WATER MIST SYSTEM

MPS For Aircraft Cargo Compartment Test Results

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OUTLINE

- *INTRODUCTION*
- *FIRE SUPPRESSION SYSTEM*
- *MPS TEST PROTOCOLS*
- *TEST RESULTS*
- *SUMMARY OF FINDINGS*

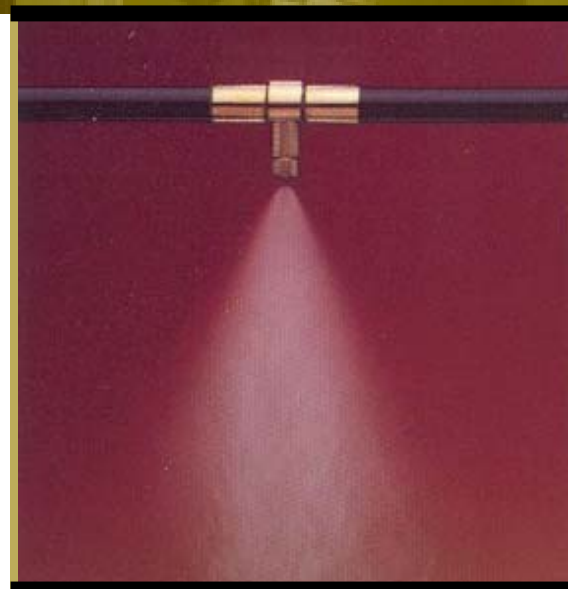
INTRODUCTION

-In September 2000, IASFPWG Halon Options Task Group submitted report entitled "Options for Aircraft Cargo Compartment Fire Protection."

-FAA tested recommended Halon 1301 alternatives (WMS/N2 and HFC 125) using MPS for aircraft cargo compartment.

-FAA had previously investigated the fire protection of water sprays/fogs in passenger cabins and cargo compartments.

-This presentation will be limited to the results of the Water Mist/Nitrogen system.

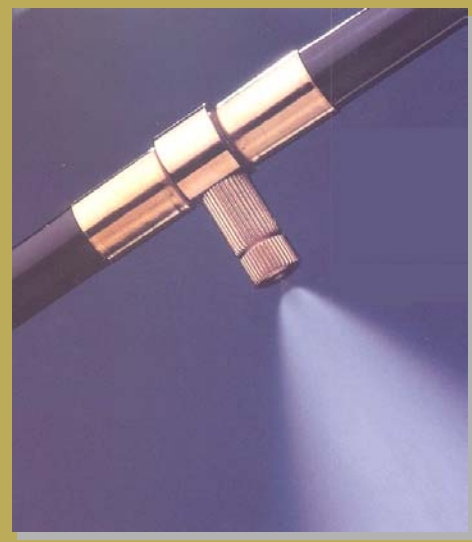


Environmental Engineering Concepts

FIRE SUPPRESSION SYSTEM

High Pressure/Class I Water Mist System

- High Pressure Pump (1150 psig)
- 125 Gallon Water Tank (Pressurized to 40 psig)
- Solenoid Valves
- Number of Nozzles = 32
- Nozzle Angle = 90^{o} Down
- Max Flow Rate per Nozzle = 0.10 gpm
- Number of Zones = 4
- Nozzles per Zone = 8
- Droplet size = 70 to 100 microns
- Distance Between Nozzles = 16”
- Distance Between Zones = 30”
- Activation Controller (Trigger Temperature - 212 ^{o}F)

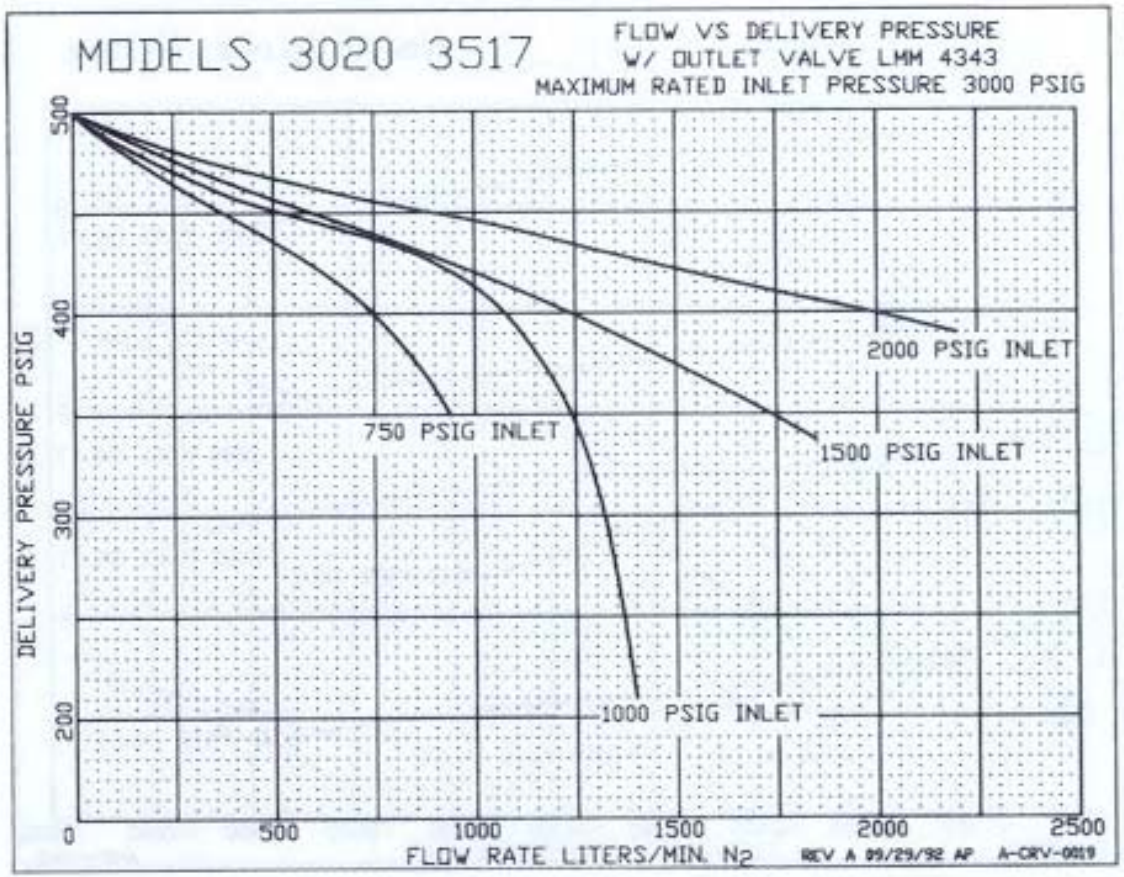


Environmental Engineering Concepts

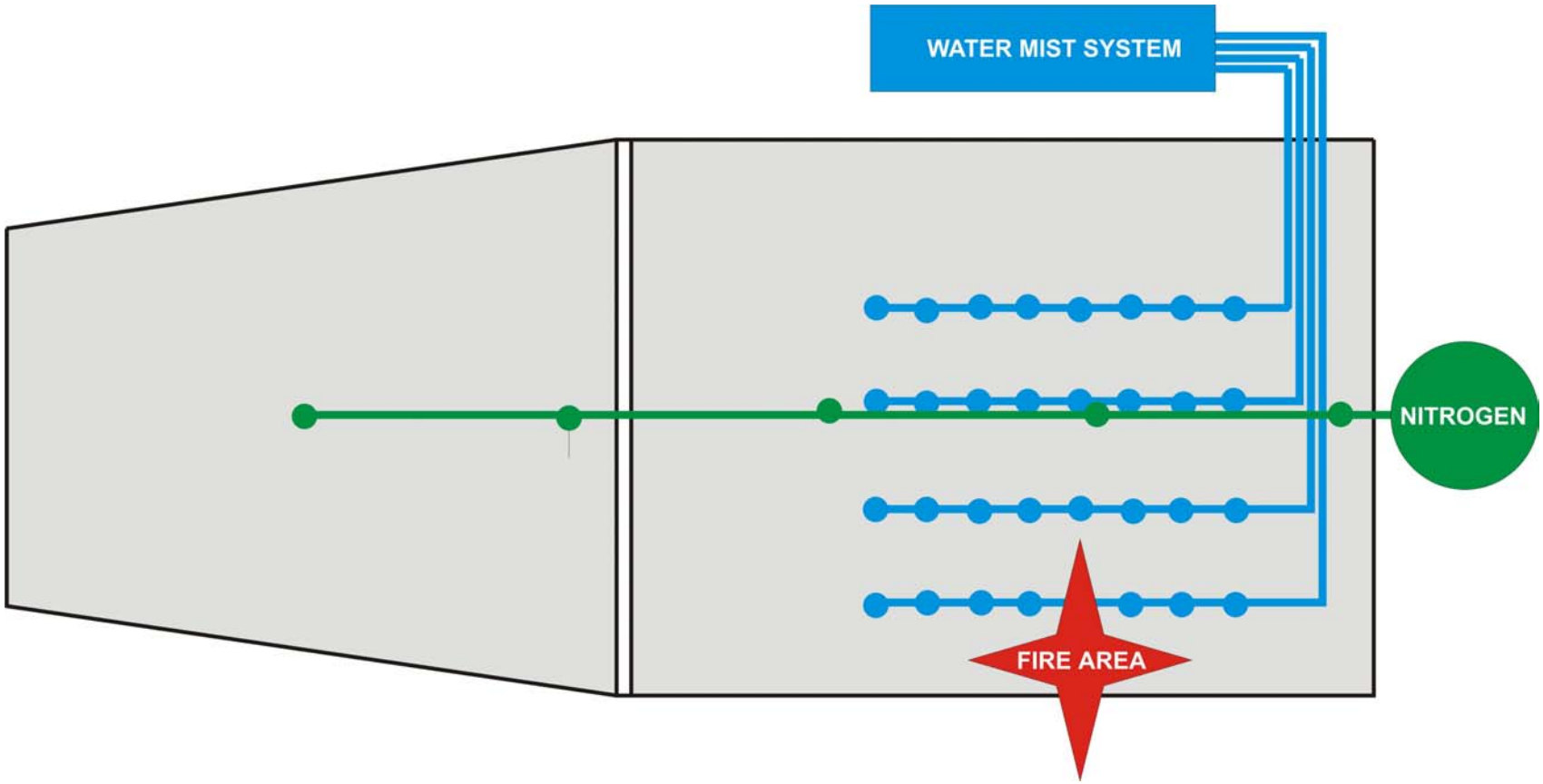
FIRE SUPPRESSION SYSTEM

- *Nitrogen System consisted of:*
  - *16 Cylinders Size-T Nitrogen Bank*
  - *Two Matheson Model 3020 Regulators*
  - *System Flow Rate = 37.5 CFM to 89.3 CFM*
  - *Pneumatic Valve*
  - *One inch plumbing network*
  - *5 Nozzles (5/8” ID)*
  - *Activation was controlled by the volumetric concentration of Oxygen (10%) in the cargo compartment (Closed loop control system)*

FIRE SUPPRESSION SYSTEM



FIRE SUPPRESSION SYSTEM



FIRE SUPPRESSION SYSTEM

ACTIVATION CONTROL LOGIC:

- *Two zones near fire were turned on for 5 minutes to knock down flames and cool down the cargo compartment. At the same time the nitrogen system was activated.*
- *After the 5 minutes:*

  - A zone will turn on only if the temperature near the zone exceeds 212 °F; turn off if temperature is below it.

  -All zones will turn on if the ceiling temperature exceeds 350 °F.

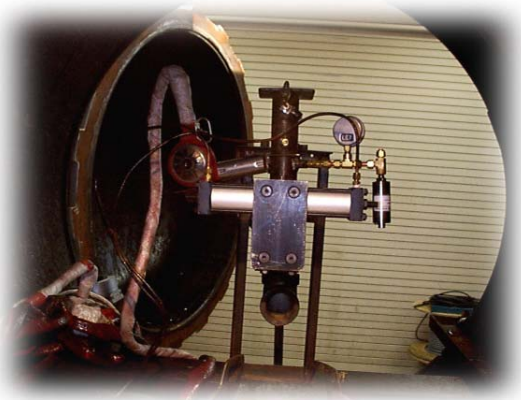
  - Oxygen vol. concentration maintained at 10%

MPS TEST PROTOCOLS

BULK LOAD FIRES

CONTAINERIZED FIRES

FLAMMABLE LIQUIDS FIRE



AEROSOL CAN EXPLOSION SIMULATION

"Minimum Performance Standard for Aircraft Cargo Compartment Fire Suppression Systems"

MPS TEST PROTOCOLS

BULK LOAD FIRE TEST

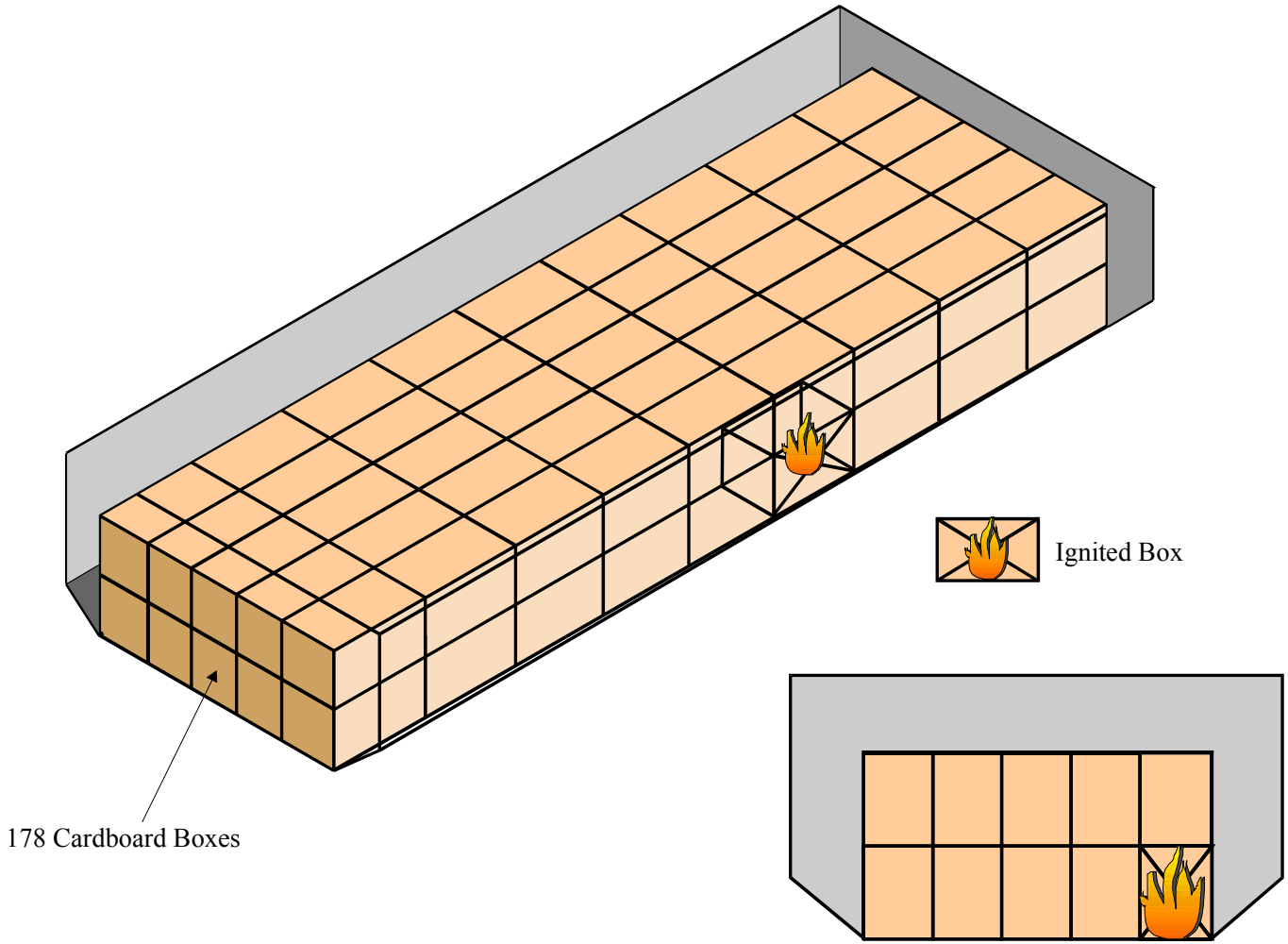
Fire Load = 178 card board boxes (30% of Vol.) containing 2.5 lbs of shredded paper

Ignition = nichrome wire wrapped around folded paper towels

System Activation = 1 min. after one of the ceiling T/C reaches 200 °F

Test Duration = Five tests @ 30 minutes each

MPS TEST PROTOCOLS



MPS TEST PROTOCOLS

CONTAINERIZED FIRE TEST

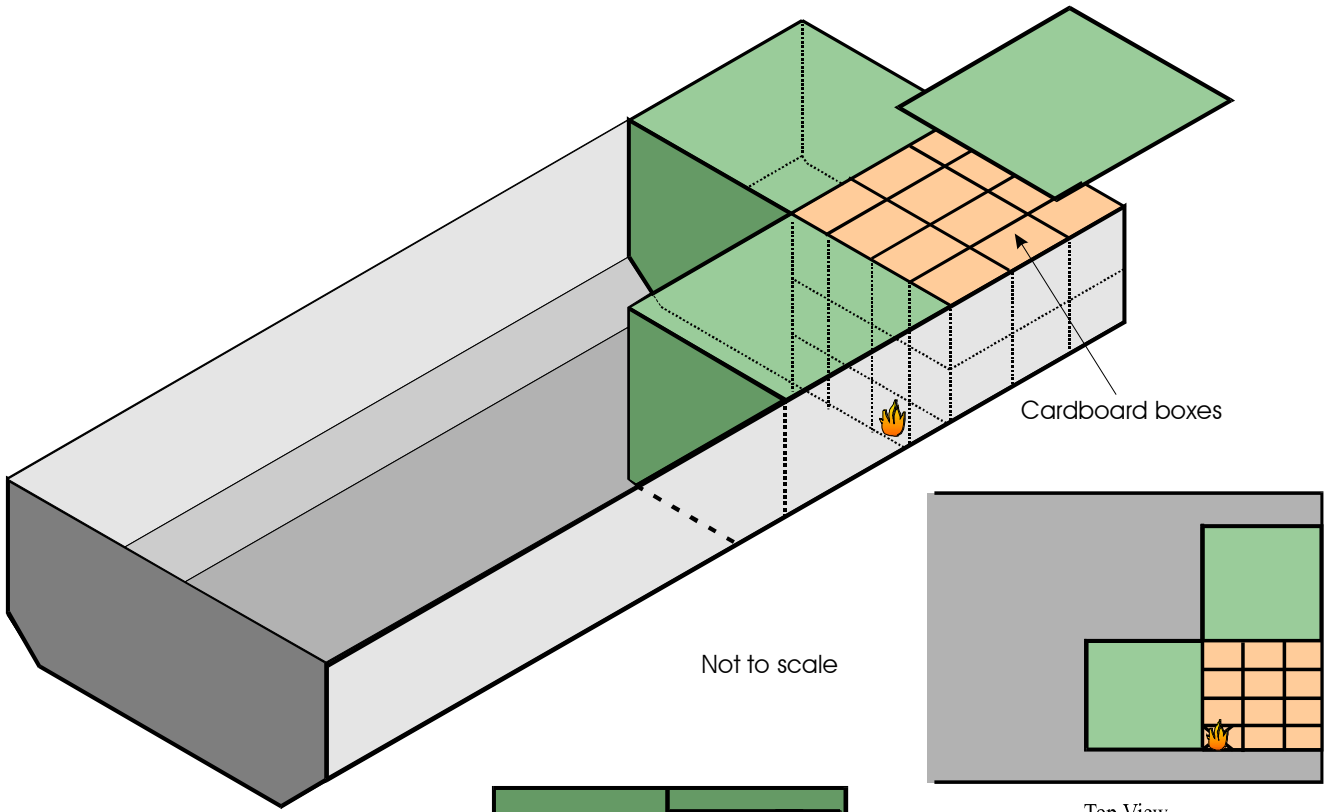
Fire Load = 33 card board boxes inside an LD3. Three LD3 in Compartment

Ignition = nichrome wire wrapped around folded paper towels

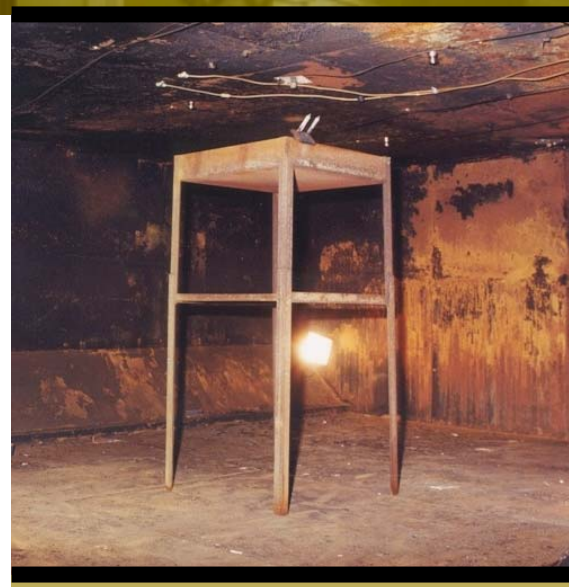
System Activation = 1 min. after one of the ceiling T/C reaches 200 ^{o}F

Test Duration = Five tests @ 30 minutes each

MPS TEST PROTOCOLS



MPS TEST PROTOCOLS



SURFACE BURN FIRE TEST

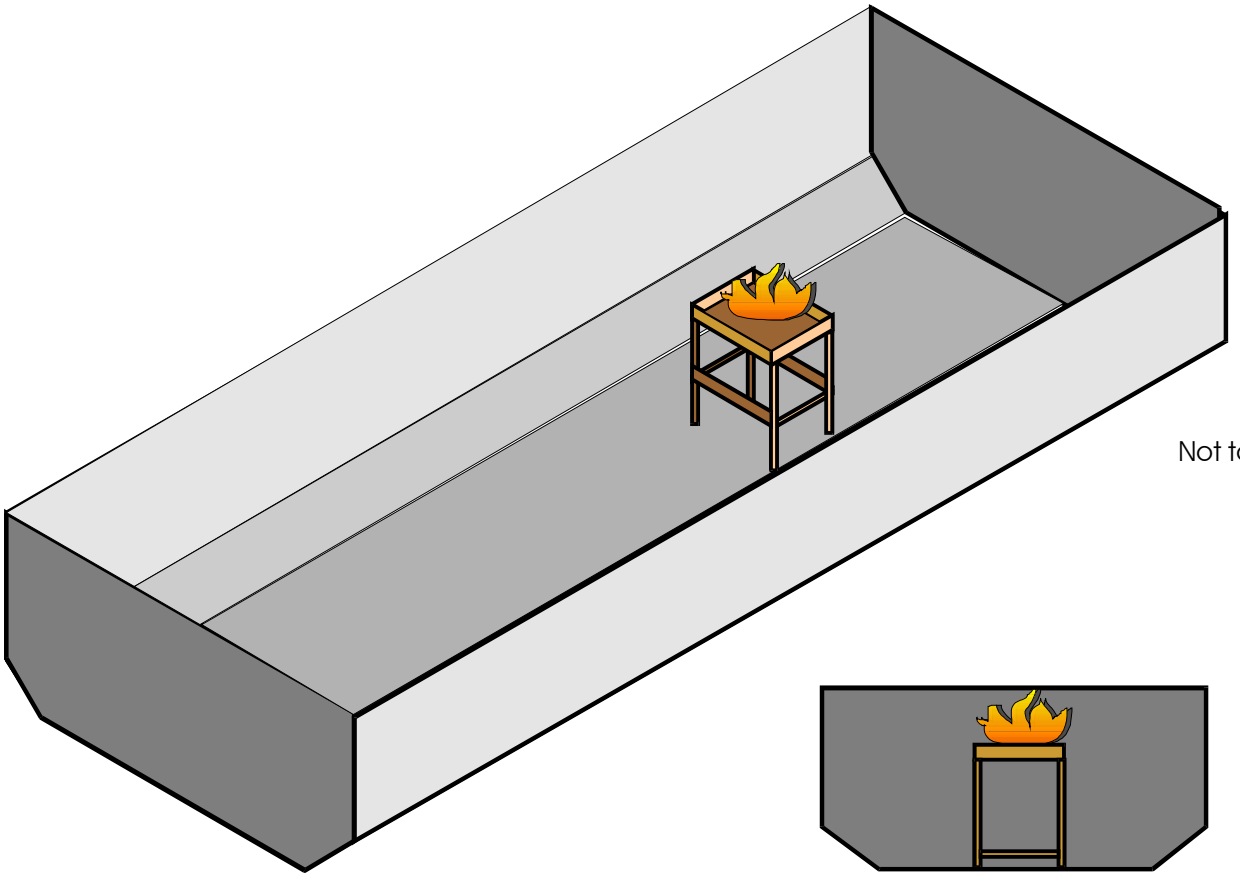
Fire Load = 0.5 U.S. Gallon of Jet A fuel (with 13 oz of gasoline)

Ignition = Arc created by two spark plugs

System Activation = 1 min. after one of the ceiling T/C reaches 200 ^{o}F

Test Duration = 5 minutes

MPS TEST PROTOCOLS

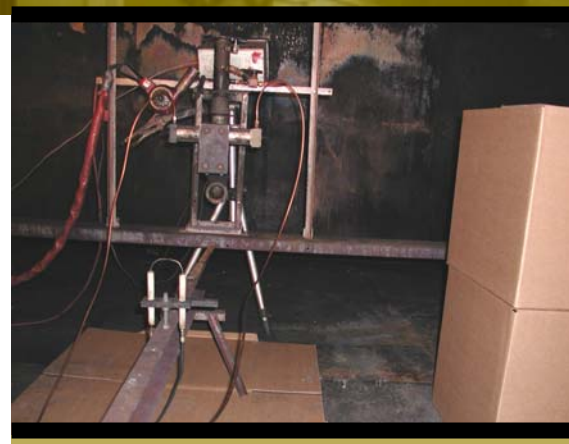


Not to scale

End View

MPS TEST PROTOCOLS

AEROSOL CAN EXPLOSION SIMULATION



Fire Load = 58 card board boxes containing 2.5 lbs of shredded paper

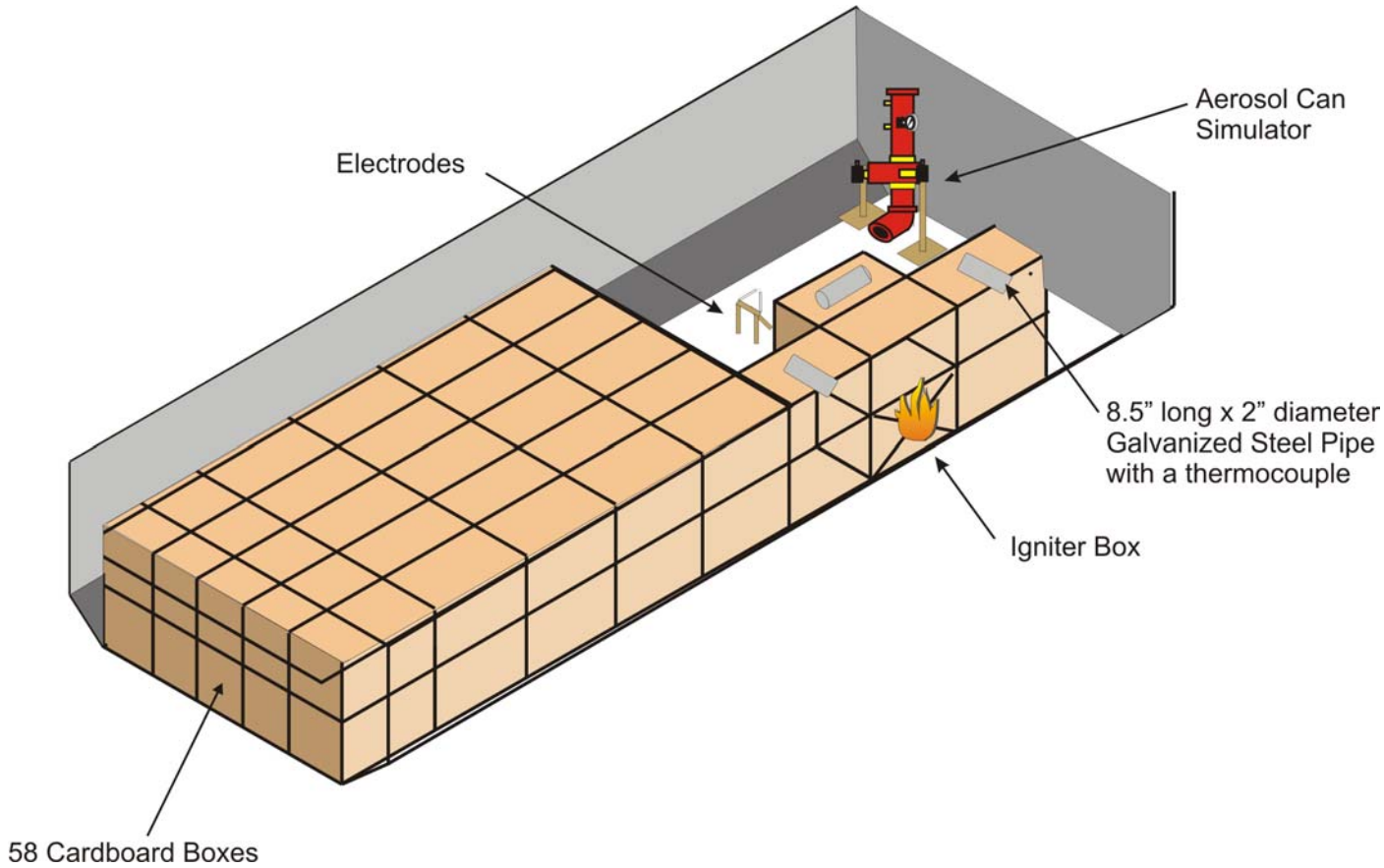
Ignition = nichrome wire wrapped around folded paper towels

System Activation = 1 min. after one of the ceiling T/C reaches 200 °F

Activate Simulator when one of the cans temp. reaches 400 °F (or test time = 29 minutes)

Test Duration = Five tests @ 30 minutes each

MPS TEST PROTOCOLS



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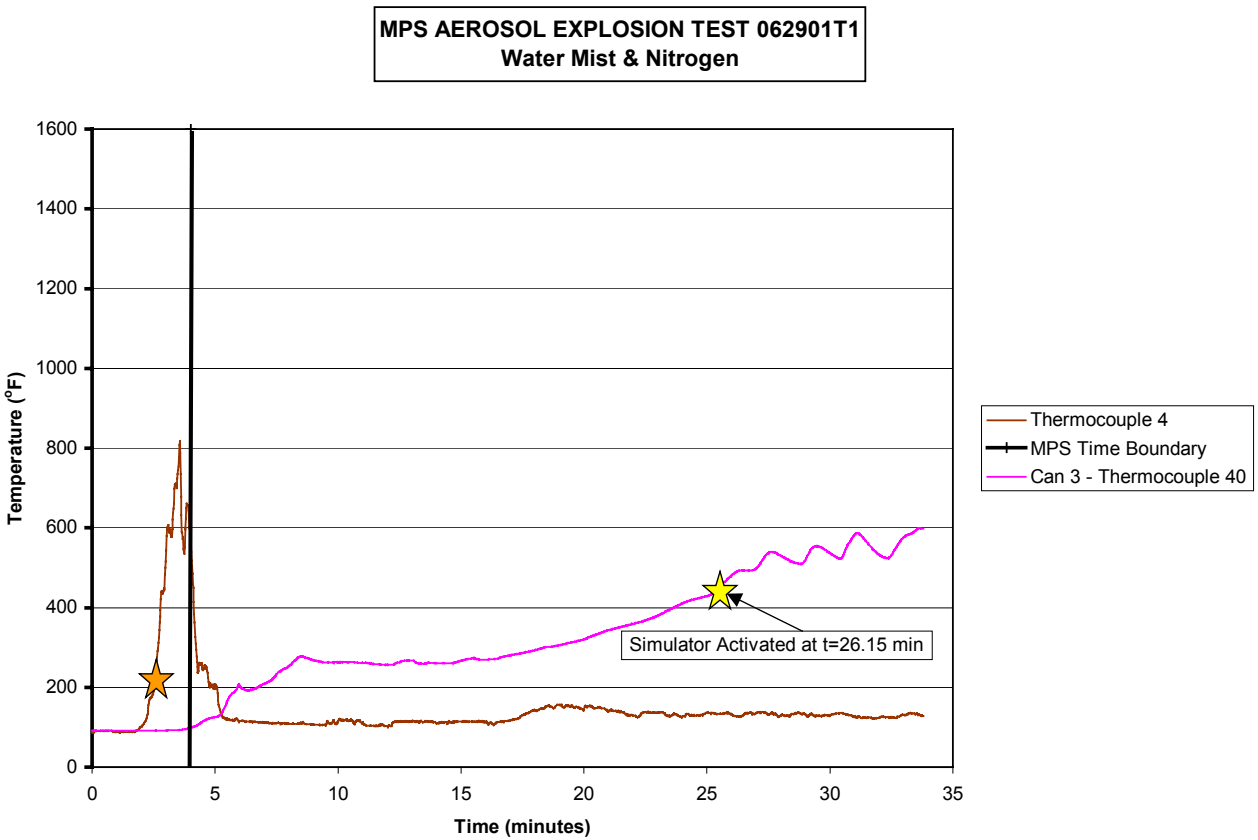

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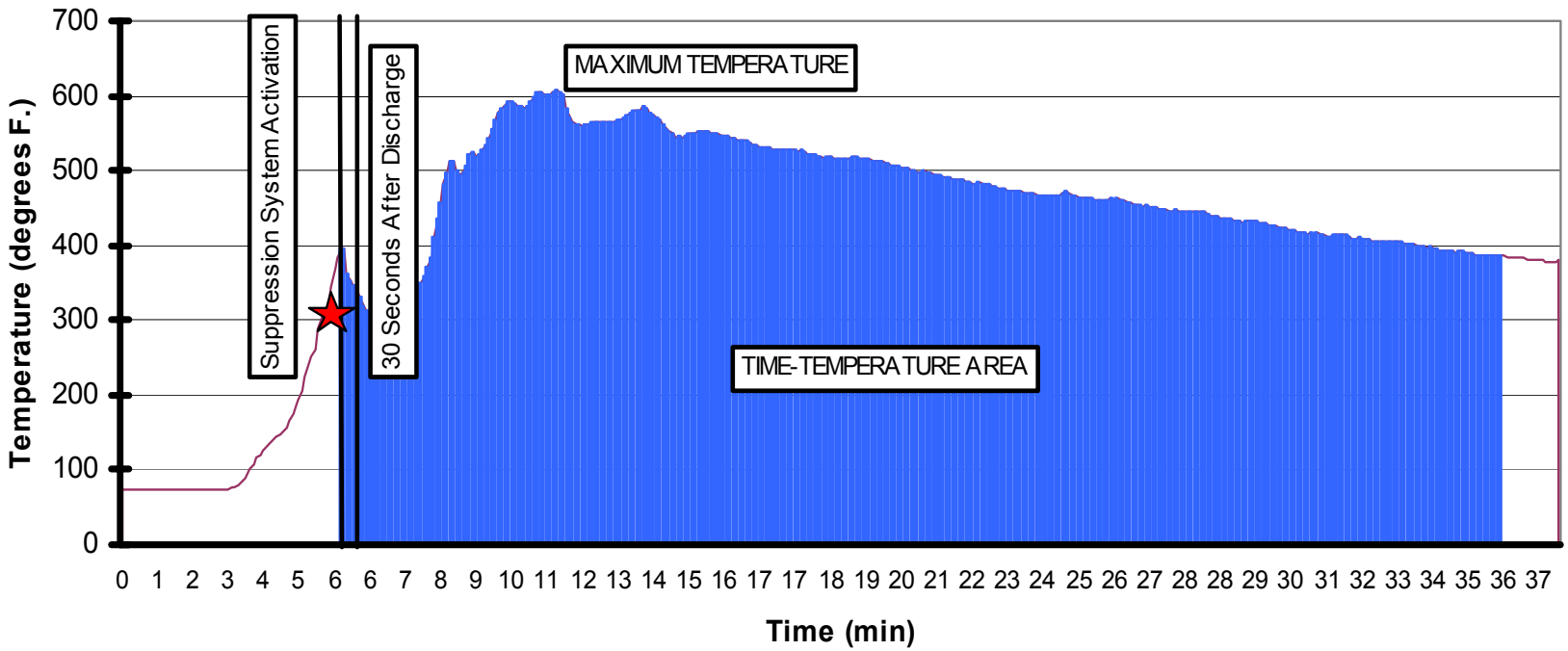


MPS TEST PROTOCOLS

FIRE SCENARIO	MAXIMUM TEMPERATURE (°F)	MAXIMUM TEMPERATURE-TIME AREA (°F-min)	MAXIMUM PRESSURE (psi)	COMMENTS
Bulk Fire Load	582	10,452	N/A	Temperature limit starting 30 seconds after suppression system activation. Temp-Time area for 30 minutes starting with suppression system activation.
Containerized Fire Load	612	14,102	N/A	Temperature limit starting 30 seconds after suppression system activation. Calculate Temp-Time area for 30 minutes starting with suppression system activation.
Surface Burning Fire	1125	2,964	N/A	Temperature limit starting 30 seconds after suppression system activation. Temp-Time area for 5 minutes starting with suppression system activation.
Exploding Aerosol Can Fire	582	10452	0	There shall be no explosion

WATER MIST SYSTEM WITH NITROGEN

BULKLOAD TEST							
	TEST NO.	MAX TEMP (^{o}F)	MAX AREA (^{o}F-MIN)	PRESSURE (PSIG)	WATER USAGE (LBS.)	NITROGEN USAGE (FT^{3})	COMMENTS
070601T1	1	346	3382	N/A	67	2730	96% of boxes were not damaged (versus 75% with Halon 1301)
072601T1	2	274	4166	N/A	70	2307	96% of boxes were not damaged (versus 75% with Halon 1301)
072701T1	3	491	5346	N/A	64	2165	96% of boxes were not damaged (versus 75% with Halon 1301)
07311T1	4	230	5036	N/A	72	2401	88% of boxes were not damaged (versus 75% with Halon 1301)
080101T1	5	595	5788	N/A	63	2024	86% of boxes were not damaged (versus 75% with Halon 1301)
Average:		**387**	**4744**	N/A	**67.2**	**2325.4**	
Std. Deviation:		**153**	**965**		**4**	**268**	
MPS Acceptance Criteria:		582	10452				
Performace Rating:		**Passed**	**Passed**	**N/A**	**(8 Gallons)**	**7.7 t-Size Cylinders at 2500 psig**	

WATER MIST SYSTEM WITH NITROGEN

CONTAINERIZED TEST							
TEST ID	TEST NO.	MAX TEMP (^{o}F)	MAX AREA (^{o}F-MIN)	PRESSURE (PSIG)	WATER USAGE (LBS.)	NITROGEN USAGE (FT^{3})	COMMENTS
070901T1	1	700.4	5295	N/A	151	4170	90-Minute Test; Water mist system was turned on seconds later it was required to turn on due to a closed valve. 61% of boxes undamaged
071101T1	2	219	5575	N/A	70	2354	70% of boxes undamaged
072001T1	3	414	5377	N/A	67	2401	64% of boxes undamaged
072301T1	4	345	6478	N/A	74	2165	33% of boxes undamaged
072401T1	5	403	5778	N/A	64	2212	58% of boxes undamaged
072501T1	6	182	4744	N/A	66	2471	67% of boxes undamaged
Average:		**313**	**5590**	N/A	**68.2**	**2320.6**	
Std. Deviation:		**106**	**630**		**4**	**129**	
MPS Acceptance Criteria:		612	14102				
Performace Rating:		**Passed**	**Passed**	**N/A**	**(8 Gallons)**	**7.9 T-Size Cylinders at 200 psig**	

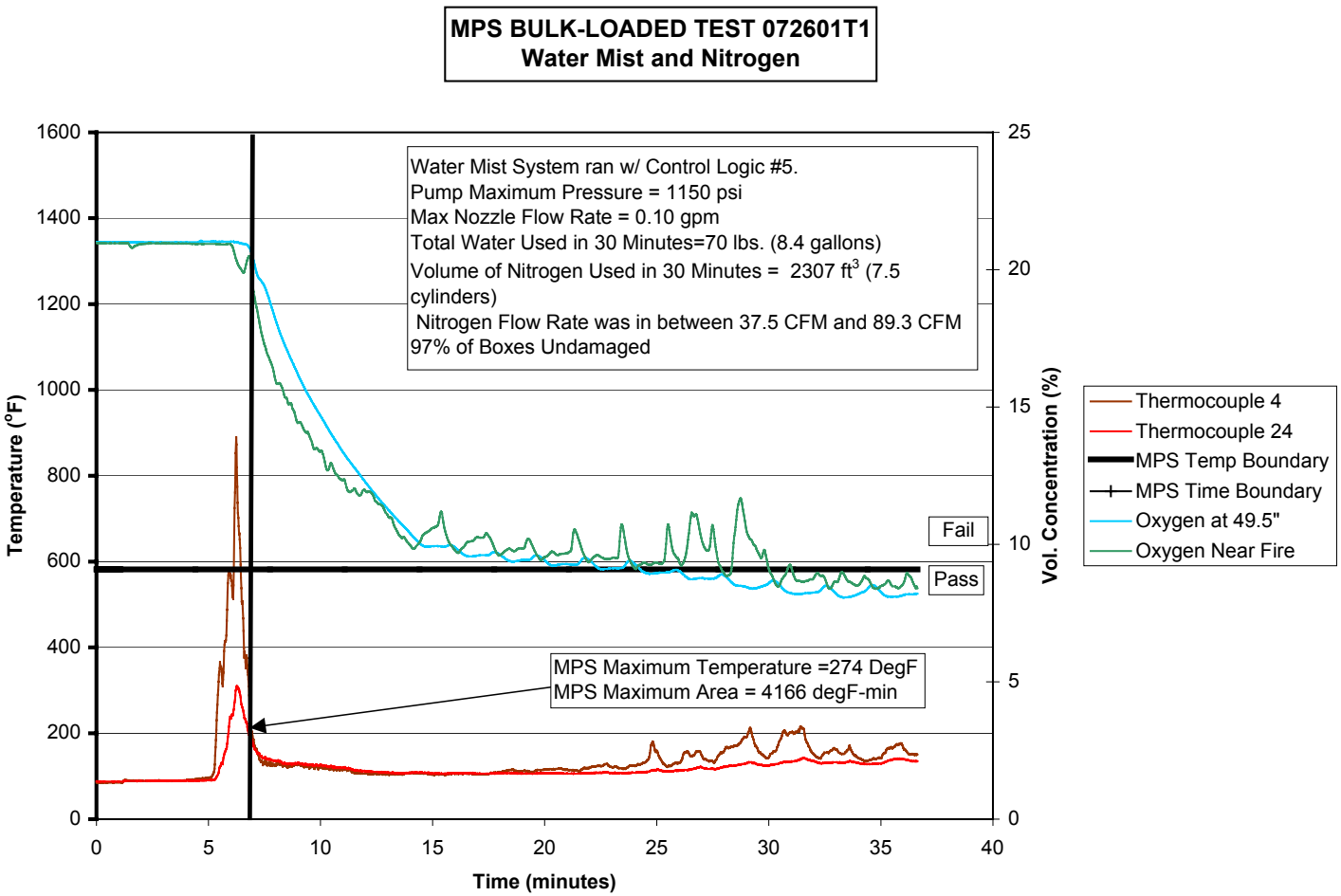
WATER MIST SYSTEM WITH NITROGEN

SURFACE BURNING TEST							
TEST ID	TEST NO.	MAX TEMP (^{o}F)	MAX AREA (^{o}F-MIN)	PRESSURE (PSIG)	WATER USAGE (LBS.)	NITROGEN USAGE (FT^{3})	COMMENTS
070301T1	1	244	840	N/A	27	200	Fire Extinguished in 37.2 secs.
070301T2	2	435	899	N/A	24	97.1	Fire Extinguished in 53.4 secs.
070501T1	3	418	1016	N/A	23	91.2	Fire Extinguished in 61.2 secs.
070501T2	4	595	1268	N/A	16	82.4	Fire Extinguished in 52.2 secs.
070501T3	5	498	1246	N/A	19	85.3	Fire Extinguished in 58.8 secs.
	Average:	**438**	**1054**	N/A	22	111.2	**52.6**
	Std. Deviation:	129	196		**4**	**50**	
	MPS Acceptance Criteria:	1125	2964				
	Performace Rating:	**Passed**	**Passed**	**N/A**	**(2.7 Gallons)**	**< 1 T-Size Cylinder at 2500 psig**	**53 seconds to extinguish fire**

WATER MIST SYSTEM WITH NITROGEN

AEROSOL EXPLOSION TEST (BULK LOAD VERSION W/ AEROSOL CAN SIMULATOR)							
TEST ID	TEST NO.	MAX TEMP (^{o}F)	MAX AREA (^{o}F-MIN)	PRESSURE (PSIG)	WATER USAGE (LBS.)	NITROGEN USAGE (FT^{3})	COMMENTS
062501T1	1	454	3694	0	73.8	2824	30 minutes test. Sim activated at t=33.18 minutes since cans did not heat up to 400 degF. No explosion
062701T1	2	368	3400	0	74	2730	30 minutes test. Sim activated at t=30.53 minutes since cans did not heat up to 400 degF. No explosion
062801T1	3	528	3891	0	74	3060	30 minutes test. Can 1 reached 400 degF. Sim activated at t=16.48 minutes. No explosion
062901T1	4	564	4190	0	73	2824	30 minutes test. Can 3 reached 400 degF. Sim activated at t=26.15 minutes. No explosion
070201T1	5	752	3876	0	70	3210	30 minutes test. Sim activated at t=31.83 minutes since cans did not heat up to 400 degF. No explosion
	Average:	**533**	**3810**	0	73	2930	
	Std. Deviation:	144	290	0	**2**	**199**	
	MPS Acceptance Criteria:	**582**	**10452**	**0**			
	Performace Rating:	**Passed**	**Passed**	**Passed**	**(8.8 Gallons)**	**10 T-Size Cylinders at 2500 psig**	**No Explosion**

TEST RESULTS



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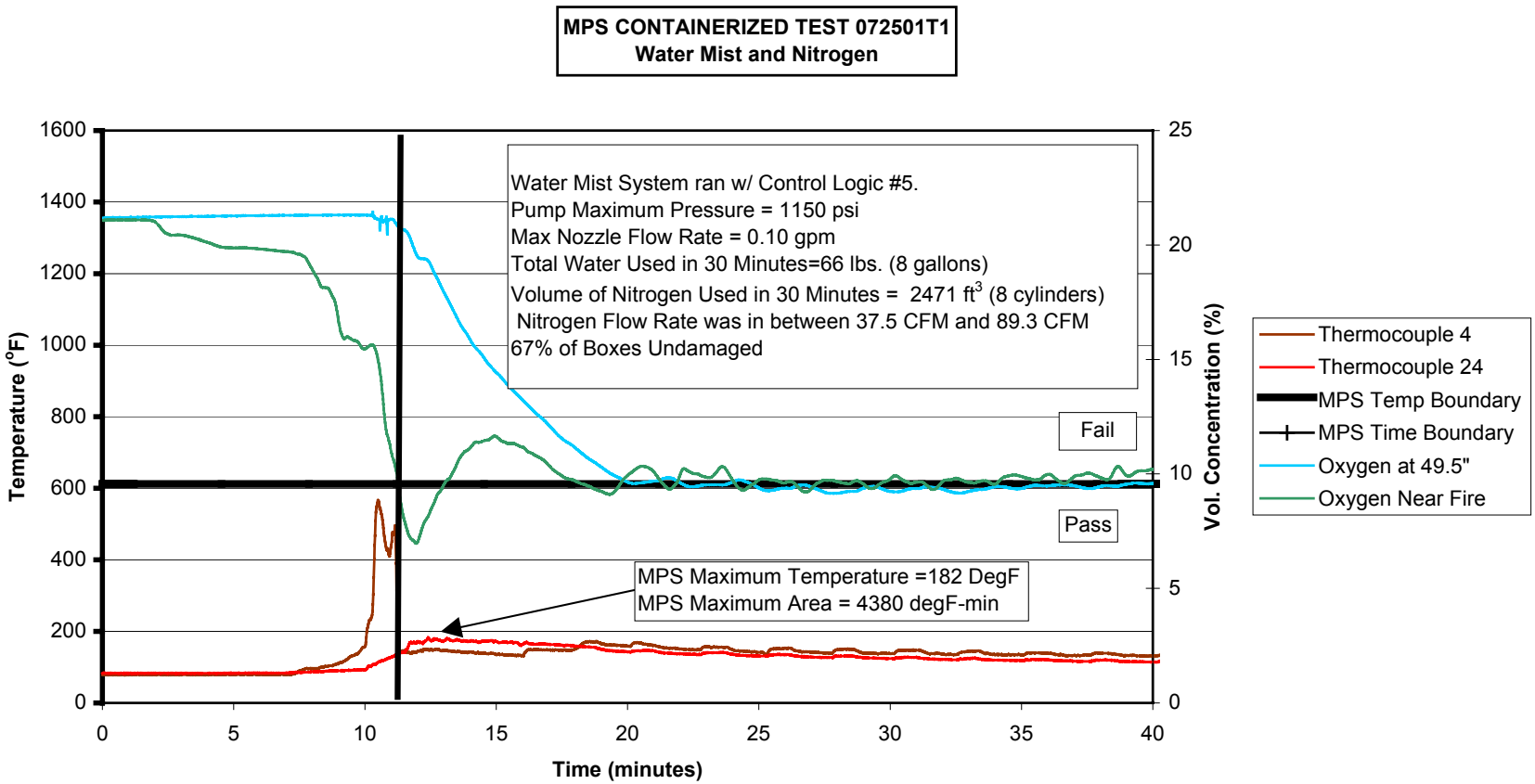

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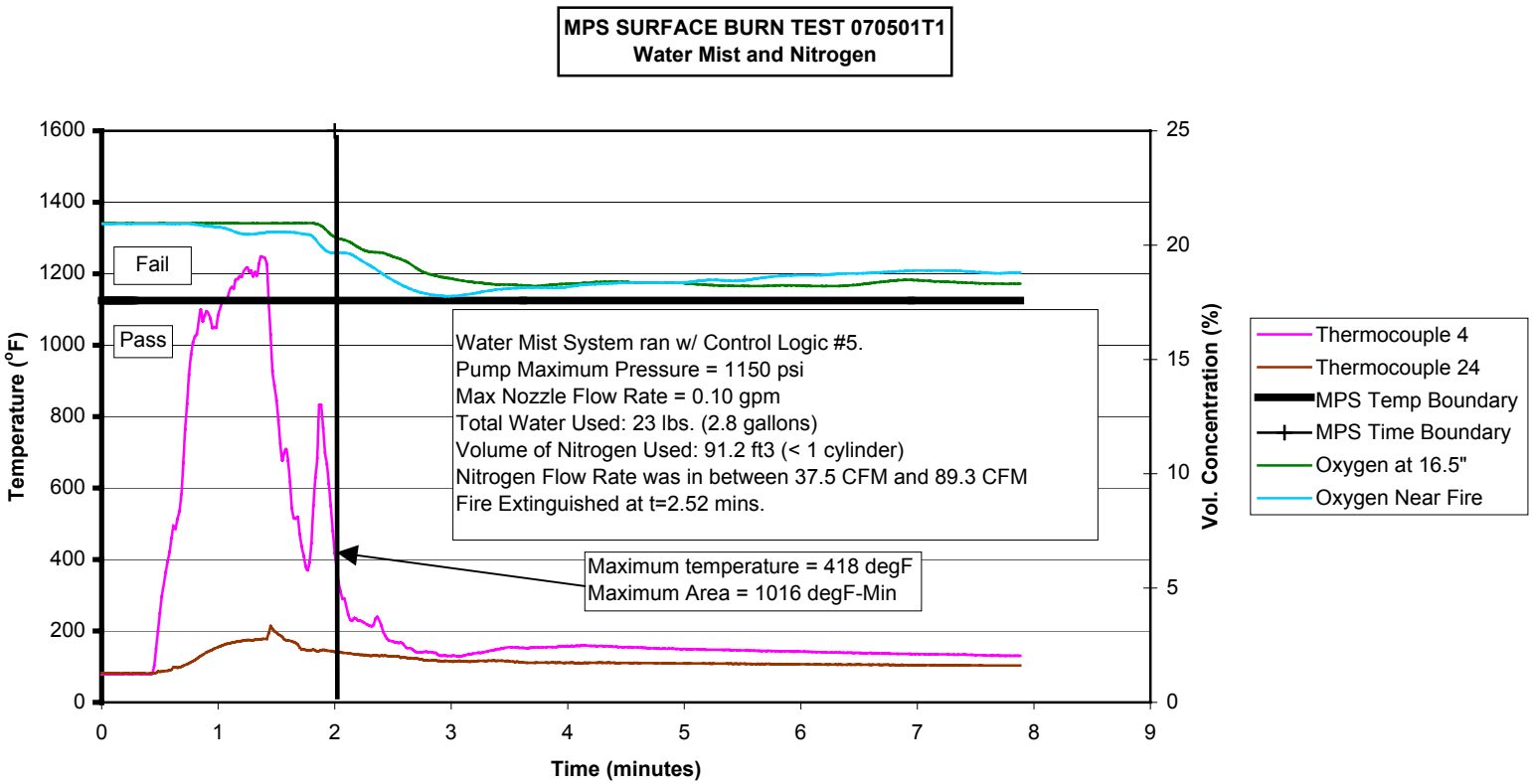

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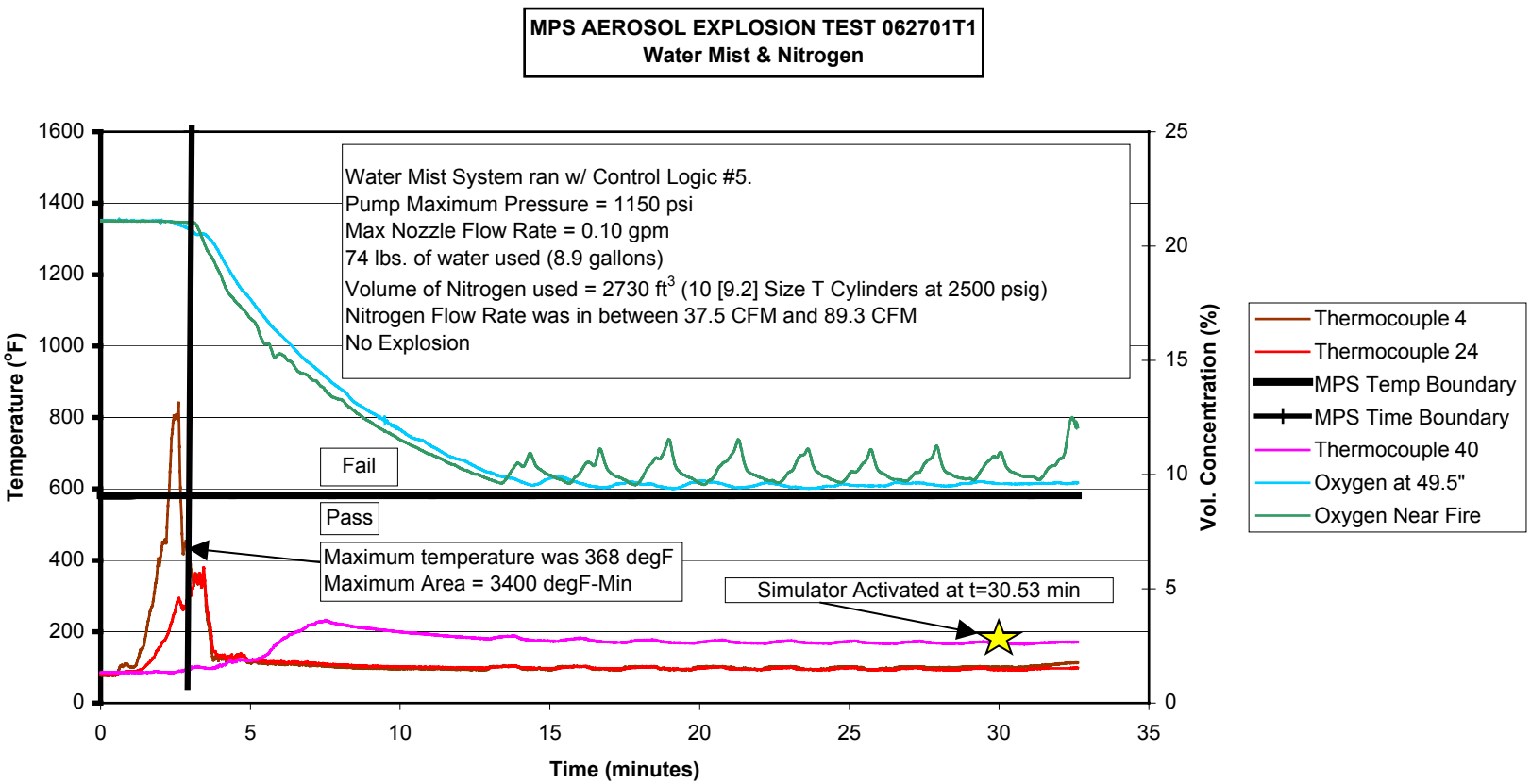
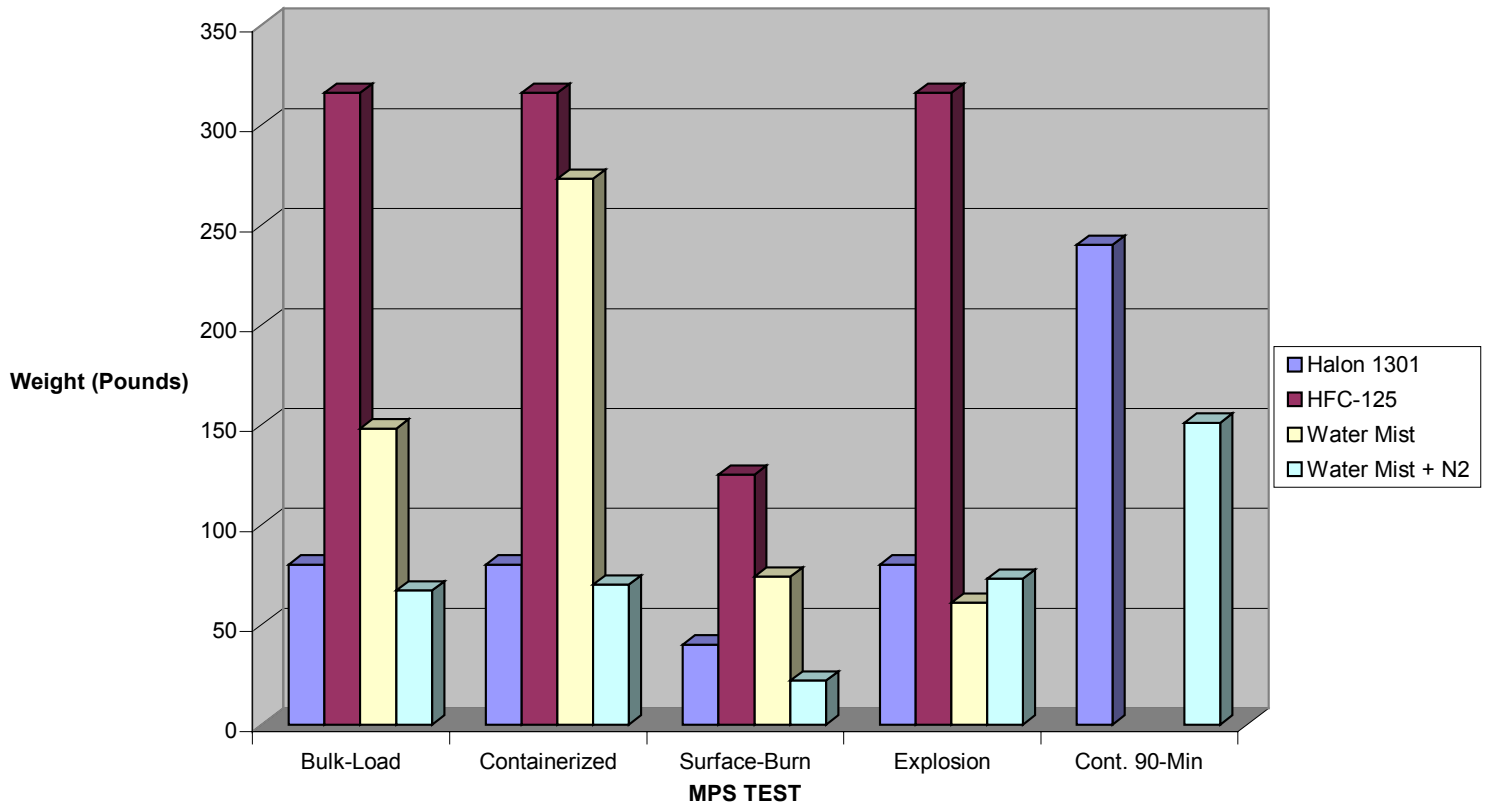


TEST RESULTS

AGENT CONSUMPTION DURING MPS TESTS

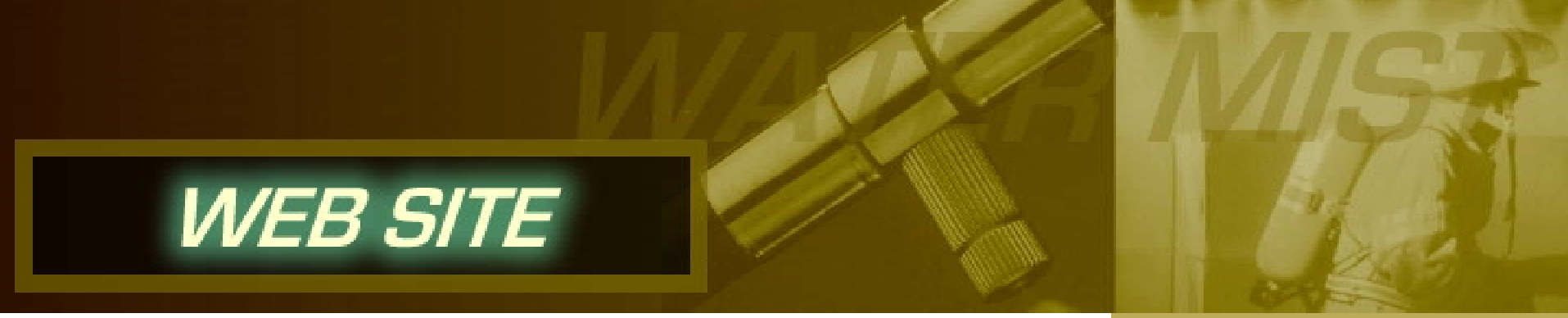


SUMMARY OF FINDINGS

-The water mist/nitrogen system completely met the MPS fire and explosion tests with competitive agent consumption rates.

-The use of nitrogen, as an independent system, reduced the consumption of water by more than 50% in the majority of the tests.

The weight advantage will come from using the proposed fuel tanks OBIGGS system for nitrogen generation.



http://www.fire.tc.faa.gov/

PDF File

"The Evaluation of a Water Mist System Combined with Nitrogen as an Aircraft Cargo Compartment Fire Suppression System"