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*Water Mist System Test Methods:
Comparison of FM, UL and IMO
Procedures*



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OUTLINE

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- Water Mist Standard Background
 - FM 5560
 - UL 2167
 - IMO Resolutions
 - NFPA 750
- Comparison of Light/Ordinary Hazard Requirements
- Comparison of Machinery Space Requirements
- Questions
- San Antonio Sights



INTRODUCTION

Hazard/Occupancy	FM 5560	UL 2167	IMO Resolution	NFPA 750*
Light/Ordinary Hazard	Appendix G	Sections 41-43, 45-46	MSC.265, Sections 5-7	Chapter 10, Annex C
Cabin/Corridor	Section G.4.1-G.4.2	Sections 41-42, 45	Section 5	Chapter 10, Annex C
Public/Open Spaces	Section G.4.3-G.4.5	Sections 43, 46	Section 6	Chapter 10, Annex C
Storage/Ord. Spaces	N/A	Sections 43, 46	Section 7	Chapter 10, Annex C
Machinery Spaces	Appendix A, C and E	Section 40	1165/1237/1269	Chapter 16, Annex C
Turbine Spaces	Appendix B, D and F	Section 40	1165/1237/1269	Chapter 16, Annex C
Local Applications	Appendix I	N/A	913/1387	Chapter 16, Annex C
Residential Applications	N/A	Section 44	N/A	Chapter 10, Annex C
Roll-on / Roll-off Spaces on a Ship	N/A	N/A	1272	N/A
Balcony Spaces on a Ship	N/A	N/A	1268	N/A

* Annex C of NFPA 750 provides a good overview of different fire test protocols, but it is not completely up to date.



INTRODUCTION

Photos of Selected Tests in Progress



TEST STANDARD BACKGROUND

FM 5560

- FM 5560, Approval Standard for Water Mist Systems
- Sections 1-3: Introduction, General Information and General Requirements.
- Section 4: Performance Requirements (system component testing)
- Section 5: Operations Requirements (QA testing)
- Appendices: Fire Test Methods
 - A-F: Machinery and Turbine Spaces
 - G: Hazard Category 1 (HC-1) [previously called Light Hazard]
 - H: Wet Bench
 - I: Local Application



TEST STANDARD BACKGROUND

FM 5560 (cont.)

- Appendices: Fire Test Methods (cont.)
 - J: Industrial Oil Cookers
 - K: Computer Room Raised Floors
 - L: Continuous Wood Board Presses
 - M: Chemical Fume Hoods (not included in Annex C of 2015 edition of NFPA 750)
- New Fire Test Methods (2016 Edition)
 - N: Data Processing Equipment Rooms/Halls – Above Raised Floor
 - O: Data Processing Equipment Rooms/Halls – Below Raised Floor
 - P: Scaling Methodology for Machinery/Turbine Spaces
 - Froude Modeling - Scaling relationships given to adjust nozzles and test setup as appropriate



TEST STANDARD BACKGROUND

UL 2167

- UL 2167, Water Mist Nozzles for Fire Protection Service
- Sections 1-7: Introduction, General Information and Construction Requirements.
- Section 8-39: Performance Requirements (system component testing)
- Section 40-47: Fire Testing
 - Section 40: Shipboard Machinery Spaces
 - Section 41: Shipboard Passenger Cabin
 - Section 42: Shipboard Passenger Cabin Greater than 12 m²
 - Section 43: Shipboard Public Spaces



TEST STANDARD BACKGROUND

UL 2167 (cont.)

- Section 40-47: Fire Testing
 - Section 44: Residential Areas
 - Section 45: Light Hazard Areas
 - Section 46: Ordinary Hazard Group 1 Areas
 - Section 47: Ordinary Hazard Group 2 Areas
- Section 48: Manufacturing and Production Tests
- Section 49-50: Instructions and Marking



TEST STANDARD BACKGROUND

IMO Resolutions

- Individual resolutions for each type of test method
- Machinery/Pump Room Space Protection
 - IMO 1165 (2005), Revised Guidelines for the Approval of Equivalent Water-Based Fire Extinguishing Systems for Machinery Spaces and Cargo Pump Rooms
 - This basically replaced the previous version published in MSC/Circ. 668 and 728, which is still referenced in NFPA 750
 - Appendix A of the Annex contains definitions, requirements for system component testing and guidance on nozzle markings
 - Appendix B of the Annex contains the fire test procedures, which are very similar to FM 5560 (Appendix E) and UL 2167 (Section 40)
 - IMO 1237 (2007), Revised Drawings for IMO 1165 fire test procedures
 - IMO 1269 (2008), Additional editorial and technical changes to 1165



TEST STANDARD BACKGROUND

IMO Resolutions (cont.)

- Cabin, Corridor, Public Spaces and Storage Space Protection
 - IMO MSC.265 (2008), Amendments to the Revised Guidelines for the Approval of Sprinkler Systems Equivalent to that Referred to in SOLAS Regulation II-2/12 (Resolution A.800(19))
 - Appendix 2 of the Annex basically replaced Appendix 2 of MSC/Circ. 800, which is still referenced in NFPA 750
 - The primary difference is that the Luxury Cabin tests are no longer included in MSC.265
 - Section 5 includes requirements for Cabin and Corridor tests
 - Section 6 includes requirements for the Public Spaces tests
 - Section 7 includes requirements for the Storage tests
 - FM 5560 (Appendix G) does not include storage tests, but does include a 'Large Compartment' test, which is basically the old Luxury Cabin Test described in MSC/Circ. A.800 (Appendix 2)



TEST STANDARD BACKGROUND

IMO Resolutions (cont.)

- Local Application Protection
 - IMO MSC/Circ. 913 (1999), Guidelines for the Approval of Fixed Water-Based Local Application Fire-Fighting Systems for use in Category A Machinery Spaces
 - The Appendix describes the fire test procedures, which include two different size spray fires, tested at different locations under a nozzle grid at minimum and maximum heights above the spray fire.
 - IMO MSC/Circ. 1387 (2010), Revised Guidelines for the Approval of Fixed Water-Based Local Application Fire-Fighting Systems for use in Category A Machinery Spaces
 - Fire test procedures are basically unchanged, but more clear guidance given as to how the results are used in a real installation after approval is obtained.
 - FM 5560 (App. I) requires many more tests, such as square and channel pool fires, combination spray/pool fires and obstructed fires.



TEST STANDARD BACKGROUND

IMO Resolutions (cont.)

- Other Applications
 - IMO MSC/Circ. 1268 (2008), Guidelines for the Approval of Fixed Pressure Water-Spraying and Water-Based Fire-Extinguishing Systems for Cabin Balconies
 - The Appendix describes the fire test procedures, which include similar fuel loads as used in cabin and corridor test from MSC.265 with and without a crosswind through the test volume.
 - IMO MSC/Circ. 1272 (2008), Revised Guidelines for the Approval of Fixed Water-Based Fire-Fighting Systems for RO-RO Spaces and Special Category Spaces Equivalent to that Referred to in Resolution A.123(V).
 - This circular supersedes IMO/Circ. 914.
 - The Appendix describes fire scenarios in roll-on and roll-off deck operations (freight truck trailer and passenger vehicle fires simulated with pallets).



TEST STANDARD BACKGROUND

NFPA 750

- NFPA 750, Standard on Water Mist Fire Protection Systems
- This standard focuses on guidance for the design, installation and maintenance of these systems, as opposed to the approval fire testing required. This is akin to most NFPA standards in the area of active fire protection, which rely on FM and UL standards for the fire test approval and listing
- Chapter 9: discusses design objectives and generic fire test protocols and makes reference to annex language.
- Chapter 10: discusses different occupancies and their associated requirements
- Chapter 16: discusses marine systems and the IMO requirements.
- Annex C: summarizes the various fire test protocols (FM, UL, IMO)



Comparison of Light/Ordinary Hazard Requirements (1 of 3)

- FM considers the same small cabin (3x4x2.4-m high) as IMO and UL and also considers a Large Compartment, similar to the old Luxury Cabin in IMO and the Large Compartment in UL (Section 42).
- FM does not consider storage spaces (Ordinary Hazard 1 or 2 in UL, Storage Spaces in IMO).
- FM considers Open Space tests at a 5-m height, but does not consider them at a 2.5-m height, as in IMO.
- FM requires 5 tests (light hazard only), IMO requires 19 tests and UL could require more than 30 tests, as applicable.

Hazard/Occupancy	FM 5560	UL 2167	IMO Resolution
Light/Ordinary Hazard	Appendix G	Sections 41-43, 45-46	MSC.265, Sections 5-7
Cabin/Corridor	Section G.4.1-G.4.2	Sections 41-42, 45	Section 5
Public/Open Spaces	Section G.4.3-G.4.5	Sections 43, 46	Section 6
Storage/Ord. Spaces	N/A	Sections 43, 46	Section 7



Comparison of Light/Ordinary Hazard Requirements (2 of 3)

- The fuel loads are very similar between FM, UL and IMO methods, however, a different foam is used in the Large Compartment (FM) test and Luxury Cabin test (UL).
- All standards define the fuel load materials in terms of material flammability performance in various bench-scale fire test methods. FM uses the Fire Propagation Apparatus for some of these materials, while UL and IMO use the Cone Calorimeter.

Table G.3.1 – Required Burning Characteristics of Foam Mattress Material

Property	Test Method	Requirement
Chemical Heat of Combustion	ASTM E 2058-02a, <i>Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)</i> , at 30 kW/m ²	17 kJ/g ± 3 kJ/g
Peak Heat Release Rate (HRR)		190 kW/m ² ± 30 kW/m ²

<i>ISO STANDARD 5660: Cone calorimeter test</i>	
Test conditions: Irradiance 35 kW/m ² . Horizontal position.	
Sample thickness 50 mm. No frame retainer should be used.	
Test results	Foam
Time to ignition (s)	2-6
3 min average HRR, q180 (kW/m ²)	270 ± 50
Minimum heat of combustion (MJ/kg)	25
Total heat release (MJ/m ²)	50 ± 12



Comparison of Light/Ordinary Hazard Requirements (3 of 3)

- For the storage tests, standard Group A plastic commodity is specified in IMO and UL for Ordinary 2, and Class II commodity is used for UL for Ordinary 1. For light hazard in UL, wood cribs are used, in addition to the shipboard requirements given in IMO.
- Nozzles are automatically activated in all testing (FM, UL and IMO).
- The fire test acceptance criteria is a function of maximum developed temperatures within the test setup (gas temperature, surface temperature) as well as the amount of damage observed to the standard test fuels.
- FM uses instantaneous temperature, while IMO and UL use a 30-s running average to evaluate the peak gas and surface temperatures during testing.



Comparison of Machinery Space Hazard Requirements (1 of 3)

- FM has separate appendices to 5560 that describe test procedures and requirements for different ranges of volumes for machinery and turbine spaces.
 - Appendix A/B: volumes not exceeding 80 m³ (2825 ft³)
 - Appendix C/D: volumes not exceeding 260 m³ (9175 ft³)
 - Appendix E/F: volumes exceeding 260 m³ (9175 ft³)
- Primary difference between machinery space tests and turbine space tests is the required spray cooling test in addition to the optional turbine insulation tests (saturated mat and spray fires).
- Appendix A-D uses a horizontal steel plate with angled baffle plates to simulate the engine/turbine, while E/F use a larger engine mockup, which is the same as specified in UL and IMO.

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Comparison of Machinery Space Hazard Requirements (2 of 3)

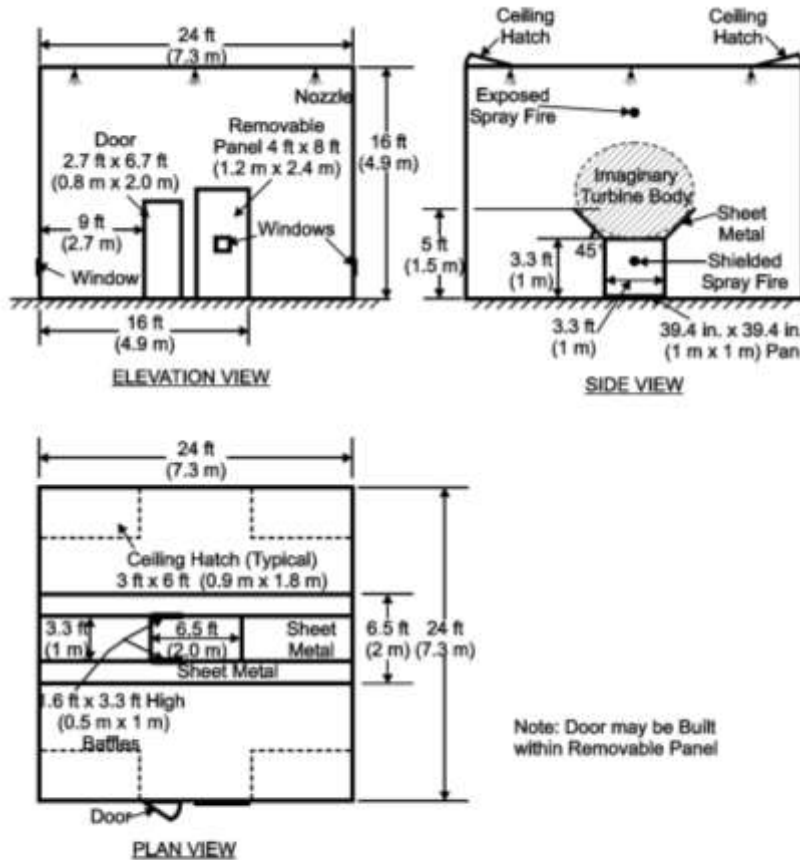


Figure D-1. Test Enclosure and Combustion Turbine Simulator Steel Plate

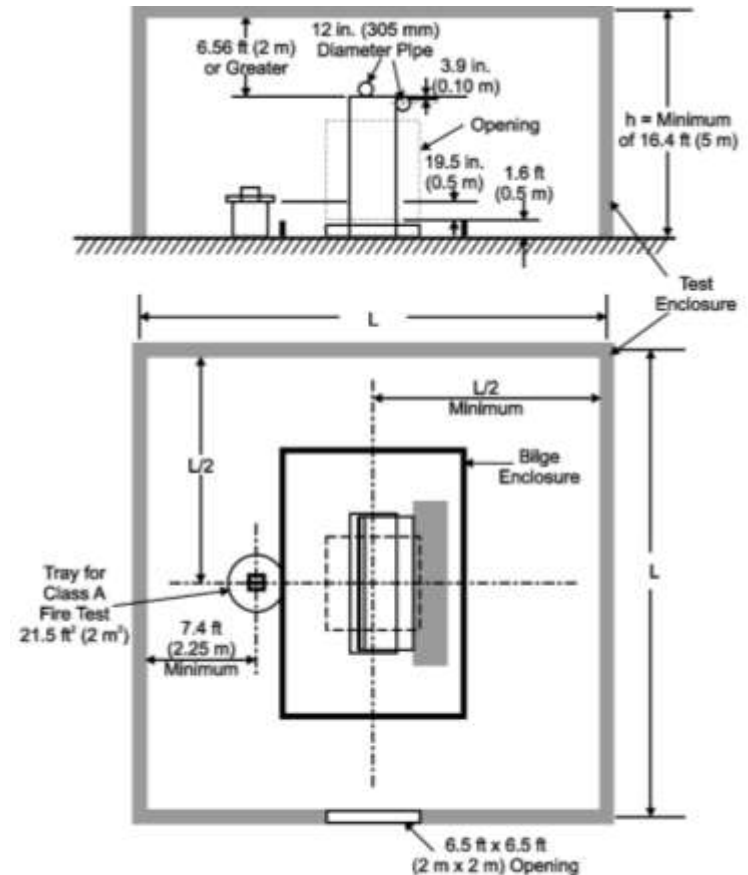


Figure E-1. Test Enclosure



Comparison of Machinery Space Hazard Requirements (3 of 3)

- The IMO and UL procedures also include bilge fire tests and IMO also includes thermal management tests.
- The bilge fire tests consist of three different pool fires (small pool with heptane and motor oil and larger pool fire with diesel fuel).
- The thermal management tests are large shielded pool fires that are sized as a function of the test enclosure. The system is discharged while the fire is burning and the 1-min peak running average temperature must be maintained below 100 °C.
- For IMO, all fires must be extinguished within 15 minutes.
- For UL and FM, there is no maximum extinguishment time, but the system must be designed to twice the capacity of the longest extinguishment time.



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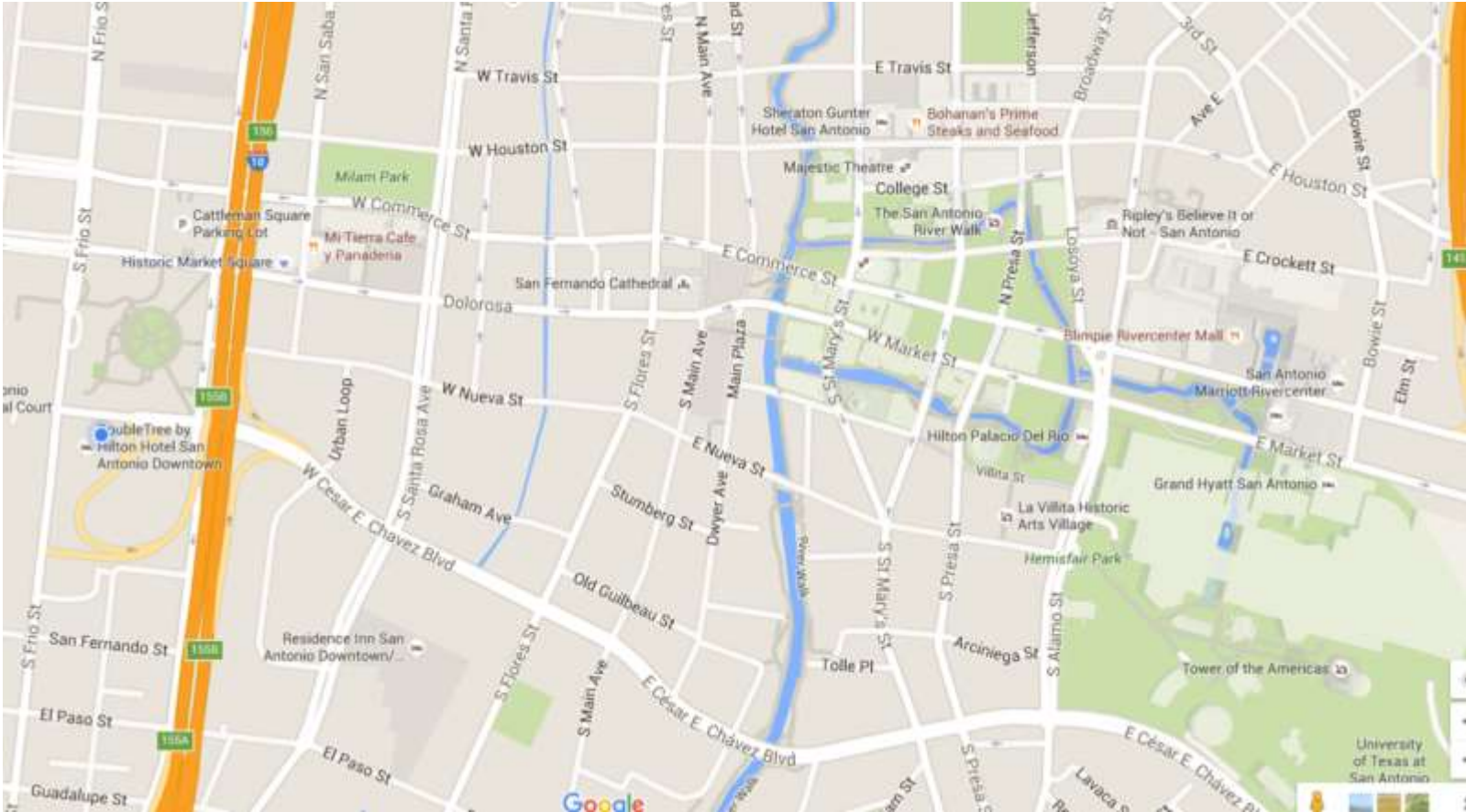


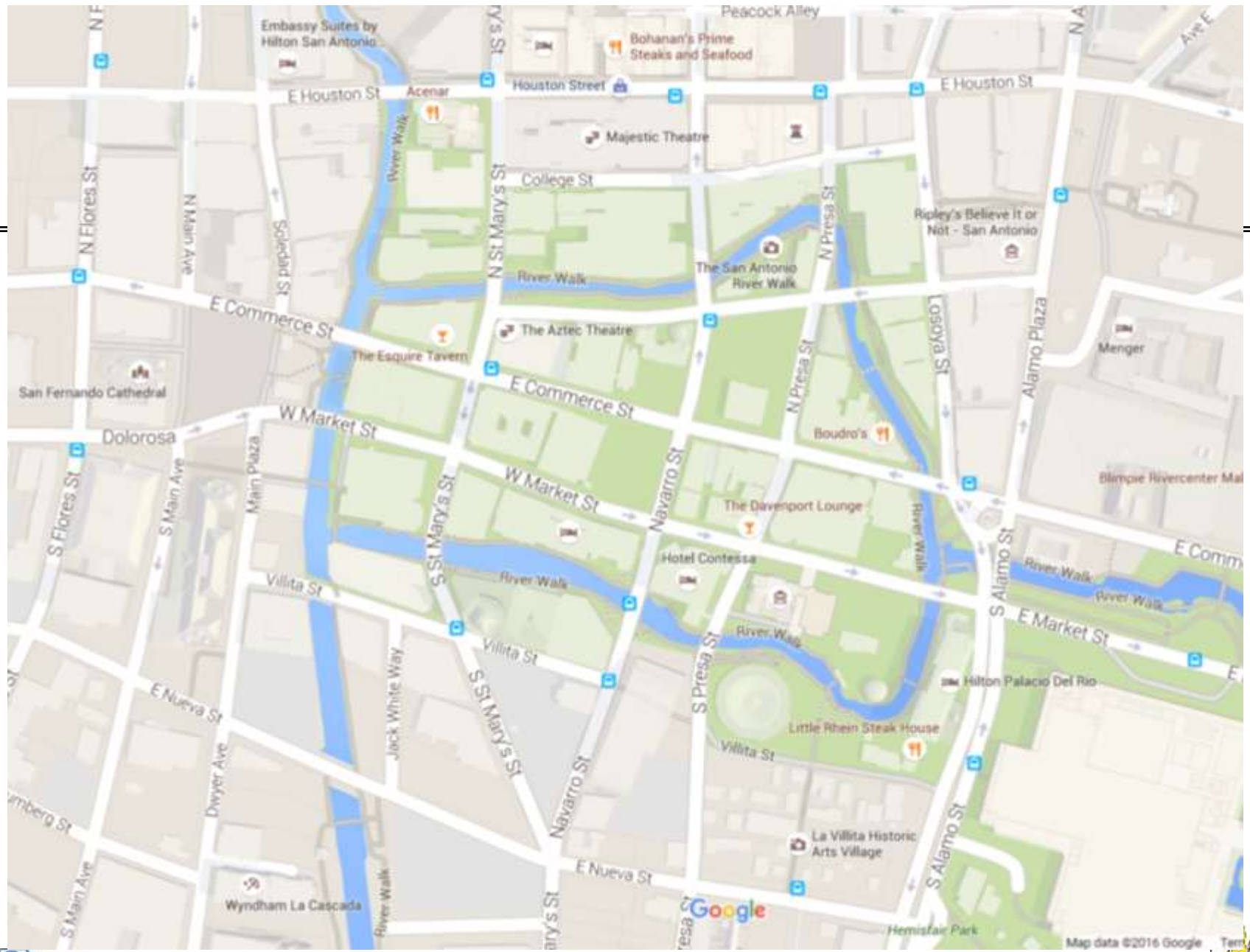
QUESTIONS?



<http://www.fire.swri.org>

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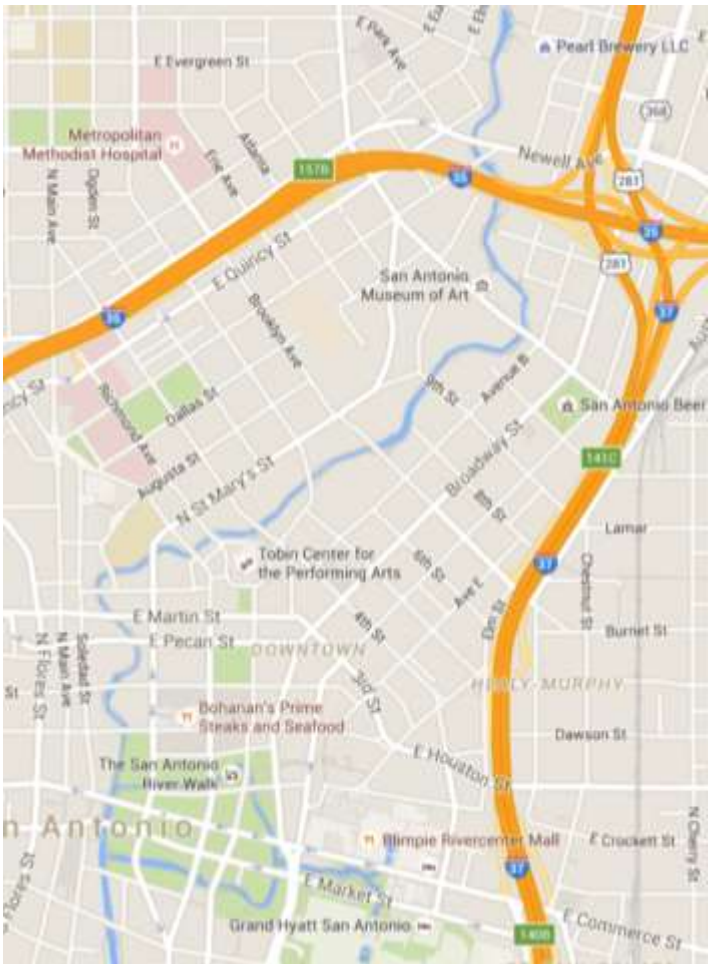




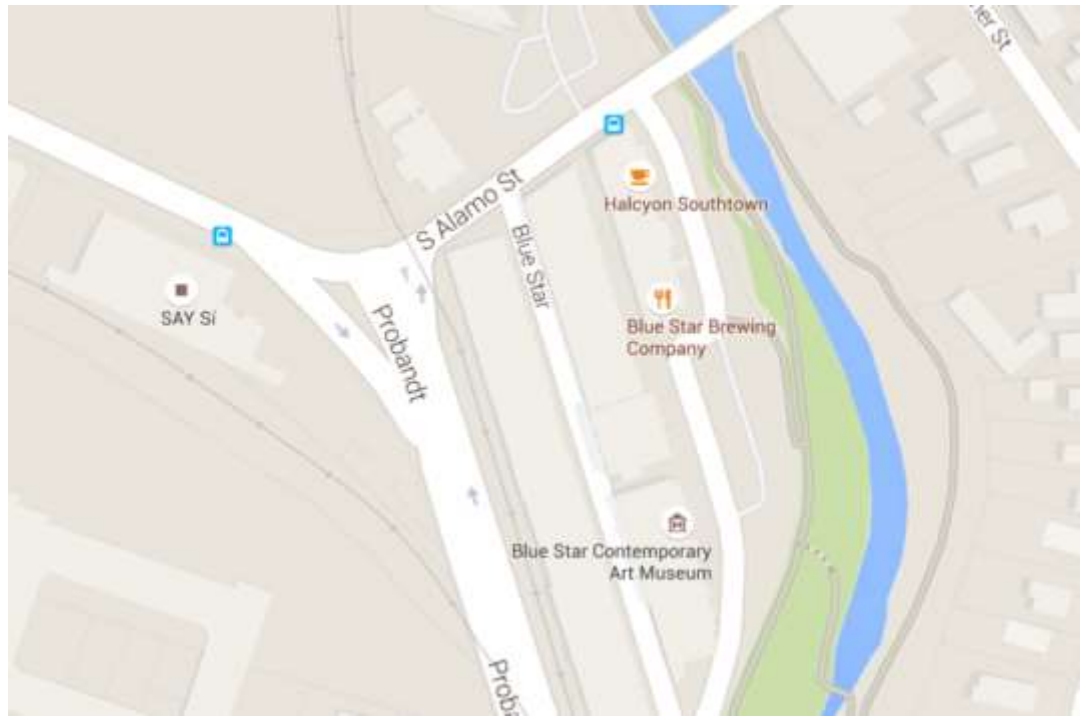
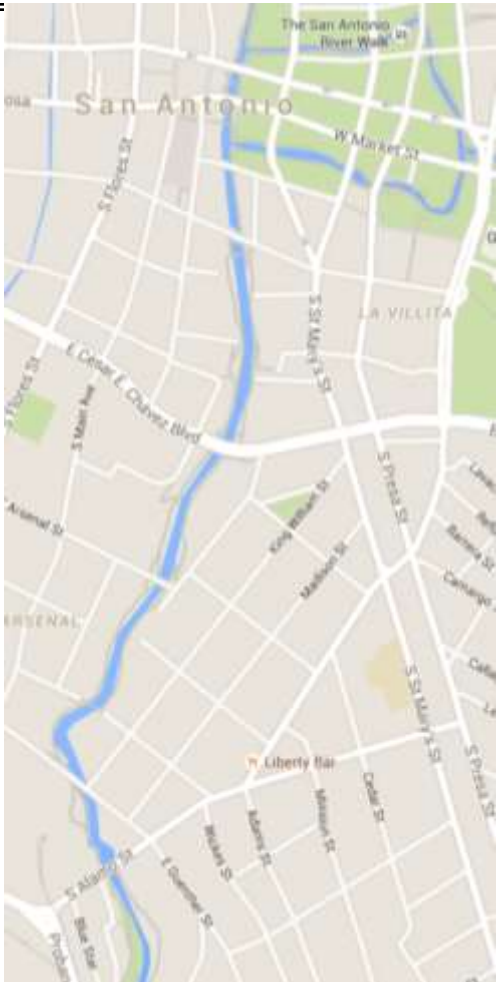
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