Tank-and-Pump Systems: Analysis and Assessment Test Plan

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Tank and Pump Systems: Analysis and Assessment Test Plan

Dates August 2017 through October 2018	
Location Test site: Selma, AL	
Supplier partners General Air Products, Talco Fire Systems, W.S. Darley & Co.	
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Goal

The objective of these tests is to assess the ease of installation, commissioning and operation of alternative tank-and-pump system (TPS) designs. The results will inform FEMA's design specifications for future TPS acquisition and identify changes that will reduce installation time and result in more durable, higher quality Manufactured Housing Unit (MHU) designs. Three supplier-developed designs will be evaluated with regard to ease of installation into the home, connection to distribution and monitoring systems, commissioning, system operation, usability, serviceability, decommissioning, and removal.

Scope of Work

Prior to the tests, two prototype MHUs were constructed. The units are equipped with sprinkler-pipe distribution systems and hardware required to connect the fire suppression system, including:

- Electrical: power supply box, conduit for annunciator panel, back box for alarm
- Plumbing: floor drain, drain-and-vent manifold, riser connection
- Vinyl flooring to later be covered by waterproof membrane
- Ratchet straps for securing TPS in closet
- Distribution system: pipes, risers, sprinkler heads, sprinkler soffits

Three TPS suppliers were invited to develop prototype designs that would complete the fire suppression system. The solutions proposed by these companies will be tested using the MHUs.

The tasks that follow describe the test procedure and test deliverables. Each system will be assessed using a set of evaluation criteria. Results will be summarized in a report that outlines

the strengths and weaknesses of each TPS and will provide specific suggestions for improvements. The results will then be used to refine FEMA's specifications and performance criteria.

Task 1. Prototype TPS design and fabrication

The TPS providers (General Air Products, Talco Fire Systems, W.S. Darley & Co.) were invited to design and build prototypes based on the FEMA design guidelines (FEMA TPS Requirements – 14 SEPT 17). The design and associated review process will precede the testing and conform to the the following timeline:

1.1 Draft TPS designs with dimensions and operational features—February 23, 2018

1.2 Designs reviewed and reponse to suppliers by TLP and FEMA—March 2, 2018

1.3 TPS revised designs (if required)—March 9, 2018

1.4 Final designs—March 16, 2018

1.5 Develop installation protocols, a list of on-site material, time, and labor requirements for installation. Materials may include: fork lift, wrenches, adhesives, shop vacs, and more—March 16, 2018

1.6 Prototype fabrication—April 20, 2018

1.7 Ship prototypes to Selma, AL test site—April 27, 2018

Task 2. Prepare for testing

Prepare all materials for tests, including TPS installion, commissioning, operating, servicing and decommissioning as follows:

- Install/supervise installation of floor membrane in each unit during installation/commissioning of test units in Selma, AL
- Permanently install drain top above floor membrane
- Prepare materials and tools needed for TPS installation
- Arrange for water source to fill tanks
- Prepare equipment and personnel for NFPA 13D testing
- Prepare equipment and connections for sprinkler operation and flow testing
- Arrange delivery of TPS prototype units to site and coordinate on-site storage
- Procure materials for structural deflection tests, including dial gauges, support beams, stands, securement, and protection materials
- Install a dial gauge at mid-span of each pair of joists below the tank area of the MHU. These will measure deflection of the joists relative to the structure. The supporting system will include beams spanning across structural members, supported by the piers

- Take measurements of dial gauges before TPS installation, and instruct full-time site-monitoring staff on performing this task

Task 3. Install TPS prototype 1 in MHU

One prototype TPS will be installed in one of the MHUs using the process outlined below. The following steps in this task may be performed by a combination of the TPS supplier, a fire safety engineer, and TLP staff, unless specifically directed to particular personel. Each of the following steps will be timed and installation observed using the Evaluation Criteria (see below)[1]. Steps in the installation process are listed below:

- Take measurements of dial gauges at floor joists
- Place prototype in TPS closet (performed by TPS providers and/or FEMA staff)
- Secure tank with ratchet straps
- Wire annunciator panel and exterior alarm through conduits
- Mount annunciator panel and alarm
- Connect CamLock water connection to sprinkler riser
- Connect drain/vent plumbing to floor drain
- Connect overflow to drain
- Make power connection to TPS
- Take another measurement of dial gages at floor joists before filling tank (performed by Selma monitoring staff)
- Fill tank
- Take third set of gauge measurements for MHU structural deflection tests/observations (performed by Selma monitoring staff)

Each step in the installation process will be documented, identifying bottlenecks, opportunities for design improvements, quality issues, and other observations that can be used to improve the TPS designs. The assessment is expected to be an iterative process. Both during and after each round of setup, testing, and decommissioning, the process will be modified as necessary, using the steps below:

- Observe any damage to TPS closet, door, floor membrane, drain, etc.
- Make repairs as necessary
- Assess how any/all processes could be improved upon or hastened
- Modify the testing protocol accordingly

Key staff

- TPS providers
- TLP
- FEMA factility personnel

Task 4. Test TPS

[1] Note that the time required for each step in the field may be different from time required at an MHU manufacturing plant, given the resources, assembly tools and expertise available in the plant.

The following steps will be performed to test the installed functionality of the TPS:

- Power on and test user interface
- Test functionality of commands and alarms
- Conduct 13D pressure testing
- Conduct single-sprinkler flow test (see below)
- Conduct two-sprinkler flow test (see below)

Flow tests

- Connect test manifold, as shown in Figure 1, to sprinkler drain line (with drain valve in betweeen) with 1-inch hose
- For single-sprinkler test: set test header valves to allow water flow to only one sprinkler
- For two-sprinkler test: set test header valves to allow water flow to both sprinklers
- Open sprinkler drain valve to allow water from filled TPS to flow to the test manifold
- Record pump discharge pressure during test
- Record water pressure in pipe close to sprinklers
- Record time to tank empty

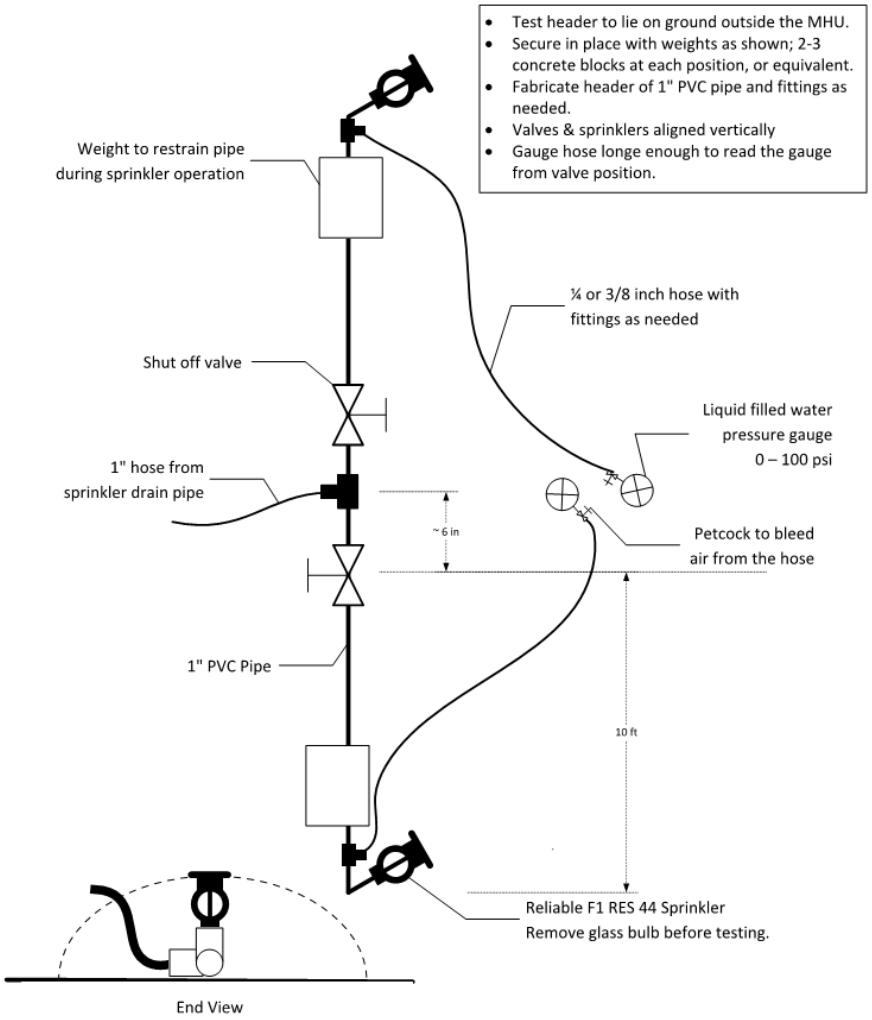

Figure 1 Flow test header

The results of the functionality tests will be recorded along with observations that can be used to improve the TPS designs.

Key staff

- TPS providers
- FEMA facility personnel

Task 5. Remove equipment

Testing the ease of decommissioning and removal of the TPS will be performed through the following steps:

- Switch off system, drain water, and disconnect all previously made connections
- Remove equipment from TPS closet

The decommissioning process will be documented along with observations that can be used to improve the TPS designs.

Key staff

- TPS providers
- TLP
- FEMA facility personnel
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Task 6. Test prototypes 2 and 3

The test protocol (tasks 3 through 5) will be repeated for the two additional prototypes and evaluated and documented in a similar fashion. (Note: the second and third prototypes will remain in the MHUs as part of subsequent structural testing.)

Key staff

- TPS providers
- TLP
- FEMA facility personnel

Evaluation Criteria

The following criteria will be used to evaluate suitability of each TPS systems during the corresponding tasks:

- **Installation:**
  - What tools and materials are required on-site for installation?
  - Does the TPS fit in the closet? Can it be installed through the door without difficulty?
  - Was the TPS easy to maneuver?
  - Do any elements inside the closet interfere with installation? (Drains, HVAC equipment if any, etc.)
  - Are the ratchet straps easy to tighten and effectively secure equipment?
  - Are the plumbing and electrical connections easily made?
  - Are the controls easily accessible by maintenance personnel from the exterior?
  - What is the time required for each task?
- **System commissioning:**
  - Is the tank/pump easily filled by connecting the TPS to a water supply?
  - Are there any leaks?
  - Is the water level visible in the tank or otherwise monitored?
  - Are the controls easy to operate? Is the interface interpretable?
- **Servicing and other components:**
  - Is the annunciator panel located appropriately?
  - Do all alarms work? Does alarm silencing work?
  - Is the interface user-friendly?
  - Is servicing of the TPS easy to perform from the compartment door?
  - Does the distribution system have any deformation, cracks, or other damage?
  - Do all components of the fire sprinkler system meet the requirements of NFPA13D?
- **Decommissioning**:
  - Is the TPS easily drained? How is this accomplished?

- Is the TPS easily disconnected from all its connections?
- Is the TPS easily removed from its compartment?
- What tools and materials are required on-site for decommissioning?
- What is the time required for each task?

Deliverables

The following deliverables will be provided:

1. **Summary report,** containing the following:
   - A summary of the tests performed
   - Photographs of test procedure
   - Qualitative and quantitative results of tests for each TPS system
   - Evaluation of each TPS system, detailing its compliance with each evaluation criterion
   - Recommendations for improvement
   - Next steps for product development and MHU design coordination
2. **TPS Specifications**, including updated product specifications and design requirements for TPSs intended for installation within FEMA Next-Generation MHUs.
3. **MHU Design Specifications**, updated to incorporate self-contained TPSs.

Timeline

Tasks		Month	FEB		MAR				APR				MAY				
		Week	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5
1	**Prototype TPS design and fabrication**																
1.1	**Draft TPS designs**																
1.2	**TLP & FEMA provide design feedback**																
1.3	**Finalize prototype designs for fabrication**																
1.4	**Submit installation manual & material req'ts**																
1.5	**Fabricate TPS prototypes**																
1.6	**Ship TPS to Selma, AL**																
2	**Prepare for testing**																
3	**Install TPS prototype 1 in MHU**																
4	**Test TPS prototype 1**																
5	**Remove prototype 1**																
6	**Test prototypes 2 and 3**																