RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

REQUEST FOR PROPOSALS FOR PROJECT CONTRACTOR

Fire door experimental testing

Full title: Fire door experimental testing to study the influence of door gaps around swinging fire doors

(16 August 2019)

Background: Fire development, smoke movement and ability of fire door to meet the test standards are affected by the gap sizes around the perimeter of the door, within the frame and between the bottom of the door and floor. Hence these gap sizes are regulated, and the current regulations in NFPA 80, Standard for Fire Doors and Other Opening Protectives, for the door clearances are from information and data gathered several years ago. Door clearances are one of the most frequently cited deficiencies on swinging doors with builders hardware. NFPA 80 currently allows a maximum bottom gap of 3/4-inch and a maximum of 1/8-inch for the perimeter (e.g. along vertical and top edges) of the swinging fire doors (with an additional 1/16-inch over-tolerance for steel doors). The clearance under swinging fire doors is frequently found to be greater than the maximum allowable gap size currently allowed by NFPA 80, due to irregularities in flatness and levelness of concrete slab floors at and around door openings. Hence it is important to have a deeper understanding of the impact of gap sizes on fire development and smoke movement.

The FPRF completed a research project that involved thorough literature research and computer modeling (Phase 1) of several types of fire door tests. Specifically, the computer models were designed to simulate fire door tests of swinging door assemblies that have clearance gaps the same dimensions as permitted by NFPA 80, Standard for Fire Doors and Other Opening Protectives, as well as larger clearance gap dimensions that are found on some existing door assemblies installed in the field. The results of that project were inconclusive. The study revealed that larger gaps under the fire door may be detrimental to the ability of a door to meet test criteria for the time duration. However, the modeling is not able to confirm the results of this study and other literature. The final report recommended actual fire door tests need to be conducted to determine the effect clearance gaps might have on the performance of fire door assemblies themselves, as well their ability to prevent fire from spreading. Hence, the need for a new research project that entails full-scale fire door tests. Full scale fire tests are needed to determine if existing provisions of the code provide adequate safety and if the gaps may be increased or reduced in some cases.

Project Goal: The goal of the project is to determine through experimental testing the effect that door under gap clearances might have on the performance of a fire door assembly to prevent a fire from spreading. This project is divided into two main sets of activities in support of experimental testing:
(1) Generic full-scale fire door testing with door assemblies having door gap dimensions as specified in NFPA 80; and, (2) Full-scale fire door testing of certain generic fire door assemblies with door gap dimensions larger than currently specified in NFPA 80.

Project Tasks:

This project will involve the following tasks:

Task 1 – Appointment and administration of project technical panel (handled by FPRF): A technical panel including the subject matter experts will be appointed to provide input and feedback throughout the project. The administration of the panel will be handled by the FPRF. The role of the panel will be to provide input to the project, review periodic reports of progress and research results, review and provide feedback on the final project report.

Task 2 – Summarize Literature Review: Summarize any literature identified in Phase 1 study and/or other literature relevant to experimental testing of fire doors with different gap sizes. Establish the current pass/fail criteria of fire door tests based on NFPA 252: Standard Methods of Fire Tests of Door Assemblies, considered for this study.

Task 3 – Experimental test plan development:

3.1. Repeatability and Reproducibility: The fire door tests are intended to assure appropriate levels of repeatability and reproducibility. To reduce as many variables as possible and maintain consistency, all like-rated doors and other hardware need to be identical, if they will compromise the repeatability and reproducibility of the tests. In other words, all 20-minute rated wood doors must be the same, with the same internal core material, stile, and rail construction, and they must be produced from the same lot of doors. Similarly, all 20-minute rated metal doors must be same, with the same face sheet thickness, internal core, and edge seam construction, and they must be produced from the same lot of doors. Similarly, this will apply for 90-minute rated doors.

3.2. Panel Review: Review and confirm the primary experimental test plan as presented in Appendix A and methodology with panel, including specific details such as scheduling test series, obtaining resources required (i.e., doors etc.), and post-test reporting. Specific details of type of doors tested, test standard (NFPA 252), measurements during testing should be clarified and confirmed with the panel. Experimental test plan should consider the most efficient arrangement for conducting the fire door tests (e.g., Appendix A) with consideration of contingencies based on the results from ongoing testing.

3.3. Fire Doors: The Contractor will procure the fire doors and associated hardware (i.e., Appendix B) by working through applicable distributors and in coordination with the panel. Throughout the project, all doors shall be generically identified using the nomenclature in the test portfolio or similar. **Tests will be conducted in a generic manner without compromising any proprietary and confidential information**.

3.3.1. Approach to keep anonymity of doors tested: The Contractor will use an approach to preserve the anonymity of the doors tested by obtaining the requisite number of doors for the testing from a pool of all unmarked doors except the rating of the door. The Contractor will then select from the pool of doors to assure anonymity is maintained. Any additional doors that are not used for fire door testing should be handled in a manner that will not compromise anonymity.

3.4. Test Facility: Building of experimental test facility, testing of fire doors, measurements are responsibilities of the Contractor.

Task 4: Experimental Test Plan Implementation

4.1. Testing: Conduct series of generic Fire Door Tests: NFPA 252 Positive Pressure Tests with Hose Stream Tests (as applicable) for the test scenarios prescribed in the test portfolio Appendix A, Table A-1.

Test Methodology for Progressive Testing: With consideration of contingencies based on the results from ongoing testing, conduct fire door test with

- Baseline test assembly to have door gap clearance dimensions in as specified in NFPA 80. Test assembly to have 3/4-inch clearance under doors with vertical and top door gap clearance dimensions as 1/8-inch (for wood doors) and 3/16-inch (for metal doors) as permitted by NFPA 80. **If successful, then**,
- Test assembly to have 1-inch clearance under doors, with vertical and top door gap clearance dimensions as 1/8-inch (for wood doors) and 3/16-inch (for metal doors) as permitted by NFPA 80.
- If the **baseline test fails**, then, bottom clearance for secondary test will be assessed along with the panel.

4.2. Measurements: Temperature and pressure measurements inside the fire chamber during the fire door tests, and temperature measurements at the non-fire side of the door should be monitored and recorded.

4.3. Videos & Images: Only thermal imaging shall be used for capturing videos and images for fire door testing, for the sole purpose of assisting the Contractor with analyzing the data and writing the report, and will not be used for any other purpose without express permission from FPRF. Contractor shall ensure no manufacturer related information are identified in the pictures and videos that are captured. For cases were direct videos and images are not appropriate, Contractor shall create “drawings” as necessary in the final report to replicate

the critical observation from tests. The images used for the final report will be clarified and confirmed with the project panel.

4.4. Coordination during testing: Coordinate with FPRF to enable panel guidance and witnessing of tests.

Task 5 – Analysis of Results

5.1. Summary: Summarize the results and observations in a clear succinct format to clarify the effect of door under clearance gaps on the performance of a fire door assembly in each of the tests conducted.

5.2. Future Research: Identify the need for future research/experimental tests, to clarify other variables pertinent to the test series portfolio. Provide a test plan to consider means (e.g., modified UL 1784 tests: Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives) to evaluate fluid flow conditions at the gaps to determine if heat transfer and smoke flow development are affected with different gap sizes and how it is related to the performance of fire door assemblies during the fire door tests.

Task 6 – Final report

6.1. Draft Report: Prepare a draft final report including the findings from above tasks and review it with the panel.

6.2. Final Report: Submit a final report after incorporating the necessary revisions based on the panel feedback.

6.3. Dissemination: Circulate and disseminate the results through a presentation (e.g., virtual) to the project technical panel.

Note: The number of tests along with other experimental details are outlined in Appendix A and B, and may be adjusted based upon review with the panel in accordance with available funding and timeline.

Reporting and Deliverables: Three interim updates: first interim update during Task 3; second interim update during Task 4; and third interim update during Task 5 are required from the Contractor. A draft final report, and final report will be developed for this project. Final report will be disseminated by the Research Foundation through FPRF website.

Implementation: This research project is led by the Fire Protection Research Foundation and will be conducted in accordance with the "Research Foundation Policies for the Conduct of Research Projects". The project will be guided by a Project Technical Panel who will provide input to the project, recommend Contractor selection, review periodic reports of progress and research results, and review the final project report.

Intellectual Property: The Research Foundation will retain rights to all project deliverables including final report which will be published on the Foundation website.

Schedule and Costs: Proposals for this project shall include an estimate of cost on a total fixed cost basis broken down by specific tasks. All indirect and travel costs incurred are intended to be included within this fixed price. The Foundation does not have a limit on indirect costs, but the total proposal cannot exceed the fixed cost.

Proposals due:	16 September 2019
Selection of Contractor:	4 October 2019
Task 1:	2 weeks after project initiation
Task 2:	4 weeks from project initiation
Task 3:	8 weeks from project initiation
Task 4:	20 weeks from project initiation
Task 5:	24 weeks from project initiation
Task 6:	30 weeks from project initiation

How to Respond: Letter proposals (not to exceed six pages) shall be submitted electronically to Sreeni Ranganathan, Research Project Manager of the Research Foundation, at sranganathan@nfpa.org no later than **5:00 pm Eastern Time 16 September 2019**. For additional details see the "Research Foundation Policies for the Conduct of Research Projects", the Foundation Operating Principles, and "Research Project Guidelines for Contractors" on the Foundation website at: www.nfpa.org/Foundation. Each proposal shall include a description

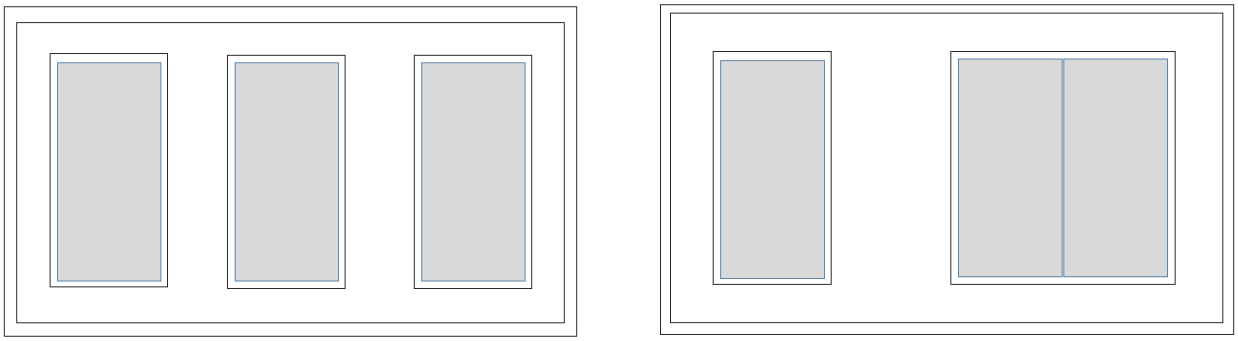
of the following which will be used as the basis for proposal evaluation: scope and approach, problem understanding, technical merit, budget allocation with cost allocation for specific tasks and test series (Appendix A), prior relevant experience and personnel expertise. In your proposal, please provide a fixed project cost which includes any indirect costs and travel to any in-person meetings and presentations.

Appendix A: Experimental Test Portfolio

This is a sample progressive testing approach by batching the tests in order to best utilize the available resources. This will be reviewed and finalized with the project technical panel prior to implementation. Different approaches are possible.

A.1. Sample batch testing approaches.

Consider doing tests in batches of either three single doors or one single and one double egress door combination as described in Table A-1 (see picture below):



(a) (b)

Figure A-1: Sample diagrams for batch test consideration either as (a) three single doors or (b) one single and one double egress door combination.

Table A-1: Experimental test portfolio to study the influence of bottom gap size on fire door assembly (Approach of Fig. A-1 (b) is considered here).

Batch/ Test No.	Door No.	Test	Door type	Bottom gap	Top gap	Side gaps	Test protocol
20 min. Rated Wood Door							
A	1	Baseline test per NFPA 80 allowed gap size	Wood (20 min. rated), Single door	3/4 inch	1/8 inch	1/8 inch	NFPA 252 positive pressure test
	2	Baseline test per NFPA 80 allowed gap size	Wood (20 min. rated), Double egress door (standard swing pair)	3/4 inch	1/8 inch	1/8 inch	NFPA 252 positive pressure test
B	3	Increased bottom gap clearance	Wood (20 min. rated), single door	1 inch	1/8 inch	1/8 inch	NFPA 252 positive pressure test
	4	Increased bottom gap clearance	Wood (20 min. rated), Double egress door (standard swing pair)	1 inch	1/8 inch	1/8 inch	NFPA 252 positive pressure test
90 min. Rated Wood Door							
C	5	Baseline test per NFPA 80 allowed gap size	Wood (90 min. rated), Single door	3/4 inch	1/8 inch	1/8 inch	NFPA 252 fire test and subsequent hose stream test
	6	Baseline test per NFPA 80 allowed gap size	Wood (90 min. rated), Double egress door (standard swing pair)	3/4 inch	1/8 inch	1/8 inch	NFPA 252 fire test and subsequent hose stream test

D	7	Increased bottom gap clearance	Wood (90 min. rated), single door	1 inch	1/8 inch	1/8 inch	NFPA 252 fire test and subsequent hose stream test
	8	Increased bottom gap clearance	Wood (90 min. rated), Double egress door (standard swing pair)	1 inch	1/8 inch	1/8 inch	NFPA 252 fire test and subsequent hose stream test
20 min. Rated Hollow Metal Door							
E	9	Baseline test per NFPA 80 allowed gap size	Hollow metal (20 min. rated), Single door	3/4 inch	3/16 inch	3/16 inch	NFPA 252 fire test
	10	Baseline test per NFPA 80 allowed gap size	Hollow metal (20 min. rated), Double egress door (standard swing pair)	3/4 inch	3/16 inch	3/16 inch	NFPA 252 fire test
F	11	Increased bottom gap clearance	Hollow metal (20 min. rated), Single door	1 inch	3/16 inch	3/16 inch	NFPA 252 fire test
	12	Increased bottom gap clearance	Hollow metal (20 min. rated), Double egress door (standard swing pair)	1 inch	3/16 inch	3/16 inch	NFPA 252 fire test
90 min. Rated Hollow Metal Door							
G	13	Baseline test per NFPA 80 allowed gap size	Hollow metal (90 min. rated), Single door	3/4 inch	3/16 inch	3/16 inch	NFPA 252 fire test and subsequent hose stream test
	14	Baseline test per NFPA 80 allowed gap size	Hollow metal (90 min. rated), Double egress door (standard swing pair)	3/4 inch	3/16 inch	3/16 inch	NFPA 252 fire test and subsequent hose stream test
H	15	Increased bottom gap clearance	Hollow metal (90 min. rated), Single door	1 inch	3/16 inch	3/16 inch	NFPA 252 fire test and subsequent hose stream test
	16	Increased bottom gap clearance	Hollow metal (90 min. rated), Double egress door (standard swing pair)	1 inch	3/16 inch	3/16 inch	NFPA 252 fire test and subsequent hose stream test

Appendix B: Fire Door and Hardware Details

B.1. Fire Door Tests: Material Resources

These are the list of material resources that are required for this project. These tests are intended to assure appropriate levels of repeatability and reproducibility. To reduce as many variables as possible and maintain consistency, all like-rated doors and other hardware need to be identical, if they will compromise the repeatability and reproducibility of the tests.

B.1.1. Wood Door Materials:

All 20-minute rated wood doors must be the same, with the same internal core material, stile, and rail construction, and they must be produced from the same lot of doors. The 20-minute rated doors can be products from one manufacturer, and the 90-minute doors can be products from a different manufacturer. (All of the wood doors could be products from the same manufacturer.)

1. 20 min. rated wood doors:
    a. Numbers = 2 single
    b. Numbers = 2 double egress
2. 90 min. rated wood doors:
    a. Number = 2 single
    b. Numbers = 2 double egress

NOTE: *The following list of wood door materials is subject to modification by the testing lab.*

Each door: 1-3/4 in. thick. X 4-feet wide x 7-feet high

Core construction: Bonded particleboard core for 20-minute rating.

Face Veneer: Red Oak or Natural Birch, Plain Sliced, Book and Center matched.
Number of plies: 5 or 7
Elevation: Flush faces without lights or louvers.
Vertical Edges: Beveled hinge and lock stiles.
Door frame: 16 gauge cold rolled Steel HMF x 5-3/4 in. Jamb Depth x 2 in. Face x 5/8 in. Stop x Full Depth and Face Welded with wire masonry anchors. (Note: Frames not grout filled.)
Wall construction: Concrete Masonry Unit (CMU)

B.1.2. Metal Door Materials:

All 20-minute rated metal doors must be same, with the same face sheet thickness, internal core, and edge seam construction, and they must be produced from the same lot of doors. The 20-minute rated doors can be products from one manufacturer, and the 90-minute doors can be products from a different manufacturer. (All of the metal doors could be products from the same manufacturer.)

3. 20 min. rated metal doors:
    a. Numbers = 2 single
    b. Numbers = 2 double egress
4. 90 min. rated metal doors:
    a. Number = 2 single
    b. Numbers = 2 double egress

NOTE: The following list of metal door materials is subject to modification by the testing lab.

Each door: 1-3/4 in. thick. X 4-feet wide x 7-feet high
Core construction: 90-minute rated: honeycomb, polystyrene, polyurethane, or steel stiffened.
Face sheet (skin): 18 gage.
Vertical Edge Seams: The respective manufacturers' standard edge seam fabrication are acceptable
Elevation: Flush faces without lights or louvers.
Vertical Edges: Beveled or Square Edged
Door frame: 16 gauge cold rolled Steel HMF x 5-3/4 in. Jamb Depth x 2 in. Face x 5/8 in. Stop x Full Depth and Face Welded with wire masonry anchors. (Note: Frames not grout filled.)
Wall construction: Concrete Masonry Unit (CMU)

B.1.3. Hardware for Doors:

Note: No supplemental hardware components (e.g., smoke seal gasketing) shall be used to mitigate the door gap clearance dimensions between doors and frames and/or the bottom of the doors and the sill of the furnace.

Each single door to be equipped with the following hardware:

3 each Steel Ball Bearing Hinges, .190 in. thick x 5 in. High x 4 in. wide x 630 (or 652) finish
Note: 4-1/2 in. wide hinges are acceptable.
1 each Mortise Lock, Entry function x Lever w/ Rose (sectional) trim x 630 (or 626) finish

Each double egress door to be equipped with the following hardware:

6 each Steel Ball Bearing Hinges, .190 in. thick x 5 in. High x 4 in. wide x 630 (or 652) finish
Note: 4-1/2 in. wide hinges are acceptable.
2 each Surface Vertical Rod Fire Exit Hardware x Less Bottom Rod
1 each Thermal Pin (in lieu of bottom vertical rod fire exit hardware)

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