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ICC-ES Evaluation Committee

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FIRE PERFORMANCE OF WOOD

Dave Bueche, Ph.D
Hoover Treated Wood Products

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PURPOSE

- Fire-Retardant Treated Wood performs at least as well as steel in large scale fire tests
- Fires aren't predictable – fire exposure can occur on all sides
- Substituting materials can change the performance of a roof assembly

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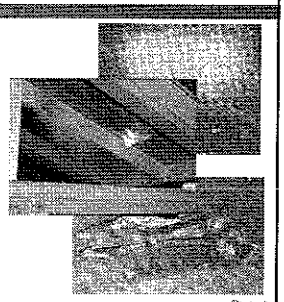
PROGRAM

- Why Wood?
- Historical Fires
- Importance of Large Scale Testing
- Difference in Wood Based Materials



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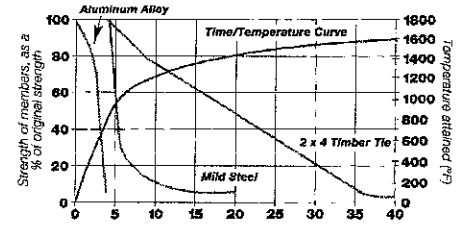
WHY WOOD?



Strength of Steel, Aluminum, and Timber in Relation to Standard Fire Test. AITC Data[1]

(1) Dock & Harbor Authority, London, England, "Why Abou[illegible]

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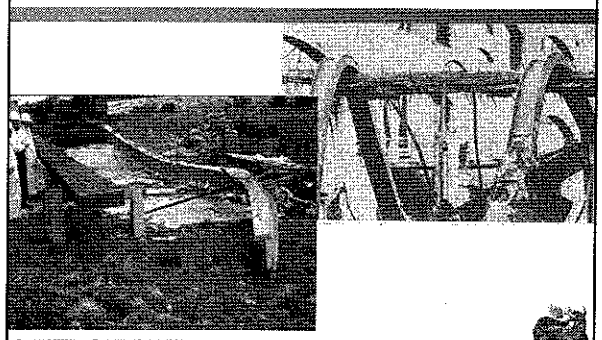
UNPROTECTED CONSTRUCTION



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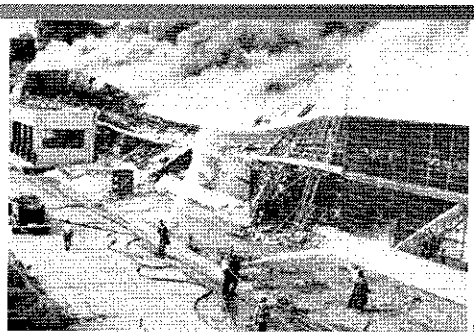
LARGE FIRE? NONCOMBUSTIBLE CONST.



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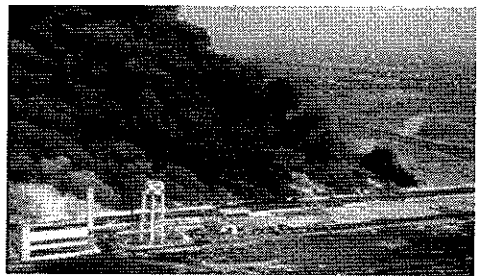
GM TRANSMISSION PLANT LIVONIA, MI



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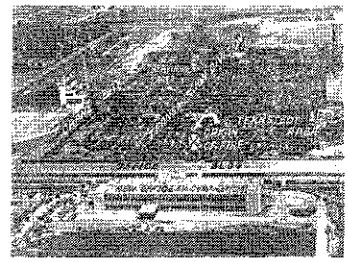
GM TRANSMISSION PLANT

- **Largest Single Industrial Loss on Record**
- **$50 - $55 M in Property Damage**
- **$750 M in Business Interruption**
- **32,000 Employees Laid Off**



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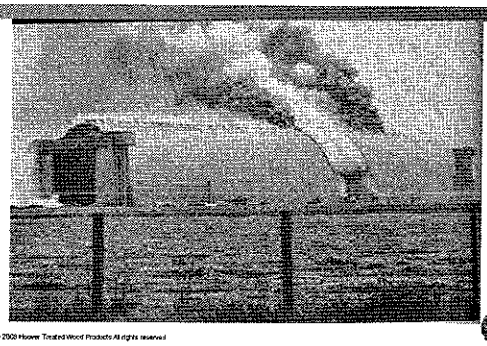
LARGE FIRE? COMBUSTIBLE CONST.



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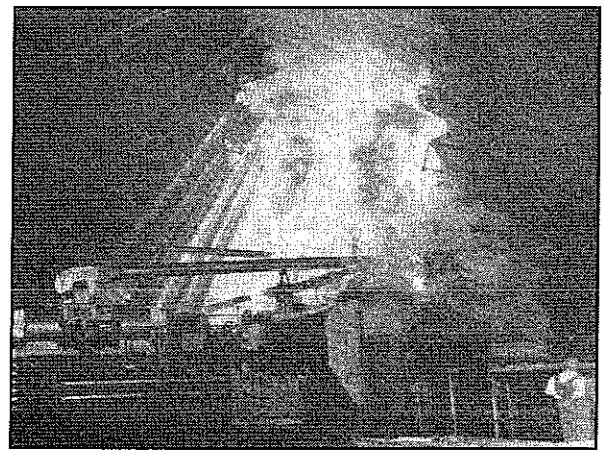
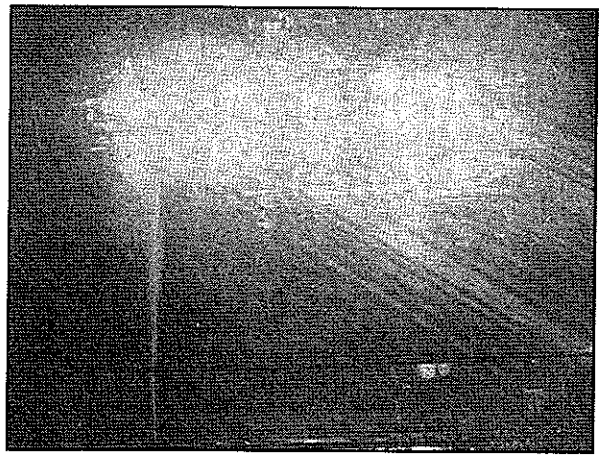
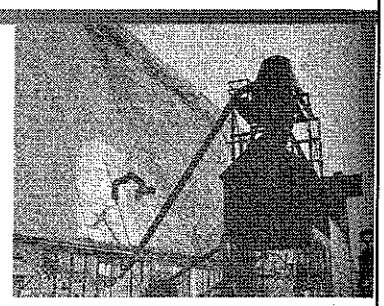




TILLAMOOK HANGAR

- **40,000 sq feet of roofing burned**
- **3,000 sq ft of 2" roof planking charred through**
- **15,000 sq ft (< 4% of the roof area) replaced**
- **Repair costs only $21,000**



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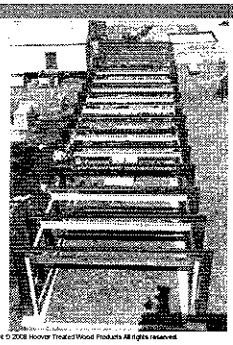
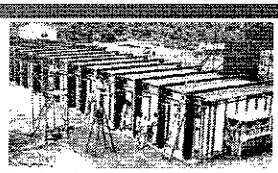
FACTORY MUTUAL "WHITE HOUSE" TEST





Non-Combustible Building
(100 ft. L x 20 ft. W x 10 ft. H)

- Gasoline Fired Burners at One End and Open On The Other End
- 30 Min. Tests of Various Roof Systems
- Satisfactory Performance if flaming on the underside of the deck limited to approx. 70 ft.

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FACTORY MUTUAL "WHITE HOUSE" TESTS

"White House" Tests demonstrated .....

..... that the presence of highly combustible materials in the vapor seal and/or adhesion between insulation and the metal deck is the governing factor of fire spread beneath the roof and within the building when the underside of the roof is exposed to fire .....

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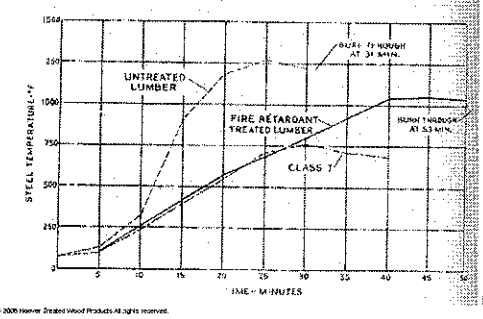
WHITE HOUSE TEST RESULTS



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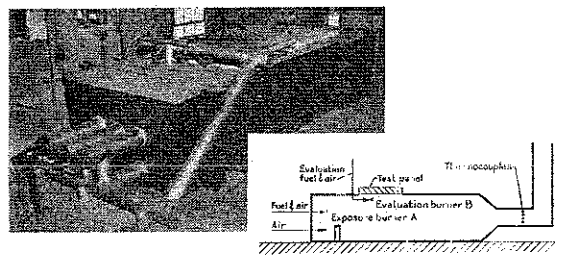
FM CONSTRUCTION MATERIALS CALORIMETER



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CONSTRUCTION CALORIMETER RESULTS

Structural Deck Description	Maximum Average Rate of Heat Contribution (BTU. Ft.²/Min.) For Various Time Intervals			
	3 min.	5 min.	10 min	Average
Treated 2" Douglas Fir (Avg.—2 tests)	323	318	299	246
Untreated 2" Douglas Fir	474	447	381	358
Treated Plywood (¾")	325	293	275	243
Standard for Cl. I Insulated Metal Deck	385	365	340	270
Insulated St. Dk. Assembly w/BU covering, wd. fiber insul. and 2 ply-3 mop asphaltic vapor barrier (Livonia)	1583	1531	1203	701

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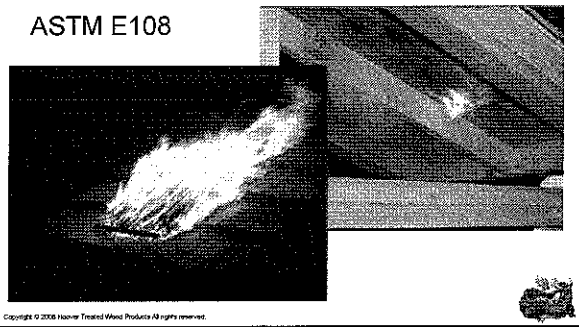
EXTERIOR FIRE TESTING

ASTM E108



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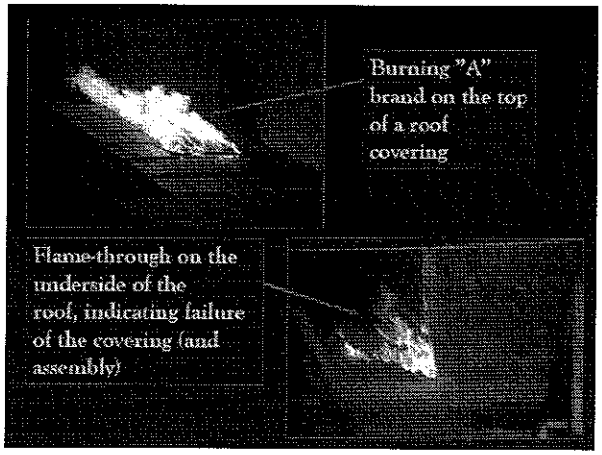

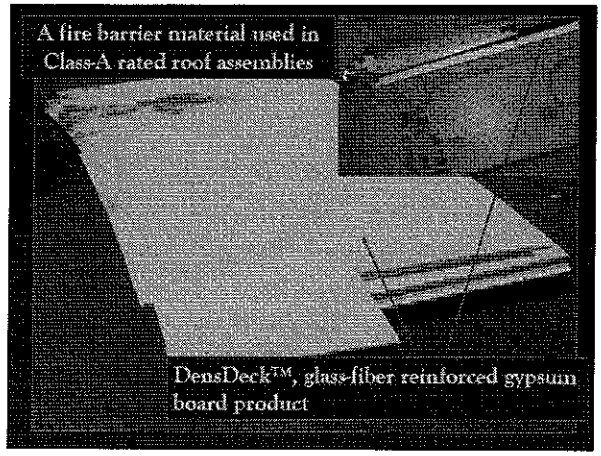

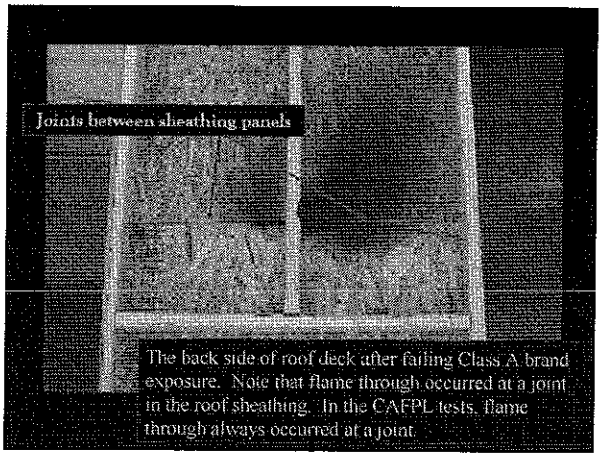

SUMMARY

- Fire-Retardant Treated Wood performs at least as well as steel in large scale fire tests
- Fires aren't predictable – fire exposure can occur on all sides
- Substituting materials can change the performance of a roof assembly

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Questions

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Wood Treatment Expertise
Member: ACS, AFPA, ASTM, AWPA, CWPA, FPS, ICC, IRGWP, SWST

McIntyre Associates, Inc.
8565 E. Grandview Lake Dr.
Walls, MS 38680-9422
www.mcintyre-inc.com

Phone: 662-781-4908
Fax: 662-781-4909
Cell: 901-277-1771
craig@mcintyre-inc.com

October 14, 2008

Michael P. O'Reardon, P.E., CBO, MCP
Senior Staff Engineer
ICC Evaluation Services, Inc.
900 Montclair Road, Suite A
Birmingham, AL 35213

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OCT 21 2008
ICC-ES Evaluation Committee

Re: AC405-1008-02 Durability Issues

Dear Michael,

The comments posted last week on AC405 suggested that a specific "durability" protocol be developed. Accordingly, we would like to discuss the various durability issues that have been raised concerning AC405-1008-R2. In short, we are proposing testing that is the equal of other testing used for FRT-panels.

ISSUE 1: TEST DURATION

Currently, it is proposed that satisfactory E84 testing will be done after panels are exposed "for 42 days to a controlled temperature of 140 °F ± 5 °F (60 °C ± 2 °C) and a relative humidity of 70% ± 5%." At first, this seems less stringent than lumber or plywood strength testing protocols but in actual fact it is the equal. The simple fact is that the lumber and plywood test values are significantly reduced by other ASTM methods. Let me explain.

Plywood strength testing per ASTM D5516 is done at 170 °F ± 2 °F (77 °C ± 1 °C) and ≥ 50% relative humidity. The plywood test values are then used in ASTM D6305 to determine treatment factors During the development of D6305 it was found that the D5516 testing vastly over-predicted the strength losses. Accordingly, a "cyclic factor" of 0.60 was used which in effect reduced the overall strength effect to 60% of the total.

Similarly, lumber strength testing per ASTM D5664 is done at 150 °F ± 4 °F (66 °C ± 2 °C) and ≥ 50% relative humidity. These test values are then used and D6841 calculations and D6841 also uses the 60% cyclic factor to adjust the final outcome. Thus, for both lumber and plywood, the cyclic factor of 60% is used and this in effect reduces the temperature effect.

The "cyclic factor" discussed above accounts for the difference in the degradation experienced during normal, diurnal cyclic exposures compared to the degradation experienced during continuous exposures as called for by the test methods. The basis for this is that it was found that cyclic exposures only had about 60% of the effect of the continuous exposures

Since there is a "straight-line" correlation of degradation with time, another way of achieving the 60% effect would have been to simply reduce the amount of the test time. This approach is being used for AC405 in that 42 days is 60% of the 70 day exposure recommended in D5516.

Thus, the proposed test time is the functional equivalent of the plywood test time and there is no justification for extending the test period.

ISSUE 2: TEMPERATURE AND RELATIVE HUMIDITY

Winandy *et al*[1] have shown that for a roof with black fiberglass shingles in central Mississippi, the hottest temperature at the bottom of roof sheathing is 140 °F (60 °C) and this occurred an average of 13 hours per year. Accordingly, 140 °F was selected as the appropriate test temperature for testing of the coating which is applied to the bottom of the roof sheathing. Simply put, the test will be done at the maximum temperature that is expected to occur during exposure.

It should be noted that in the same paper, the maximum temperature of the rafters was found to be 131 °F (55 °C) for an average of 11 hours annually. The maximum temperature of the top of the sheathing was found to be 167 °F (75 °C) for an average of 2 hours annually. Thus, the use of 140 °F is a reasonable compromise based on known data

For relative humidity, it is proposed to use 70% RH at 140 °F which equates to 40 grains/CF of absolute humidity. This is 10% more than the 36 grains/CF of absolute humidity that one obtains under the lumber test conditions. Since the proposal is for higher absolute humidity than comparable existing testing, there is no need to further increase it.

ISSUE 3: FLEXIBILITY AND ADHESION

The flexibility and adhesion issues are addressed in 4.2.1 where no more than 10% of the surface area can delaminate during the D5516 strength testing. Since there is considerable expansion, contraction and flexure involved during the test, this should address these concerns

The flexibility and adhesion issues are further addressed by the subsequent E84 fire testing after the above temperature and relative humidity exposure. If significant adhesion problems occur, then it will not be possible to pass the fire test.

[1] Winandy, J.E., H.M. Barnes and C.A. Hatfield, 2000. Roof Temperature histories in matched attics in Mississippi and Wisconsin. Res. Pap. FPL-RP-589. USDA Forest Serv., Forest Prod. Lab., Madison, WI

Although the adhesion issue is adequately addressed as above, we are amenable to incorporating an adhesion test per ASTM D3359-08 Standard Test Methods for Measuring Adhesion by Tape Test. The conditions of acceptance would allow essentially 10% delamination. Specifically, revise AC405 to include ASTM D3359-08 in the referenced standards in Section 1.3.2 and add a new Section 4.5 to read:

4.5 **Adhesion Testing--Fire-retardant Coatings:** Panels with factory-applied fire-retardant coating shall be tested in accordance with Method A of ASTM D3359.

Conditions of Acceptance: A classification of 3A or better shall be obtained.

ISSUE 4: ABRASION RESISTANCE

Although it is difficult to conceive of significant abrasion occurring in an attic scenario, one can conduct abrasion testing by ASTM D4060-07 Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser. Limited testing has shown that 1000 cycles of the Taber® Abraser with a 1000 g load and CS-17 Calibrase® abrasion wheels gave good resistance. However, this is a single test and the test method itself seems to have a fairly large variance (up to 40% for some coatings per Precision and Bias Table 1 of ASTM D4060). Accordingly, we propose that the conditions of acceptance show less than 3% weight loss at the above conditions. Specifically, revise AC405 to include ASTM D4060-07 in the referenced standards in Section 1.3.2 and add a new Section 4.6 to read:

4.6. Abrasion Testing-Fire-retardant Coatings: Panels with factory-applied fire retardant coating shall be tested in accordance with ASTM D4060 for 1000 cycles with a 1000 g load and a CS-17 Calibrase® abrasion wheel.

Conditions of Acceptance: Testing by ASTM D4060 as above shall result in a maximum of 3% weight loss.

As shown above, we are proposing durability testing at conditions equivalent to or more stringent than those used to test existing products Efforts to make the test conditions harsher can be rejected on the basis that this would unfairly single out our product or that the proposal would not reasonably represent known exposure conditions.

We are also proposing adhesion and abrasion testing. The conditions of acceptance for these tests are reasonably based in comparison to the performance requirements of the factory-applied fire-retardant coating

We trust that this suitably addresses the durability issues

Best regards,

Craig R. McIntyre

Craig R. McIntyre, Ph.D.
President

cc: Pat Thompson, FlameDxx