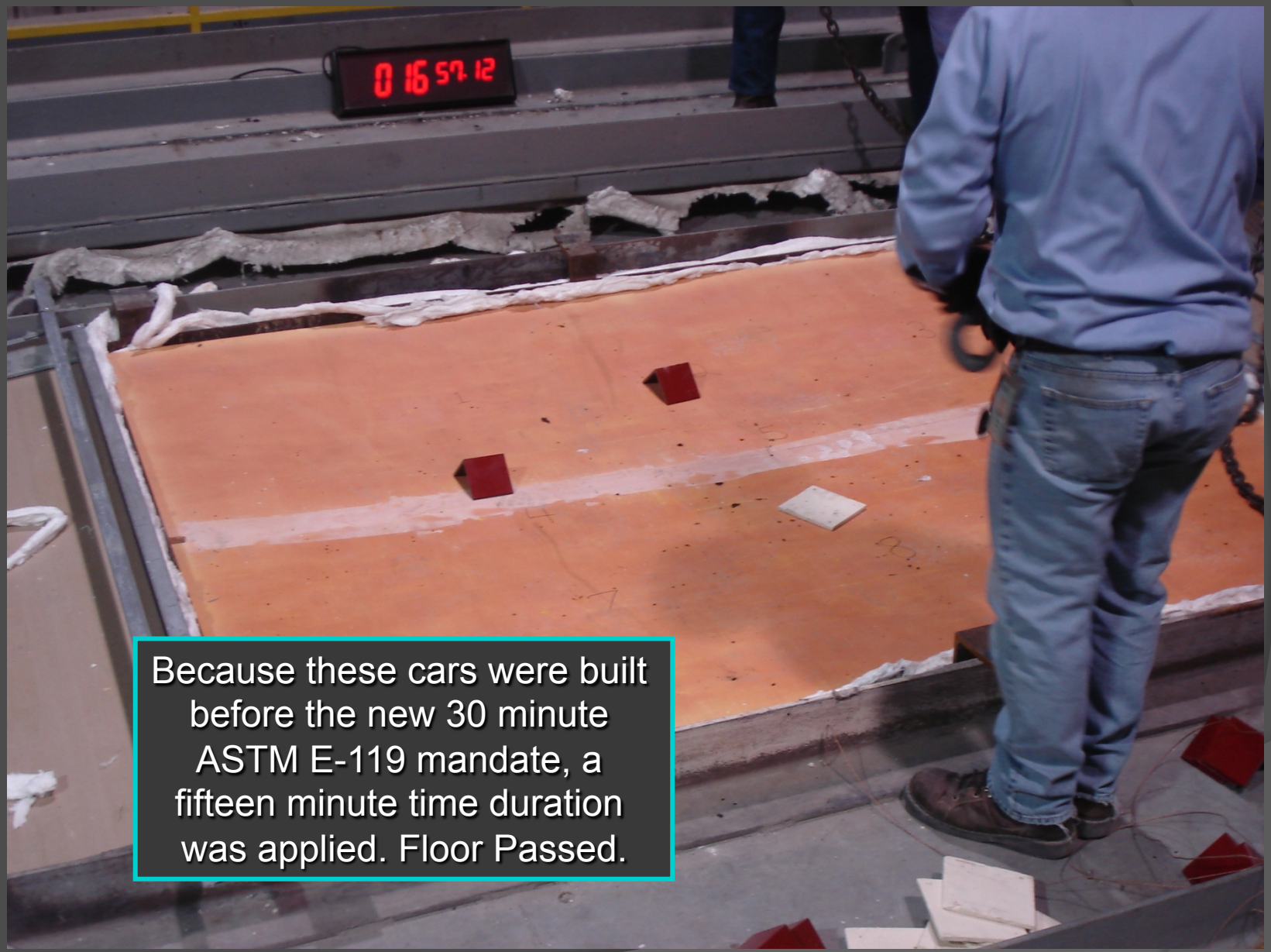

PORTLAND, OREGON

Composite Floors Used on New York City Subways also Required ASTM E-119 (30 minute burn test).


An Old Car getting new flooring to extend useful life. Had no underpan. Had to Be Revalidated.



Retrofit floor being installed in test chamber for a Small Platform Floor Burn Test.


0 16 57 12
Because these cars were built before the new 30 minute ASTM E-119 mandate, a fifteen minute time duration was applied. Floor Passed.

# Flame & Smoke Compliance:

**ASTM E162: Flame Spread Testing:**
**Test for Surface Flammability of Materials Using Radiant Energy Source.** Floor test samples shall exhibit an average final Flame Spread Index (FSI) of not more than 5. No flaming or dripping pieces permitted. **MCI panels passed at FSI = 4.0**

**ASTM E662: Smoke Generation Testing:**
**ASTM E662-94a / NFPA 258 Test for Evaluating the Smoke Generation Characteristics of Solid Materials Non flaming and Flaming** exposure tests are to be conducted. The average specific optical density ($D_s$) shall not exceed the following limits:

- Non-flaming $D_s$ (maximum); at 1.5 minutes: 2.5; at 4 minutes: 20.
  **MCI passed at $D_s$= 0.3; and $D_s$ = 13.2 respectively.**
- Flaming $D_s$ (maximum); at 1.5 minutes: 7.5; at 4 minutes: 60.
  **MCI Panels passed at $D_s$= 3.6; and $D_s$= 44.3 respectively.**

# Toxicity Compliance:

**BSS 7239 Boeing Specification Support Standard**. All materials used in the construction of the phenolic composite floor panels shall be tested in accordance with BSS 7239 and test results shall not exceed the following maximum limits:

| | **LIMITS** | **MCI PANEL** |
|---|---|---|
| Carbon Monoxide (CO) | 3500 ppm | **60ppm** |
| Hydrogen Fluoride (HF) | 200 ppm | **none** |
| Nitrogen Dioxide ($NO_2$) | 100 ppm | **trace** |
| Hydrogen Chloride (HCl) | 500 ppm | **none** |
| Hydrogen Cyanide (HCN) | 150 ppm | **none** |
| Sulfur Dioxide ($SO_2$) | 100 ppm | **0.5 ppm** |

# OUR GOAL: SECURE IMPROVED PASSENGER FIRE PROTECTION THROUGH BETTER TRANSIT INDUSTRY COOPERATION & GLOBALLY ADOPTING REALISTIC & APPLICABLE STANDARDS & TESTING. WE MUST PROTECT THE PASSENGERS.