NISTIR 5925

Water Leakage of Elevator Doors With Application to Building Fire Suppression

John H. Klote
Emil Braun

Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

December 1996

U.S. Department of Commerce
Michael Kantor, *Secretary*
Technology Administration
Mary L. Good, *Under Secretary for Technology*
National Institute of Standards and Technology
Arati Prabhakar, *Director*

Cooperative Research and
Development Project With:
National Elevator Industry Incorporated
Fort Lee, NJ

Table of Contents

List of Tables

List of Figures

Water Leakage of Elevator Doors With Application to Building Fire Suppression

John H. Klote
Emil Braun

1. Introduction

In recent years, considerable interest has been expressed in improving elevator use during fires (ASME 1991 and 1995, Klote et al. 1992). Water exposure due to sprinklers and fire hoses is a major concern of the fire service with the use of elevators during fires, because of the effect that water can have on electrical and electronic elevator components.

The National Elevator Industry Incorporated (NEII) and NIST are engaged in a cooperative research project to study water flow issues of elevator use during fires. Because of the wide range of designs of elevator components, studying the impact of water on specific elevator components would have limited applicability. Thus the project focuses on water flow rates into elevator hoistways (elevator shafts) and the flow paths in the hoistways with the intent of providing information that might be useful to industry in dealing with this issue.

This paper describes a series of laboratory tests to: (1) determine typical flow rates of water through elevator doors, (2) observe water leakage patterns, (3) evaluate the performance of modified door gibs and brackets intended to reduce or redirect water leakage, and (3) evaluate a test enclosure concept for possible field testing.

2. Laboratory Facility

A facility was constructed at NIST to represent an elevator lobby with the capability of exposing a pair of elevator doors to water flow representative of that occur during fire suppression. The walls were constructed of concrete block, and the floor and ceiling were concrete. The floor of the simulated elevator lobby was 0.74 m (2.4 ft) above the laboratory floor to allow collection and measurement of water flow through the gaps and cracks in the elevator doors (figure 1). A water collection tank located in the "hoistway" area was divided into three sections (figure 1) to facilitate collection over a wide range of flow rates. However, only the section nearest to the elevator doors was used, except for the fire hose test which required all three sections.

The elevator doors were installed according to commonly accepted industry practice. These center opening doors were 1.07 m (42 in) wide and 2.1 m (7 ft) high. This installation did not include electronic

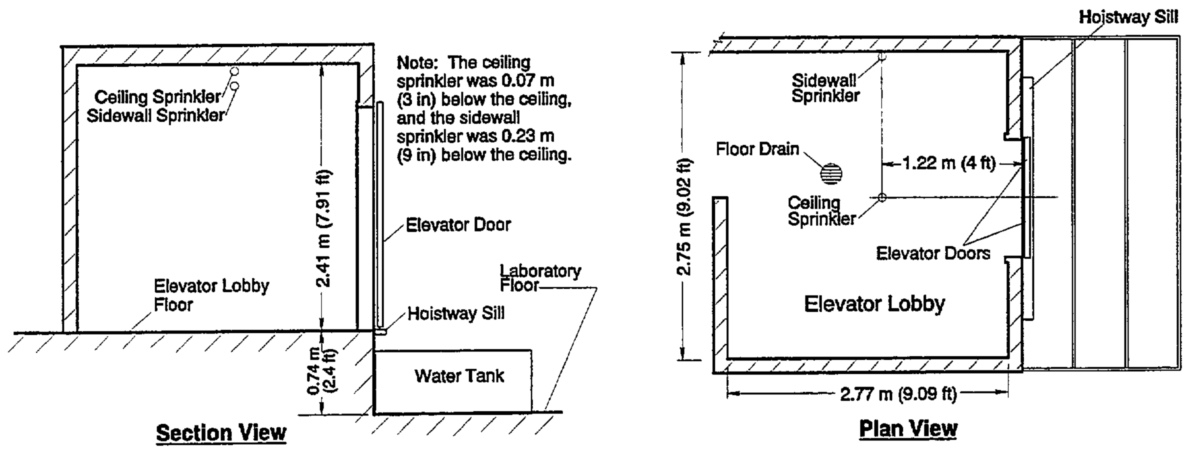


Figure 1. Laboratory facility for testing water leakage of elevator doors

or electrical components, because the authors believe that these components have no significant effect on leakage. The simulated elevator lobby facility included a ceiling sprinkler, a sidewall sprinkler and a floor drain in the elevator lobby.

3. Standard and Modified Door Gibs and Brackets

Tests were conducted with both standard and modified elevator door gibs and brackets. A gib is a part that guides the motion of a sliding elevator door (figure 2). The modified brackets were designed and supplied by an elevator manufacturer with a tab that extends into the groove on the hoistway sill with the intent of reducing leakage. The modified gibs and brackets were not tested for door operation.

4. Description of Tests

The tests were conduced with both gibs, various lobby conditions and water exposures. Table 1 is a summary list of test conditions. This list was reordered from the chronological sequence of tests in order to present a logical sequence of tests.

4.1 Sprinkler Tests With Open Floor Drain

Most of the tests (tests 1 – 6), for which sprinklers were the source of water, were conducted in the lobby as shown in figure 1 with an open floor drain. The intent of the open floor drain was to minimize the depth of water on the floor near the elevator doors so that the test results would be primarily from the sprinkler spray impinging on the elevator door and door frame. Water flowing through gaps in elevator doors collected in the tank, and the door leakage rates for these tests and all of the other tests discussed in this report were determined as described below.

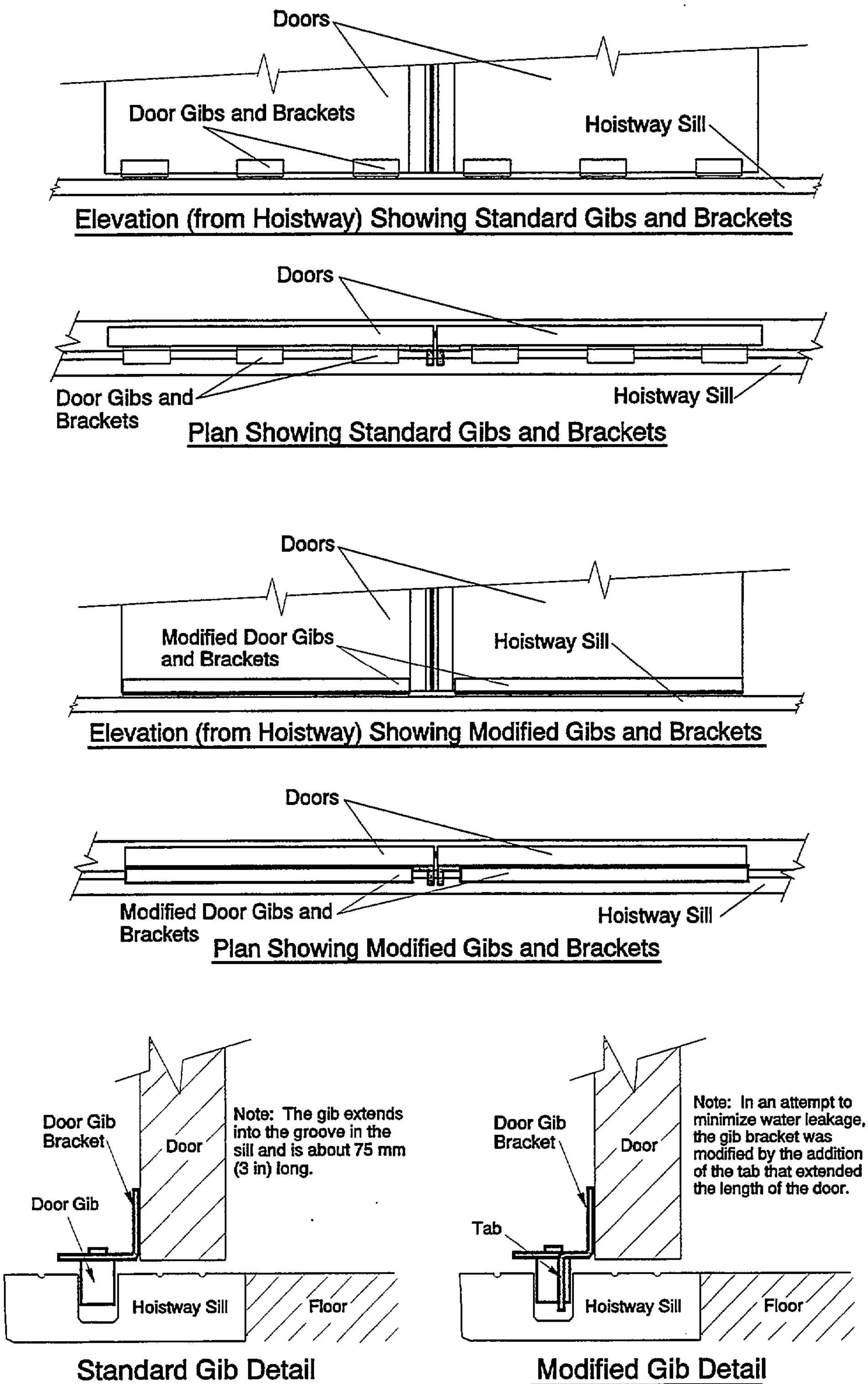


Figure 2. Standard and modified elevator door gibs and brackets

These tests included ceiling sprinkler and sidewall sprinklers. Parallel and perpendicular orientations of the support arms (figure 3) of the ceiling sprinkler were used in an effort to take into account variations in spray density on the elevator doors. For the parallel orientation, the plane formed by the centerlines of the two support arms was parallel to the plane of the elevator doors. Conversely, for the perpendicular orientation this support arm plane was perpendicular to the door plane.

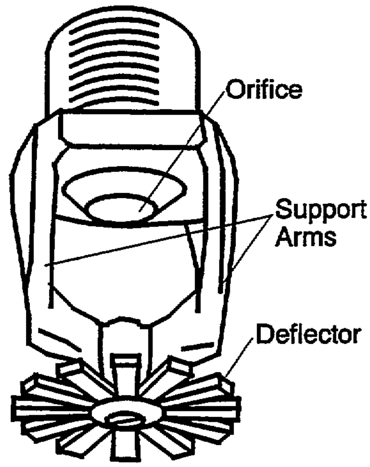


Figure 3. Typical open pendant sprinkler

4.2 Standing Water Tests

Tests 7 and 8 were conducted with a water reservoir built in the vicinity of the elevator doors in order to produce an exposure of standing water of constant depth of 12 mm (0.5 in). A weir 12 mm (0.5 in) high was built in the elevator lobby to form a reservoir around the elevator doors. Water was supplied to the reservoir such that it was full and there was a small flow over the weir. Flow restrictions were located in the reservoir as flow obstructions to reduce turbulence near the elevator doors (figure 4). It was felt that the depth of 12 mm (0.5 in) of water would be representative of many exposures due to a fire hose remote from the elevator lobby. However, further studies may be needed to evaluate the depths of standing water that are likely to occur during fire fighting.

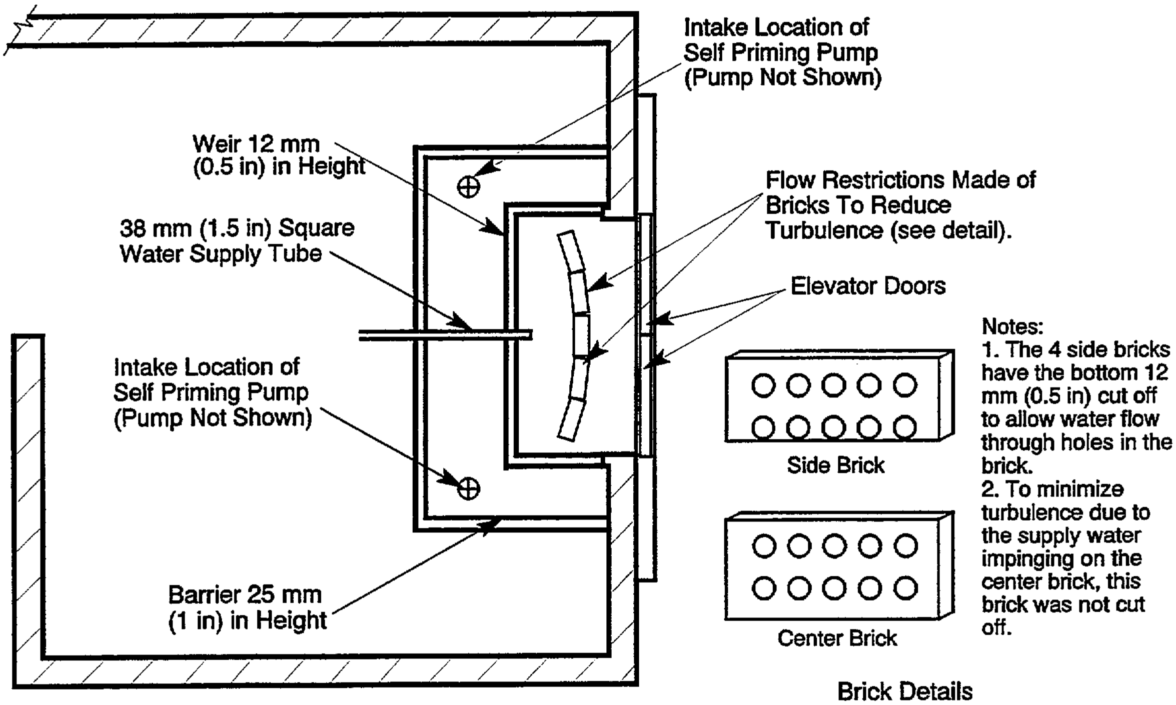


Figure 4. Set up for standing water tests

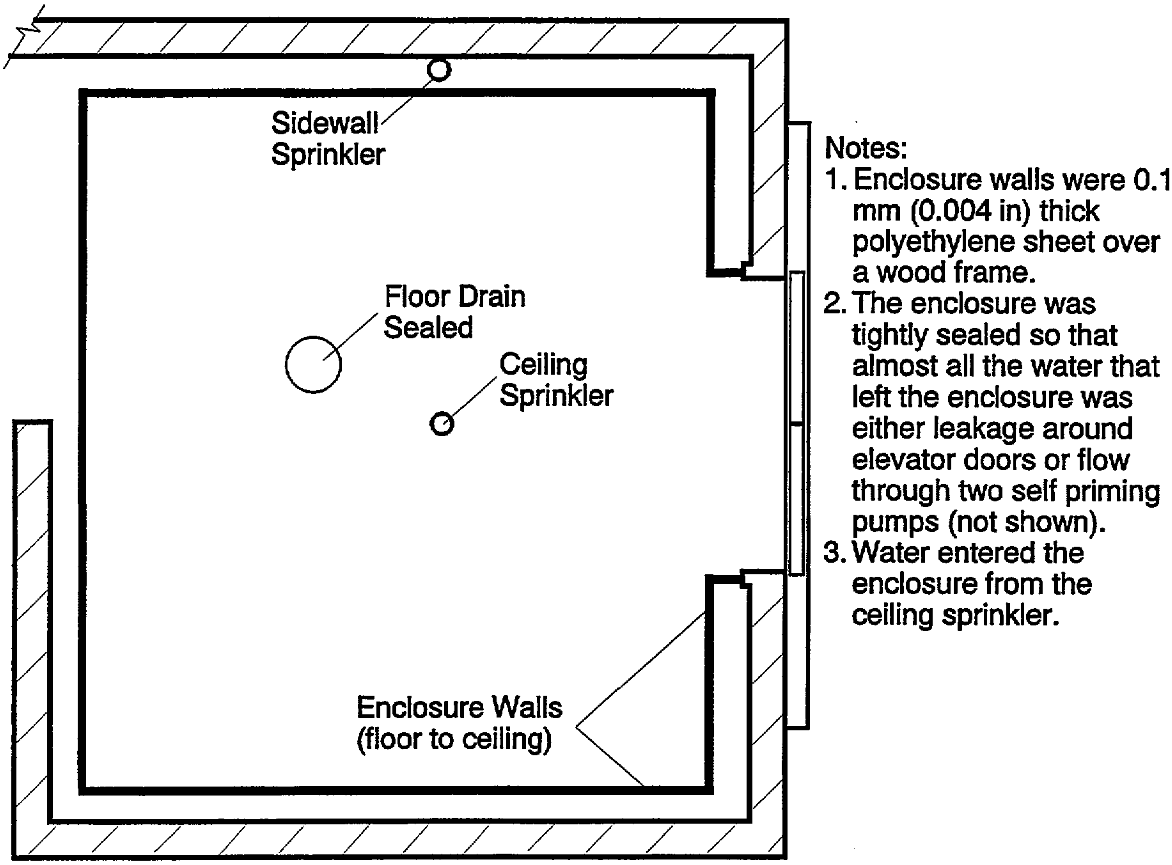


Figure 5. Test enclosure in elevator lobby

4.3 Sprinkler Tests With Enclosure

A test enclosure was built and evaluated for possible field testing. Tests 9 and 10 were conducted with this enclosure which was constructed of 0.1 mm (0.004 in) thick polyethylene sheet over a wood frame (figure 5). The enclosure was tightly constructed including sealing the floor drain so that almost all the water that left the enclosure was either leakage around the elevator doors or flow through two self priming pumps [each rated at 0.94 L/s (15 gpm)]. As is discussed later, these pumps did not remove sufficient water to maintain a low level of standing water similar to that of the sprinkler tests without an enclosure.

4.4 Fire Hose Tests

For test 11, a fire hose was hand held by three technicians standing about 2.7 m (9 ft) away from the elevator doors. The hose stream was directed at the center of the top third of the pair of doors (figure 6). The hose had a 38 mm (1.5 in) diameter stack tip nozzle that produced a solid stream.

5. Measurements

5.1 Sprinkler Flow

In order to calibrate each sprinkler head, water from the sprinkler was collected in a drum a over period of time. The flow rate was calculated by dividing the change in volume of water in the drum by the time period (figure 7). The volume of water was determined from a load cell which measured the weight of the water and the drum. The sprinkler flow was calibrated before each test in which a sprinkler was used. The sources of error in such flow calibration include supply water pressure fluctuations, errors in weight measurement, errors in timing (stop watch), and some water escaping capture in the drum. Drift of supply water pressure during the tests is another source of error. The sprinkler flows are presented later, and these flows have an estimated uncertainty of ± 0.25 L/s (± 4 gpm) defining a level of confidence of approximately 95%. Sprinkler flow measurements are listed in Table 2.

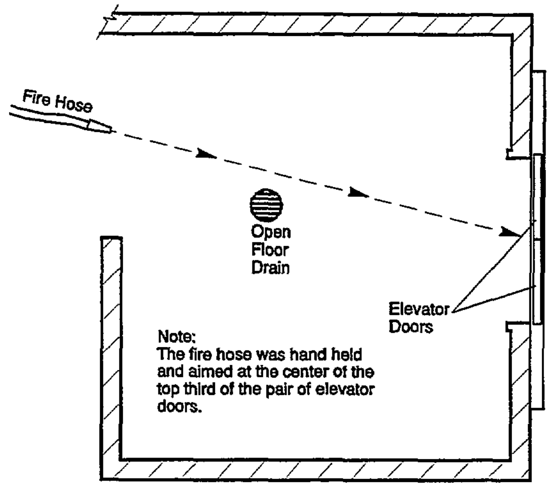


Figure 6. Set up for fire hose tests

5.2 Fire Hose Flow

The flow of the fire hose was calculated from the equation for solid hose streams (Purington 1991) using the measured pressure difference between the base of the nozzle to the atmosphere. The pressure difference was measured by a Bourdon tube gage with a range of 0 to 1720 kPa (0 to 250 psi). Sources of error for such flows include supply water pressure fluctuations, deviations from uniform flow at the nozzle inlet, and deviations in nozzle dimensions. The hose flow was 28 L/s (440 gpm) with an estimated uncertainty of ± 4 L/s (± 63 gpm) defining a level of confidence of approximately 95%.

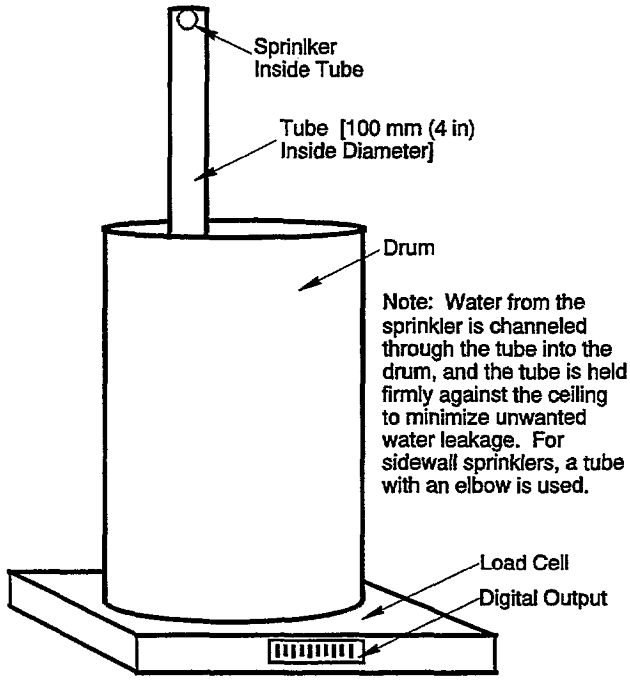
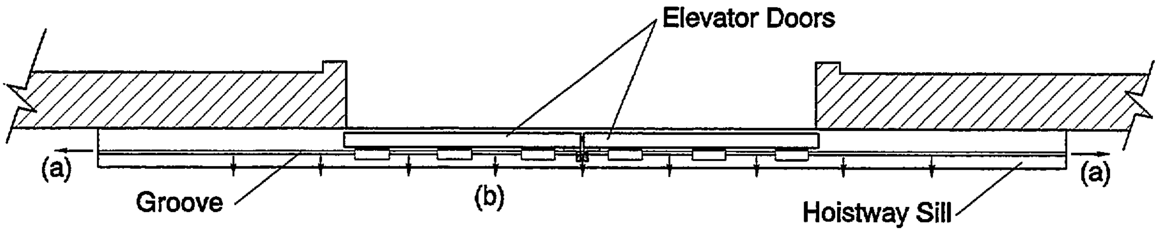


Figure 7. Set up for measuring sprinkler flow

5.3 Door Leakage

Once steady flow conditions were established, water leakage through the doors was collected over a period of time, and the flow rate was calculated by dividing the change in volume of water in the tank



Note: The water leakage at the bottom of the elevator door can be divided into two categories (a) flow channeled to the ends of the hoistway sill through the groove in the sill and (b) flow that spilled over the edge of the hoistway sill.

Figure 8. Categories of leakage flow at the bottom of the elevator doors for all the experiments other than the fire hose test

by the time period. The change in volume was determined by measurement of the depth of water in the tank. Each test was replicated three or four times, and the values presented later are averages of the replications. The door leakage measurements are discussed later, and the uncertainty of those measurements is listed in Table 3.

6. Discussion of Results

The results of the tests are summarized in table 2.

6.1 Sprinklers

For the tests 1 – 6, water exposure was by sprinklers, and the floor drain was open in the elevator lobby. For these tests, the leakage through the elevator door ranged from 0.11 to 0.30 L/s (1.7 to 4.8 gpm).

There was only a small amount of trickling flow (probably less than 1% total leakage) down the sides of the door frame. The vast majority of the water leakage was at the bottom of the elevator door set (through the gap between the doors and the hoistway sill and through the bottom of gaps between the doors and the door frame). This flow can be divided into two categories: (a) flow channeled to the ends of the hoistway sill through the groove in the sill and (b) flow that spilled over the long edge of the hoistway sill (figure 8). These categories were observed for all the tests except for the fire hose test.

6.2 Standing Water

The standing water tests (tests 7 and 8) had door leakage of 0.68 and 0.84 L/s (11 and 13 gpm). This is much greater than the 0.11 to 0.30 L/s (1.7 to 4.8 gpm) leakage of the sprinkler tests. Thus it appears that standing water would a much greater challenge to elevator operation than sprinkler flow.

While the flow restrictions in the reservoir (figure 4) helped reduce turbulence, turbulence was still visible on the surface of the water near the elevator doors. It is difficult to tell to what extent this turbulence is due to flow from the water supply tube or due to flow going through the gaps around the doors.

As already stated, the pumps in the enclosure tests (tests 9 and 10) did not remove sufficient water to maintain a low level of standing water similar to that of the sprinkler tests without an enclosure. This deeper standing water is probably the reason for the relatively high leakage of these tests. The sprinkler water application for these enclosure tests was similar to that for tests 1 and 2. However, the leakage for tests 9 and 10 was four to seven times greater than that of tests 1 and 2 (table 2). Only small leakage was observed at the sides of the door frame similar to that during tests 1 and 2. The differences between the two sets of tests are that tests 9 and 10 had deeper standing water and higher leakage than tests 1 and 2. Thus the higher flow rates with the enclosure were probably due to the standing water depth.

6.3 Test Enclosure

The intent of the test enclosure experiments (9 and 10) was to evaluate the enclosure approach for possible field testing. As already stated, the pumps in these tests did not remove sufficient water to maintain the desired water level, and unexpectedly deep levels of standing water resulted. Some possible corrections could be greater pump capacity or installation of pumps in sumps.

However, it seems that the enclosure test may not be needed for field testing. The standing water tests and the sprinkler tests both produce the same kind of leakage at the door bottom, and the trickle of water on the door side unique to the sprinkler exposure does not pose a significant threat to elevator operation. Further, the standing water tests are simpler and less time consuming to perform than the enclosure tests. Thus the standing water tests are preferable for future tests and would eliminate the added complication of the test enclosure.

6.4 Fire Hose

The leakage when the doors were exposed to a fire hose (test 11) was 13.5 L/s (210 gpm). This is at least an order of magnitude greater than the other leakages. This flow was different from the other tests in that water penetrated the "hoistway area" from: (1) the vertical gaps between the doors and the frame, (2) the horizontal gaps between the doors and the top of the frame, and (3) the gasketed gap between the two door panels. The flows at these locations consisted of forceful water jets. In a real application, these flows would expose cars in the hoistway and elevator components above and to the sides of the doors. Because of the penetrating nature of this flow, it would be difficult for this water to be channeled away from the cars or from the electrical or electronic components of the elevator doors in an operating building elevator.

6.5 Elevator Door Gibs and Brackets

As already stated, the modified door gibs and brackets were designed with the intent of reducing leakage. Tests 1 through 10 are five pairs of tests for which everything was the same except the gibs and brackets. As expected, using modified gibs and brackets in place of the standard ones resulted in reduced leakage for most of the test pairs (table 2). The exception was the first pair (tests 1 and 2) for which the flow was 43% larger with the modified gibs and brackets. The reason for this difference between these tests and the other four pairs is unknown.

For the rest of the test pairs (tests 3 – 10), the flow rates were 14% to 27% less with the modified gibs and brackets (table 2). The leakage with the standard gibs and brackets ranged from 0.13 to 0.84 L/s (2.1 to 13 gpm), and that with the modified gibs and brackets ranged from 0.11 to 0.68 L/s (1.7 to 11 gpm). Based on engineering judgement, the reduced flow rates with the modified gibs and brackets may not represent a significant improvement with respect to potential water damage to electrical or electronic components.

While the modified gibs and brackets had an effect on the flow patterns of the water after it leaked through the elevator door, this modified flow probably has little if any benefit for the application of this paper. With the exception of the fire hose exposure, the leakage flows tended to fall into two categories: (1) low flow rates and (2) high flow rates.

With leakages of 0.11 to 0.30 L/s (1.7 to 4.8 gpm), tests 1 – 6 are considered low flow rates for this paper. For these tests it was observed that the groove in the hoistway sill carried more water with the modified gibs and brackets, and less water flowed over the edge of the hoistway sill. Reduction of water flowing over this edge is desirable because this water would flow onto the elevator door below in a real application. For these tests there appeared to be the potential to channel such water from the end of the hoistway sill away from elevator components. However such an approach would deal with only a fraction of the leakage.

Leakages of 0.68 to 1.5 L/s (11 to 24 gpm) are considered high flow rates (tests 7 – 10). For these tests the type of gibs and brackets had no noticeable effect on the flow through the groove in the hoistway sill or over the edge of the hoistway sill. Because these higher leakages are the greater concern, it seems that modified gibs and brackets do not have any significant benefit with respect to flow patterns inside the hoistway. Therefore, the changes in water leakage and flow paths due to using the modified gibs and brackets are insignificant with respect to elevator water protection.

6.6 Water Flow Patterns

For the most part, the water flow patterns have already been discussed, and they are summarized below.

(1) The leakage resulting from the fire hose exposure (test 11) was different from the other tests in that jets of water were observed far beyond the elevator doors into the hoistway space and into the space above the elevator doors.
(2) A small trickle of water flowed down the sides of the door frame during the tests with sprinklers (tests 1 – 6, 9 and 10).
(3) For all tests except the fire hose test (test 11), the vast majority of the water leakage was at the bottom of the elevator door set (through the gap between the doors and the hoistway sill and through the bottom of gaps between the doors and the door frame).
(4) For all tests except the fire hose test (test 11), the flow at the bottom of the door set can be divided into two categories: (a) flow channeled to the end of the hoistway sill through the groove in the hoistway sill and (b) flow that spilled over the long edge of the hoistway sill (figure 8).

(5) For the high flow rates (tests 7 – 10), the flow category (a) was relatively small in comparison to category (b).

(6) For all tests except the fire hose test (test 11), the flow category (b) did not penetrate into the "hoistway area." However, after spilling over the edge of the sill, this flow fell and moved slightly back towards the wall under the door set. For the low flow rates (tests 1 – 6), this flow consisted of small streams flowing over the sill. For the high flow rates (tests 7 – 10), this flow tended to form a number of sheets flowing over the sill.

7. Summary and Conclusions

1. The leakage due to sprinkler exposures was mostly at the bottom of the elevator doors. Sprinkler tests 1 – 6 were developed to study sprinkler leakage in the absence of standing water exposure. During these tests, there was only a small amount of leakage at the door sides. This leakage was not significant, because it would not be able to contact elevator components of concern.

2. Standing water resulted in significantly greater leakage than that due to sprinkler exposures. While the standing water of tests 7 and 8 had leakages of 0.84 and 0.68 L/s (13 and 11 gpm) respectively, the leakage of the sprinkler tests (tests 1 – 6) ranged from 0.11 to 0.3 L/s (1.7 to 4.8 gpm). Further, the significant standing water of the enclosure tests (tests 9 and 10) was probably the cause of the high leakage flows of these 2.7 and 2.8 L/s (43 and 44 gpm).

3. A test enclosure was evaluated for possible application in field testing. However, this enclosure would probably not be needed, because the simpler standing water test produces the same kind of leakage at the bottom of the door and the side door leakage is not of concern.

4. Changes in water leakage and flow paths due to using the modified gibs and brackets are insignificant with respect to elevator water protection.

5. Water protection by shielding components and directing water flow away from components may be feasible for the water exposures of this report (tests 1 – 10) with the exception of the fire hose exposure (test 11). The water leakage from tests 1 – 10 at the bottom of the elevator doors can be divided into two categories: (a) flow channeled to the end of the hoistway sill through the groove in the hoistway sill and (b) flow that spilled over the long edge of the hoistway sill (figure 8). Category (b) leakage fell and moved slightly back towards the wall under the door set. Because none of this leakage penetrated into the hoistway, shielding components and directing water flow away from components may be feasible for the water exposures of tests 1 – 10.

6. The water leakage due to the fire hose exposure (test 11) was a very large and penetrating flow of about 13.5 L/s (210 gpm). Jets of water were observed far beyond the elevator doors into the hoistway space and into the space above the elevator doors. Protection of elevator components from this type of water exposure may not be practical.

8. Acknowledgements

The authors wish to acknowledge all of the input of the members of the ASME Task Group of Elevators and Fires. This task group consisted of representatives of industry, consulting firms, the fire service, and several other government agencies. Each task group participant gave freely of their time, and the interchange of ideas and insights that resulted was most helpful to this project. Chief John J. Hodgens of the New York City Fire Department (NYCFD) identified the concern with water and elevator fire use. Chief Hodgens and other members of the NYCFD participated in the ASME Task Group, and particular thanks are due to Chief Edmond P. Cunningham and Chief Herbert (Ted) V. Rohlfing. This project could not have been accomplished without the highly competent contributions of NIST technicians Gary Roadamerl, Laurean DeLauter and Jack Lee. Thanks are also due to NEII members for supplying elevator door sets. In particular thanks are due to the NEII Project Team: Edwin M. Philpot, Edward A. Donoghue and John J. Faup.

9. References

ASME 1991. Symposium on Elevators and Fire, Baltimore MD, Feb 19 and 20, 1991, American Society of Mechanical Engineers, New York.

ASME 1995. The 2nd Symposium on Elevators, Fire, and Accessibility, Baltimore MD, March 19–21, 1991, American Society of Mechanical Engineers, New York.

Purington, R.G. 1991. Section5/Chapter 7 *Fire Streams*, Fire Protection Handbook, 17th Ed, NFPA, Quincy, MA.

Klote, J.H., Deal, S.P., Levin, B.M., Groner, N.E., and Donoghue, E.A. 1992. Workshop on Elevator Use During Fires, National Institute of Standards and Technology, NISTIR 4993.

Table 1. Summary of Door Leakage Tests

Test	Elevator Lobby Condition	Type of Gibs[1]	Type of Water Exposure
1	Open Floor Drain	S	Ceiling Sprinkler (Perpendicular[2])
2	Open Floor Drain	M	Ceiling Sprinkler (Perpendicular[2])
3	Open Floor Drain	S	Ceiling Sprinkler (Parallel[2])
4	Open Floor Drain	M	Ceiling Sprinkler (Parallel[2])
5	Open Floor Drain	S	Sidewall Sprinkler
6	Open Floor Drain	M	Sidewall Sprinkler
7	Water Reservoir	S	Standing Water
8	Water Reservoir	M	Standing Water
9	Test Enclosure	S	Ceiling Sprinkler (Perpendicular[2])
10	Test Enclosure	M	Ceiling Sprinkler (Perpendicular[2])
11	Open Floor Drain	M	Fire Hose

[1]S indicates standard gibs and brackets, and M indicates modified gibs and brackets.
[2]Parallel indicates that the support arms of the sprinkler were parallel to the elevator doors, and perpendicular indicates that the support arms of the sprinkler were perpendicular to the elevator doors to the elevator doors.

Table 2. Results of Door Leakage Tests

Test	Type of Gibs[1]	Type of Water Exposure	Water Exposure		Measured Water Leakage L/s	(gpm)	Change With Modified Gibs[2]
1	S	Ceiling Sprinkler (Perpendicular[3])	2.8 L/s	(44 gpm)	0.21	(3.3)	+43%
2	M	Ceiling Sprinkler (Perpendicular[3])	2.9 L/s	(46 gpm)	0.30	(4.8)	
3	S	Ceiling Sprinkler (Parallel[3])	2.9 L/s	(46 gpm)	0.22	(3.5)	−27%
4	M	Ceiling Sprinkler (Parallel[3])	2.8 L/s	(44 gpm)	0.16	(2.5)	
5	S	Sidewall Sprinkler	2.8 L/s	(44 gpm)	0.13	(2.1)	−15%
6	M	Sidewall Sprinkler	2.8 L/s	(44 gpm)	0.11	(1.7)	
7	S	Standing Water	12 mm	(0.5 in)	0.84	(13)	−19%
8	M	Standing Water	12 mm	(0.5 in)	0.68	(11)	
9	S	Ceiling Sprinkler[4] (Perpendicular[3])	2.7 L/s	(43 gpm)	1.50	(24)	−14%
10	M	Ceiling Sprinkler[4] (Perpendicular[3])	2.8 L/s	(44 gpm)	1.30	(21)	
11	M	Fire Hose	28 L/s	(440 gpm)	13.5	(210)	NA

[1]S indicates standard gibs and brackets, and M indicates modified gibs and brackets.
[2]The change is the change in leakage with the modified gibs and brackets opposed to that with the standard gibs and brackets. This change was calculated as $100\,(F_m - F_s)/F_s$, where F_m is the leakage with a modified gibs and brackets and F_s is the leakage with standard gibs and brackets.
[3]Parallel indicates that the support arms of the sprinkler were parallel to the elevator doors, and perpendicular indicates that the support arms of the sprinkler were perpendicular to the elevator doors to the elevator doors.
[4]These tests were conducted to evaluate the test enclosure for field use, and an unknown quantity of standing water resulted.

Table 3. Uncertainty of Water Leakage Measurements

Test	Type of Gibs[1]	Type of Water Exposure	Number of Replicates	Mean Leakage L/s	Standard Deviation L/s	Uncer-tainty[2] L/s	Uncer-tainty[2] %
1	S	Ceiling Sprinkler (Perpendicular)	4	0.21	0.024	0.066	31
2	M	Ceiling Sprinkler (Perpendicular)	4	0.30	0.018	0.049	17
3	S	Ceiling Sprinkler (Parallel)	3	0.22	0.005	0.017	8
4	M	Ceiling Sprinkler (Parallel)	3	0.16	0.007	0.022	13
5	S	Sidewall Sprinkler	4	0.13	0.004	0.011	9
6	M	Sidewall Sprinkler	3	0.11	0.003	0.009	9
7	S	Standing Water	3	0.84	0.047	0.15	18
8	M	Standing Water	3	0.68	0.026	0.082	12
9	S	Ceiling Sprinkler (Perpendicular)	3	1.50	0.094	0.30	20
10	M	Ceiling Sprinkler (Perpendicular)	3	1.30	0.002	0.006	0.5
11	M	Fire Hose	1	13.5	NA	1.9	14

[1]S indicates standard gibs and brackets, and M indicates modified gibs and brackets.
[2]The uncertainty is based on a t−distribution, and the interval defined by the mean ± the uncertainty is believed to represent a level of confidence of approximately 95%, except for the leakage due to the fire hose (test 11) where the uncertainty was taken to be the same as the average of the percent uncertainties for the other tests.
[2]This uncertainty is expressed as the percent of the mean leakage.

NIST-114
(REV. 6-93)
ADMAN 4.09

U.S. DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

MANUSCRIPT REVIEW AND APPROVAL

(ERB USE ONLY)

ERB CONTROL NUMBER	DIVISION
PUBLICATION REPORT NUMBER	CATEGORY
NISTIR 5925	
PUBLICATION DATE	NUMBER PRINTED
December 1996	

INSTRUCTIONS: ATTACH ORIGINAL OF THIS FORM TO ONE (1) COPY OF MANUSCRIPT AND SEND TO THE SECRETARY, APPROPRIATE EDITORIAL REVIEW BOARD.

TITLE AND SUBTITLE (CITE IN FULL)

Water Leakage of Elevator Doors With Application to Building Fire Suppression

CONTRACT OR GRANT NUMBER

TYPE OF REPORT AND/OR PERIOD COVERED

AUTHOR(S) (LAST NAME, FIRST INITIAL, SECOND INITIAL)

John H. Klote, Emil Braun

PERFORMING ORGANIZATION (CHECK (X) ONE

- [X] NIST/GAITHERSBURG
- [ ] NIST/BOULDER
- [ ] JILA/BOULDER

LABORATORY AND DIVISION NAMES (FIRST NIST AUTHOR ONLY)

Fire Safety Engineering Division, Building & Fire Research Laboratory

SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (STREET, CITY, STATE, ZIP)

Cooperative Research with
National Elevator Industry Incorporated
Fort Lee, NJ

PROPOSED FOR NIST PUBLICATION

- [ ] JOURNAL OF RESEARCH (NIST JRES)
- [ ] J. PHYS. & CHEM. REF. DATA (JPCRD)
- [ ] HANDBOOK (NIST HB)
- [ ] SPECIAL PUBLICATION (NIST SP)
- [ ] TECHNICAL NOTE (NIST TN)
- [ ] MONOGRAPH (NIST MN)
- [ ] NATL. STD. REF. DATA SERIES (NIST NSRDS)
- [ ] FEDERAL INF. PROCESS. STDS. (NIST FIPS)
- [ ] LIST OF PUBLICATIONS (NIST LP)
- [X] NIST INTERAGENCY/INTERNAL REPORT (NISTIR)
- [ ] LETTER CIRCULAR
- [ ] BUILDING SCIENCE SERI
- [ ] PRODUCT STANDARDS
- [ ] OTHER

PROPOSED FOR NON-NIST PUBLICATION (CITE FULLY) [ ] U.S. [ ] FOREIGN

PUBLISHING MEDIUM

- [ ] PAPER
- [ ] C
- [ ] DISKETTE (SPECIFY)
- [ ] OTHER (SPECIFY)

SUPPLEMENTARY NOTES

ABSTRACT (A 2000-CHARACTER OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRA OR LITERATURE SURVEY, CITE IT HERE. SPELL OUT ACRONYMS ON FIRST REFERENCE.) (CONTINUE ON SEPARATE PAGE, IF NECESSARY.)

In recent years, considerable interest has been expressed in improving elevator use during fires. Water exposure due to sprinklers and fire hoses is a major concern with the use of elevators during fires, because of the effect that water can have on electrical and electronic elevator components. This paper describes the first phase of a project which comprised a series of laboratory tests to: (1) determine typical flow rates of water through elevator doors, (2) observe water leakage patterns, (3) evaluate the performance of modified door gibs and brackets intended to reduce or redirect water leakage, and (3) evaluate a test enclosure concept for possible field testing. A facility was constructed to represent an elevator lobby with the capability of exposing a pair of elevator doors to sprinkler spray, fire hose stream and 12 mm (0.5 in) deep standing water.

KEY WORDS (MAXIMUM OF 9; 28 CHARACTERS AND SPACES EACH; SEPARATE WITH SEMICOLONS; ALPHABETIC ORDER; CAPITALIZE ONLY PROPER NAME

doors; elevators (lifts); fire suppression; fire fighting; water.

AVAILABILITY

- [X] UNLIMITED
- [ ] FOR OFFICIAL DISTRIBUTION - DO NOT RELEASE TO NTIS
- [ ] ORDER FROM SUPERINTENDENT OF DOCUMENTS, U.S. GPO, WASHINGTON, DC 20402
- [X] ORDER FROM NTIS, SPRINGFIELD, VA 22161

NOTE TO AUTHOR(S): IF YOU DO NOT WISH THIS MANUSCRIPT ANNOUNCED BEFORE PUBLICATIO PLEASE CHECK HERE. [ ]

ELECTRONIC FORM