TECHNICAL BULLETIN

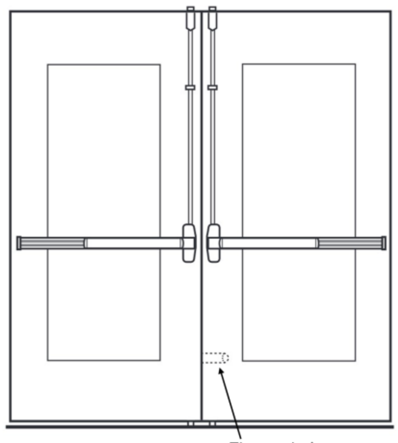
Fire Door Assemblies with Thermal Pins

INTRODUCTION

This bulletin addresses common questions and concerns regarding thermal pins (i.e. fire pins, auxiliary fire pins, fire bolts, fusible alignment pins, or fusible pins) used in fire-rated doors (fire doors). Thermal pins are door hardware components essential to the function of fire door assemblies, which is to reduce fire spread. Thermal pins do not impede occupant use of fire doors and do not interfere with firefighting efforts.

SPECIFIC FIRE DOOR CONFIGURATION

A common door and door hardware configuration which is the subject of this bulletin is a pair of fire doors installed in a framed opening and with latches at the top of each door (often referred to as fire doors with “top rod only,” “less bottom rod,” or LBR door hardware). These pairs of doors commonly have one or more thermal pins mortised into the edge of one door aligned with hollow receptors in the other door or frame. Thermal pins are also used in single-door fire door assemblies where the hollow receptors are installed in the frame.



When fire doors are exposed to the untenable elevated temperatures of a fire, the covers of the thermal pins melt away and the spring-loaded pins extend into the opposing receptor. During a fire, in combination with the other latches of the door, thermal pins keep the closed fire doors aligned in the opening enabling the fire doors to achieve their intended function – protecting life and property by helping to compartmentalize the building and control the spread of fire.

Thermal, or fusible, components are used in many other types of approved fire door hardware, and although the exact mechanisms vary by hardware design, they follow similar principles of function and safety.

DESCRIPTION OF A THERMAL PIN

The thermal pin is essentially a spring-loaded short metal rod mortised into the edge of a fire door. During a fire, when the door is exposed to high temperatures, the thermal material restraining the spring-loaded pin softens or melts (at an internal door temperature of 350ºF to 450ºF) and the pin is released from its retracted position allowing the pin to extend about 1” from the edge of one door and into the mating receptor of the other door.

FIRE DOOR TESTS

Fire doors, per most building codes in the United States, are required to be tested to UL 10C “Positive Pressure Fire Tests of Door Assemblies” or NFPA 252 “Standard Methods of Fire Tests of Door Assemblies”. These tests require doors to remain closed and latched during and after exposure to the test fire and subsequent hose stream test. These fire and hose stream tests, as expected, subject the doors to a prescribed, but aggressive, fire exposure and impact force.

The fire door test (per UL 10C or NFPA 252) is conducted on an apparatus that is essentially a tremendously oversized gas “grill” turned on its side in front of the test doors. This oversized grill is larger than the doors to be tested. The test doors are positioned in front of the grill, the burners ignited, and fuel is regulated to provide a prescribed heat exposure over a prescribed test period – the time-temperature curve.

The time-temperature curve requires the door to be exposed to 1,000ºF heat at 5 minutes into the test, and 1,300ºF heat at 10 minutes, and the temperature within the furnace is gradually increased for the remainder of the test (minutes to hours). Thermal pins commonly activate 8 to 12 minutes after the start of the fire door test, when the fire test exposure temperature has been rising above 1,000ºF for 3 to 7 minutes.

In addition to the fire door burn test of UL 10C and NFPA 252, fire doors are required to be subjected to a hose stream test immediately after the fire exposure test. The hose stream test requires fire doors to remain closed when impacted by a solid straight stream of water (not a fog spray) from a smooth bore nozzle applied in a grid pattern back and forth and up and down over the entire door assembly. This stream of water impacts the door with adequate force that hardware could be “operated” by the hose stream, thereby unlatching the door. For this reason, thermal pins, fire exit hardware, and other fire-rated latching hardware is designed to be not functional after fire exposure.

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This standardized hose stream test, which represents a rough usage test, is an integral performance requirement of the UL 10C and NFPA 252 tests, and in other test standards utilized for fire-rated construction (i.e. ASTM E 119, Standard Test Methods for Fire Tests of Building Construction and Materials; ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems) to demonstrate a fire-rated assembly is resistant to unintentional breaching during a fire.

HEAT EXPOSURE, BUILDING OCCUPANTS, FIREFIGHTERS, AND FIRE DOORS

Building occupants become evacuees in a fire emergency. Disregarding the lethal effects of smoke progressing ahead of a fire, research indicates evacuees can be expected to withstand a heat flux of 4.5 kilowatts per square meter (kW/m²) for about 30 seconds or 23 kW/m² for about 3 seconds before exposed skin (i.e. face, hands) receive 2nd degree burns. This human limit is equivalent to approximately 70 kilojoules of heat energy exposure (for the short exposure) to 135 kilojoules of heat energy exposure (for the 30 sec. exposure) to each square meter (kJ/m²) of skin during each of these time periods.[1]

Firefighter personal protective equipment (turnout gear) is designed to provide limited protection for the firefighter and is required to be tested to NFPA 1971. NFPA 1971 requires turnout gear to be tested with a radiant and convective heat flux of 84 kW/m² and achieve a Thermal Protective Performance (TPP) of 35.[2] The heat flux of 84 kW/m² is based on a close-to-the-floor firefighter's heat exposure during a fire flashover. A TPP of 35 is equivalent to 17.5 seconds before skin protected by the turnout gear would suffer 2nd degree burns. This means a firefighter in turnout gear, exposed to flashover, can be expected to receive 2nd degree burns in 17.5 seconds (or sooner, regrettably, if there is moisture inside the turnout gear).[3] Heat flux exposure of 84 kW/m² for 17.5 seconds is equivalent to 1,470 kJ/m² of heat energy exposure to the firefighter. Comparing firefighter heat exposure limits to building occupant heat exposure limits, a firefighter in turnout gear can withstand 10 to 20 times the heat exposure that a building occupant can withstand.

To achieve the temperatures required by the UL10C or NFPA 252 tests, the test doors are subject to radiant and convective heat from the burners of the test apparatus, which reach heat output rates of approximately 45 kW/m² at 10 minutes and 100 kW/m² at 60 minutes.[4] The UL 10C or NFPA 252 tests, at 90 seconds into the fire door test, have applied approximately 1,500 kJ/m² of heat energy. At 8 minutes into the fire door test – the earliest the thermal pins are observed to release – the UL 10C and NFPA 252 tests have delivered approximately 12,000 kJ/m² of heat energy to the exposed door surfaces. These estimates indicate it takes a minimum of 8 times as much heat for a thermal pin to release as a firefighter can withstand fully protected by firefighter PPE. Considering building occupants, these estimates indicate it takes a minimum of 90 times as much heat exposure for a thermal pin to release than a building occupant may be able to withstand.

LIFE SAFETY AND FIRE DOORS

Environmental conditions on the fire-exposed side of a door often become untenable (not compatible with life) because of elevated temperatures and smoke. Fire doors, when exposed to the ravages of a fire, commonly expand, warp, and become inoperable while performing as intended to help control the fire. Fire doors must transition from functioning as doors for egress to functioning as fire barriers. The elevated temperatures of a fire, along with smoke, create untenable conditions much sooner than the elevated temperatures may cause fire-protection rated doors to become inoperable.

Firefighters, when protected by their personal protective equipment (turnout gear) and exposed to heat at levels similar to fire door tests, could be expected to withstand these temperatures for only a short period of time (less than 90 seconds). Firefighters – for personal safety – will have exited the building long before fire doors become silent sentries and do their job of controlling the fire's spread. Thus, occupant and fire fighter life safety is not compromised if fire-protection rated doors become inoperable from exposure to elevated temperatures of a fire.

SUMMARY

Fire-rated doors (fire doors) with thermal pins meet fire and life safety requirements by helping to prevent the spread of fire, do not impede emergency escape and rescue, and do not impede fire fighting activities.

The Builders Hardware Manufacturers Association (BHMA) represents commercial door hardware manufacturers in North America. Our members are responsible for the design and production of builders hardware offering safety and security along with compliance to building and fire codes throughout the United States and Canada.

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[1] Stoll, M.A., Chianta, M.A, "Method and Rating System for Evaluation of Thermal Protection," Aerospace Medicine, November 1969

[2] NFPA 1971 Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting, 2018 Edition, National Fire Protection Association, Quincy, Mass.

[3] Mell, W.E., Lawson, J.R., "A Heat Transfer Model for Fire Fighter's Protective Clothing", NISTIR 6299, National Institute of Science and Technology, 1999

[4] Berhinig, R., Ghandi, P., "Report on Development and Application of ISO PDGUIDE 834-2, Fire resistance tests-Elements of building construction – Part 2: Guide on measuring uniformity of furnace exposure on test samples", Underwriters Laboratories, Northbrook, Illinois, April 4, 2008