NIST World Trade Center Investigation

Project 4: Active Fire Protection Systems Issues

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OUTLINE

Four issues and supporting findings from investigation of active fire protection systems in WTC 1, 2, and 7

<u>All tall buildings and selected other buildings</u>

(1) The minimum level of performance for active fire protection systems.

(2) The quantity and reliability of information available to first responders at the fire and emergency command center.

OUTLINE (continued)

All tall buildings

(3) Adequacy of information provided by Fire Alarm Systems for management of emergency response and evacuation.

(4) Survival of fire alarm system and other building status records of events for investigation purposes, either through off-site transmission or on-site "black box."

ISSUE 1

The minimum level of performance for active fire protection systems in all tall buildings and selected other buildings.

Findings

- The Fire Sprinkler Systems design method for WTC 1, 2, and 7 was based on the occupancy hazard fire control approach from NFPA 13, *Standard for the Installation of Sprinkler Systems*.

- The minimum water spray density and minimum design area of operation were based on a "Light Hazard" occupancy classification.

- Light Hazard is normally used for office spaces in most buildings.

ISSUE 1

Occupancy Hazard Class and Minimum Design Area

Hazard	Examples	Density / Minimum Area
Light	**offices**, data processing facilities, clubs and restaurant seating areas, commercial shops	**0.1 gpm/ft² / 1500 ft²**
Ordinary Group 1	manufacturing and processing plants, laundries, and restaurant service areas	0.15 gpm/ft² / 1500 ft²
Ordinary Group 2	dry cleaners, library stack areas, post office, and repair garages	0.2 gpm/ft² / 1500 ft²
Extra Group 1	metal extruding and plywood and particleboard manufacturing plants containing little or no flammable and combustible liquids	0.3 gpm/ft² / 2500 ft²
Extra Group 2	flammable liquid spray booths, open oil quenching areas containing moderate to substantial amounts of flammable or combustible liquids or having areas where combustibles were shielded from spray	0.4 gpm/ft² / 2500 ft²

Source: NFPA 13, Standard for the Installation of Sprinkler Systems

ISSUE 1

Additional underlying assumptions for sprinkler system design:

- Fires will involve ordinary office materials and will start in relatively small areas (i.e., < 1500 ft^2).
- Only one fire in the building.

Finding

The installed fire sprinkler systems in WTC 1, 2, and 7 exceeded minimum NFPA requirements.

ISSUE 1

Factors that could influence selection of sprinkler design area/density, but not explicitly considered in common design practice for office buildings, include

- threat profile,
- total area and height of the building,
- compartmentation,
- population in the building,
- prohibited activities and fuel loads in the building,
- excessive fire department response time, and
- acts of terrorism.

Industrial/special facilities may consider some or all of above as part of loss-risk profile to base decisions for protection.

ISSUE 1

Level of performance includes factors such as

- System design basis
- Automatic vs. manual operation
- Redundancy
- Survivability
- Single point vulnerability for system failure

ISSUE 1

Automatic vs. Manual Operation

Findings

- Fire sprinkler systems in WTC 1, 2, and 7 were automatic from water tank supplies but depended on manually operated pumps or fire department connections for continued operation.

- Fire alarm systems in WTC 1 and 2 provided for automatic fire detection, but required manual activation of notification devices. WTC 7 system provided automatic detection and notification.

- Smoke purge systems in WTC 1, 2 and 7 were manually initiated.

ISSUE 1

Single Point Vulnerability for System Failure

Findings

- WTC 1, 2, and 7 fire sprinkler and standpipe systems were vulnerable to single point failures.

- WTC 1 and 2 fire alarm system voice notification, fire warden telephones, and fire fighter telephones were vulnerable to single point failures.

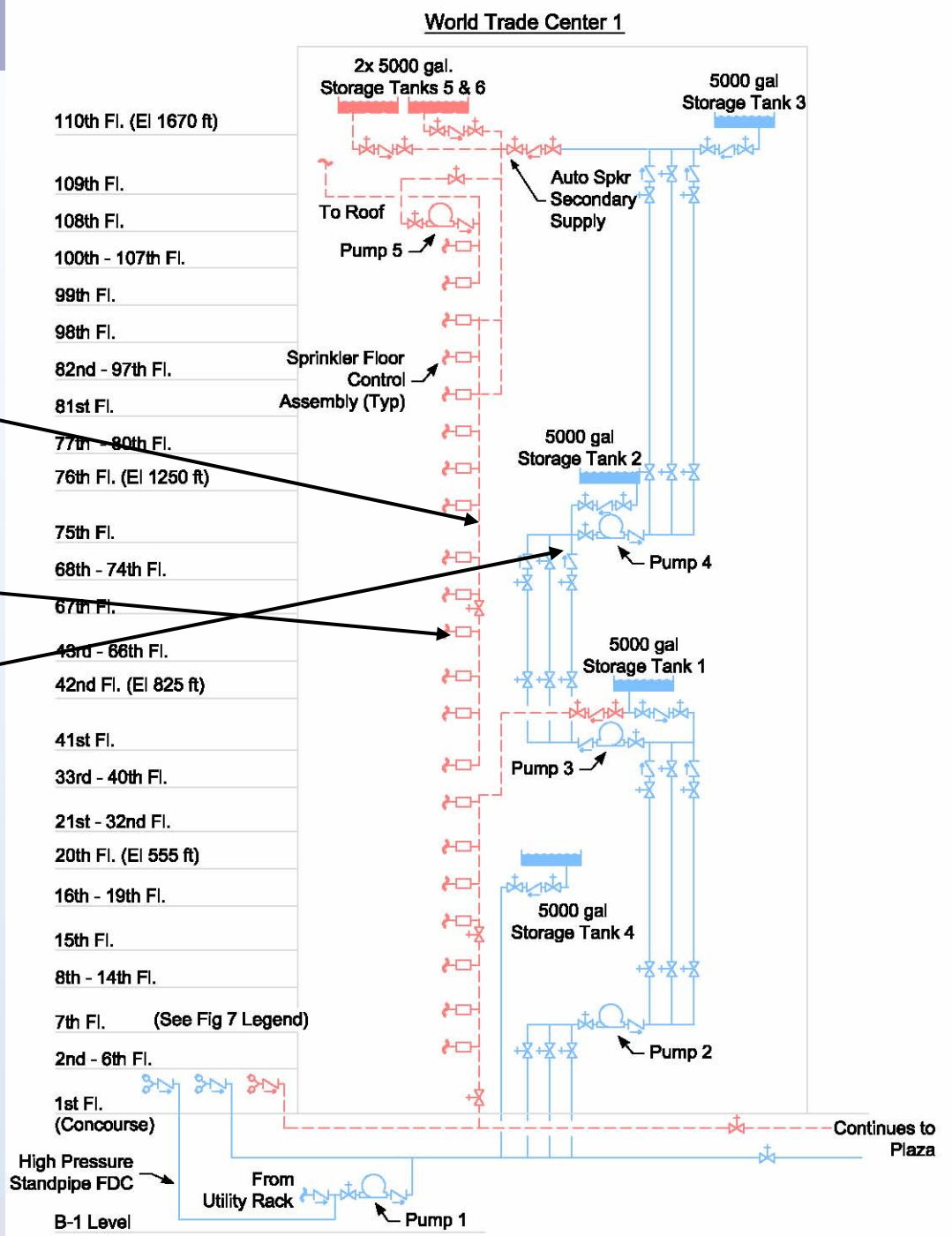
ISSUE 1

Single point failures:

Sprinkler riser

Sprinkler floor control assembly (typ.)

Standpipe



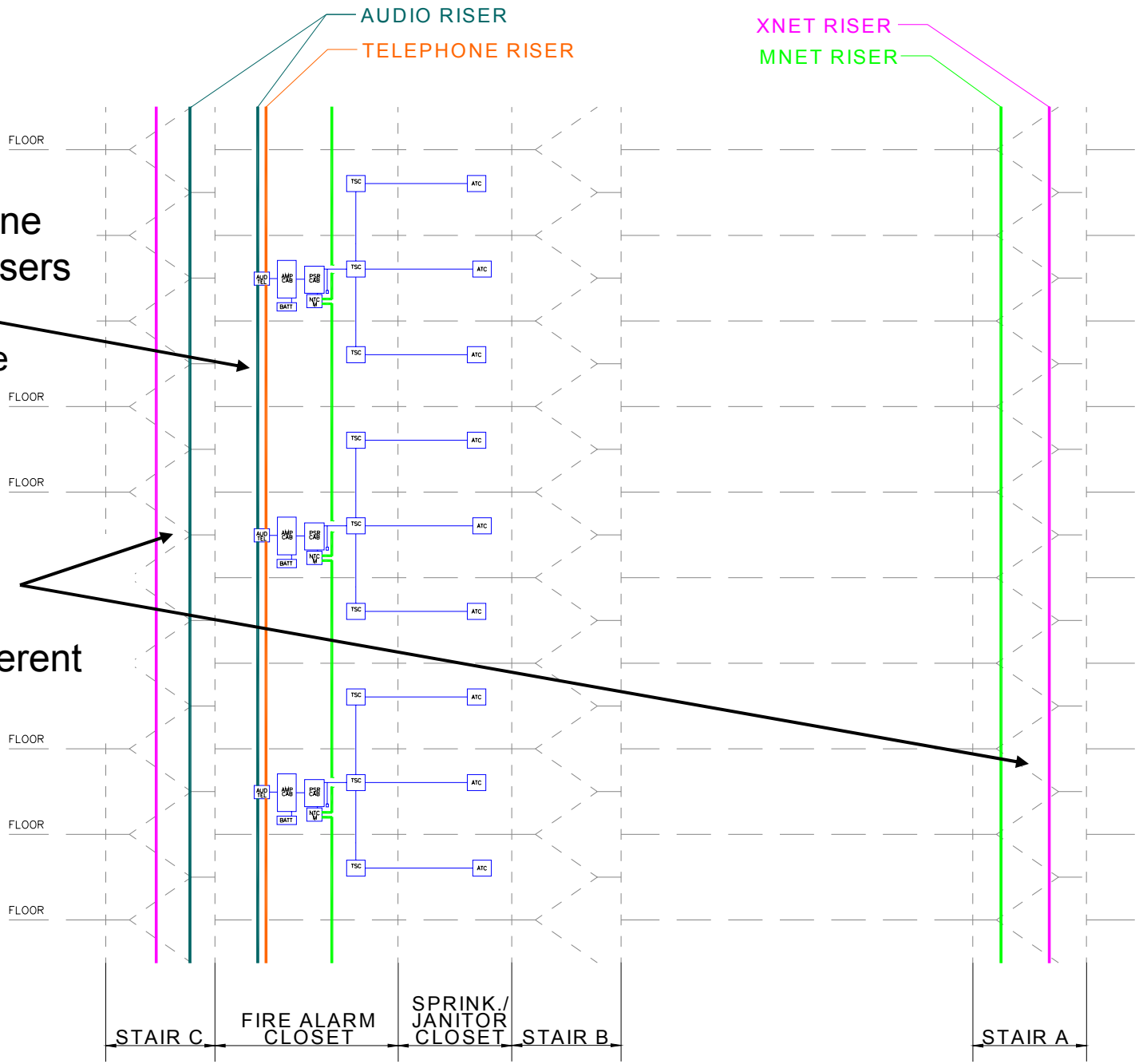
ISSUE 1

Audio and telephone communications risers in one location:

- Single point failure possible

Alarm system communications separated into different stairways:

- Separated but within core



ISSUE 2

Adequacy of information (continuity, reliability, accuracy, sufficiency) provided by fire alarm and communications systems for management of emergency response and evacuation.

Findings

- WTC 1 had overwhelming number of alarms registered and displayed (scrolling) at fire command station (FCS). No information was available at fire command station in WTC 1 about water supply in areas that were burning. One PANYNJ person was sent up to assess situation.

- In WTC 1, fire and other automatic alarm information at the FCS was not used to manage evacuation.

ISSUE 2

(Continued)

Findings

- Alarm systems in WTC 1, 2, and 7 were only capable of determining and displaying (a) areas that had at some time reached alarm point conditions and (b) areas that had not.

- There was no means at the FCS to determine whether or not announcements made in WTC 1 and 2 reached and could be heard on intended floors.

ISSUE 3

Transmission of fire alarm and building systems information outside the building to enhance situational awareness of first responders and to aid in response decisions during emergencies.

Findings

- The alarm system in WTC 1 and 2 was monitored by PANYNJ.
- No information from WTC 1 and 2 alarm system was available outside of the building.

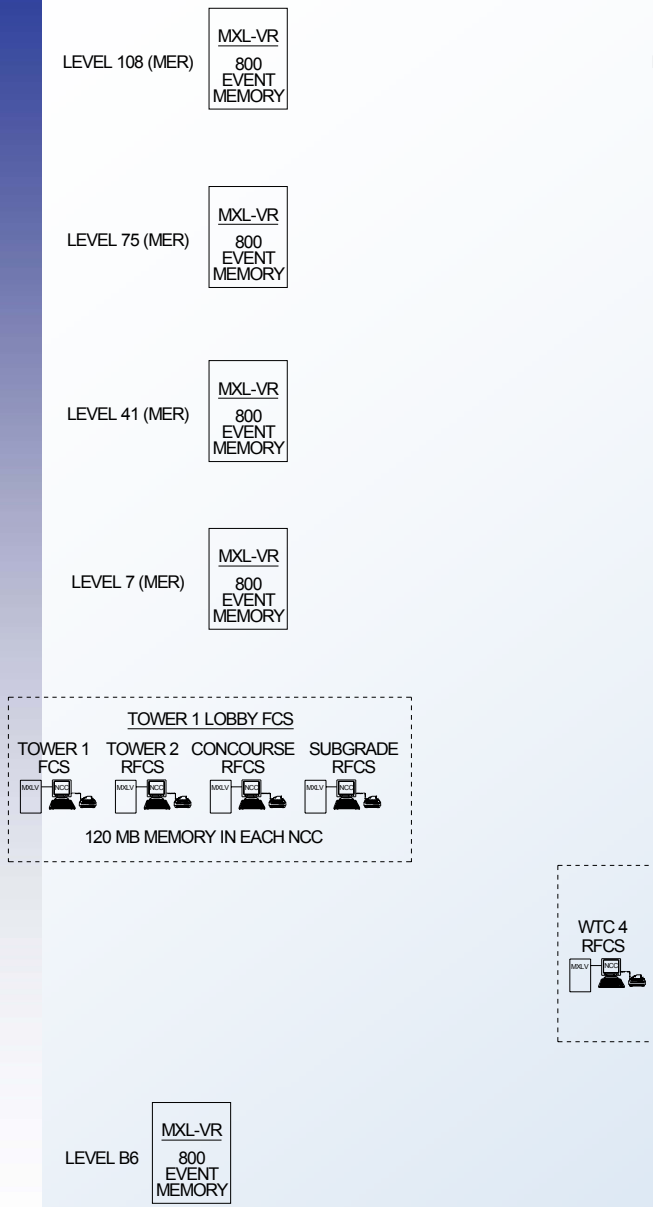
ISSUE 4

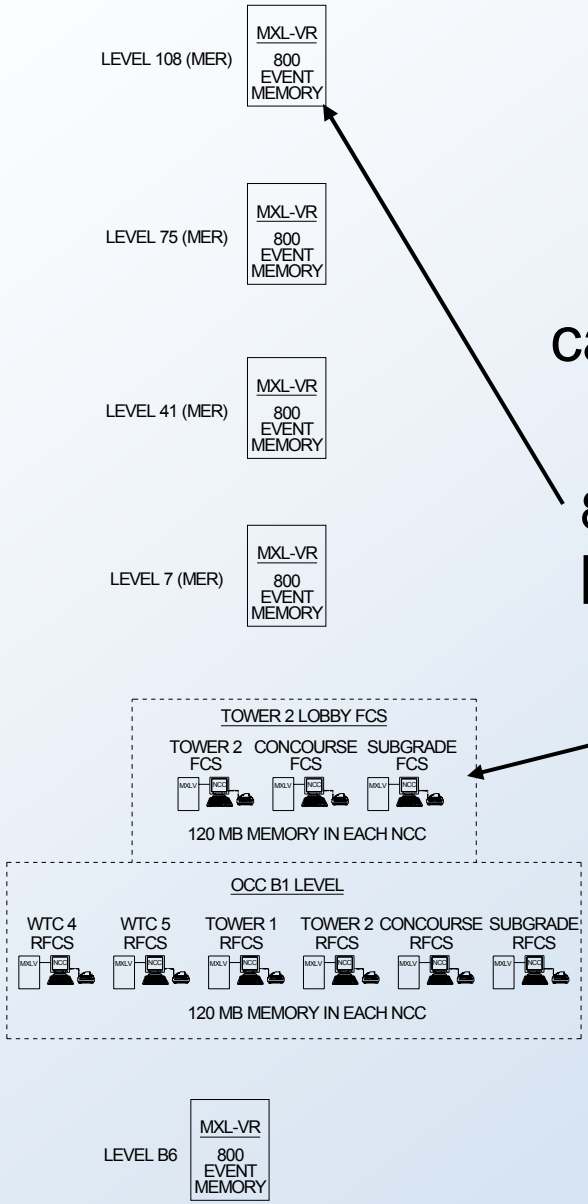
Survival of fire alarm system and other building status records of events for investigation purposes, either through off-site transmission or on-site "black box."

Findings

- Alarm systems collect information that is valuable for understanding the fire and smoke development in a building.
- The extensive back-up command capabilities and hardware installed in WTC 1 and 2 provided multiple places in the building where some alarm history data were stored. Up to 13 locations have been identified.

ISSUE 4





Thirteen alarm system memory location and capacity in WTC 1 and 2

800 event memory chip (typ.)
[Automatic recycle]

120 MB Hard Disk (typ.)
[Automatic recycle]

ISSUE 4

Survival of fire alarm system and other building status records …

Findings

- WTC 7 alarm system recorded information at one location: the Fire Command Station in the 3rd floor lobby.
- WTC 7 Fire Alarm System was monitored offsite, but provided only one piece of information -- “a fire alarm was triggered in the building.”
- No information from the fire alarm system was recovered.
- No indication was found that anyone looked for it.

ISSUE 4

Monitoring station history tape record for the WTC 7 fire alarm system on September 11, 2001

09/11/01	14:48:22	DYJ 4612	**** FULL CLEAR ****
09/11/01	14:47:22	LATE 3923	SYSTEM TEST OVER
09/11/01	14:47:22	COMMENT:	TEST: ALL
09/11/01	14:47:21	COMMENT:	LAST SET: 091101 64742
09/11/01	10:00:52	1 1510	CO TO CLASS E AREA:1 *T
09/11/01	06;47:43	COMMENT:	RIC: WILLIAMS
09/11/01	06:47:03	RIC 4210	PLACE ON TEST CAT:11
09/11/01	06:47:03	COMMENT:	091101 647 091101 1447
09/11/01	06:47:02	COMMENT:	TEST: ALL
09/11/01	06:05:01	RP	20 TIMER TEST

Note: Area: 1 = Building WTC 7 *T = System on TEST

ISSUE 4

Survival of fire alarm system and other building status records of events for investigation purposes…

Findings

- Survivability of alarm systems data on computer hard drives, memory modules, or printouts in building fire and collapse environments (“Black Box” capabilities) is not addressed in present installation standards.
- Transmission of critical data outside building to monitoring station would provide one means to preserve event data. Although modern systems are capable of this communication, it is not done in practice.

NIST WTC Investigation Web Site

http://wtc.nist.gov

Thank You

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