

National Construction Safety Team Investigation

**Report on
The Station Nightclub Fire**

**National Institute of Standards and Technology
Technology Administration
U.S. Department of Commerce**

June, 2005

Duties of National Construction Safety Teams

To establish likely technical causes of building failure;

To evaluate technical aspects of evacuation and emergency response procedures;

To recommend specific improvements to model building standards, codes, and practices based on findings; and

To recommend research and other appropriate actions needed to improve structural safety of buildings, evacuation and emergency response procedures, based upon findings of this investigation.

Conduct of Investigation into The Station Fire

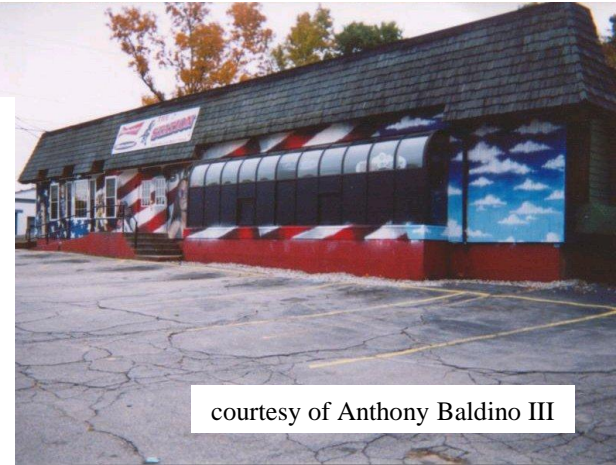
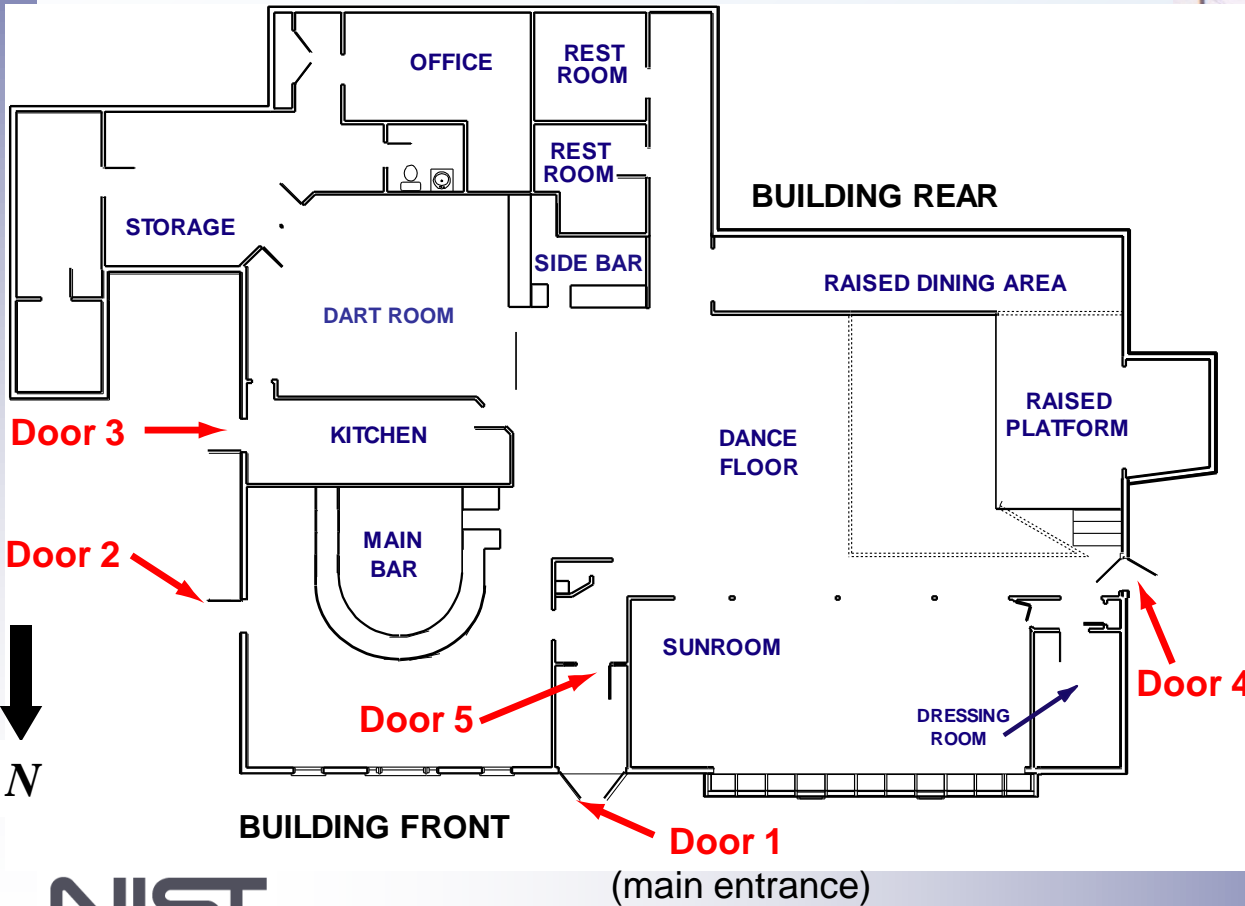
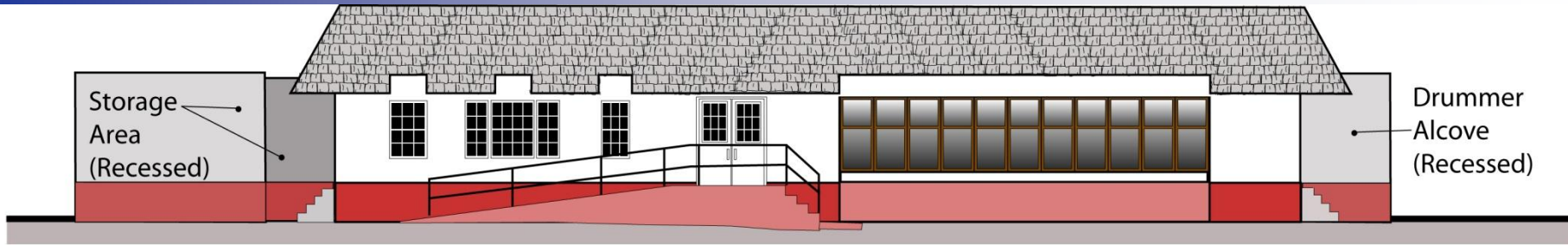
Identified technical issues through consultations with experts in fire protection engineering, emergency evacuation, and members of other investigative teams.

Collected data from the site, local authorities, contractors, building design documents, video/photographic data, telephone/radio transmissions, oral and written accounts.

Compared model building and fire codes and practices, and reviewed practices used in operation of building.

Simulated and analyzed fire spread, smoke movement, tenability, evacuation, and operation of fire protection systems.

Conducted tests to support analysis and simulation predictions.



courtesy of Anthony Baldino III

Views of Building

Overall Timeline

<u>Time</u>	<u>Event</u>
11:08 pm	<ul style="list-style-type: none">- ignition of foam by pyrotechnics- band stops playing, crowd begins to evacuate
11:09	<ul style="list-style-type: none">- cell phone callers report fire to 911- fire alarm sounds and strobes begin to flash- report received of fire at Station nightclub; off-duty police on scene- people caught in doorway, smoke pouring out above
11:10	<ul style="list-style-type: none">- 4 fire engines, a ladder truck and battalion chief assigned and dispatched
11:13	<ul style="list-style-type: none">- Engine 4 on scene; running first hose line (1 3/4")
11:20	<ul style="list-style-type: none">- master stream off Engine 2 operational
11:23	<ul style="list-style-type: none">- Fire Chief 1: implement mass casualty plan
11:32	<ul style="list-style-type: none">- roof over main bar appears down
12:15 am	<ul style="list-style-type: none">- partial collapse of pool room area begins
~ 12:45	<ul style="list-style-type: none">- State Fire Marshal on scene
~1:00	<ul style="list-style-type: none">- all patients transported

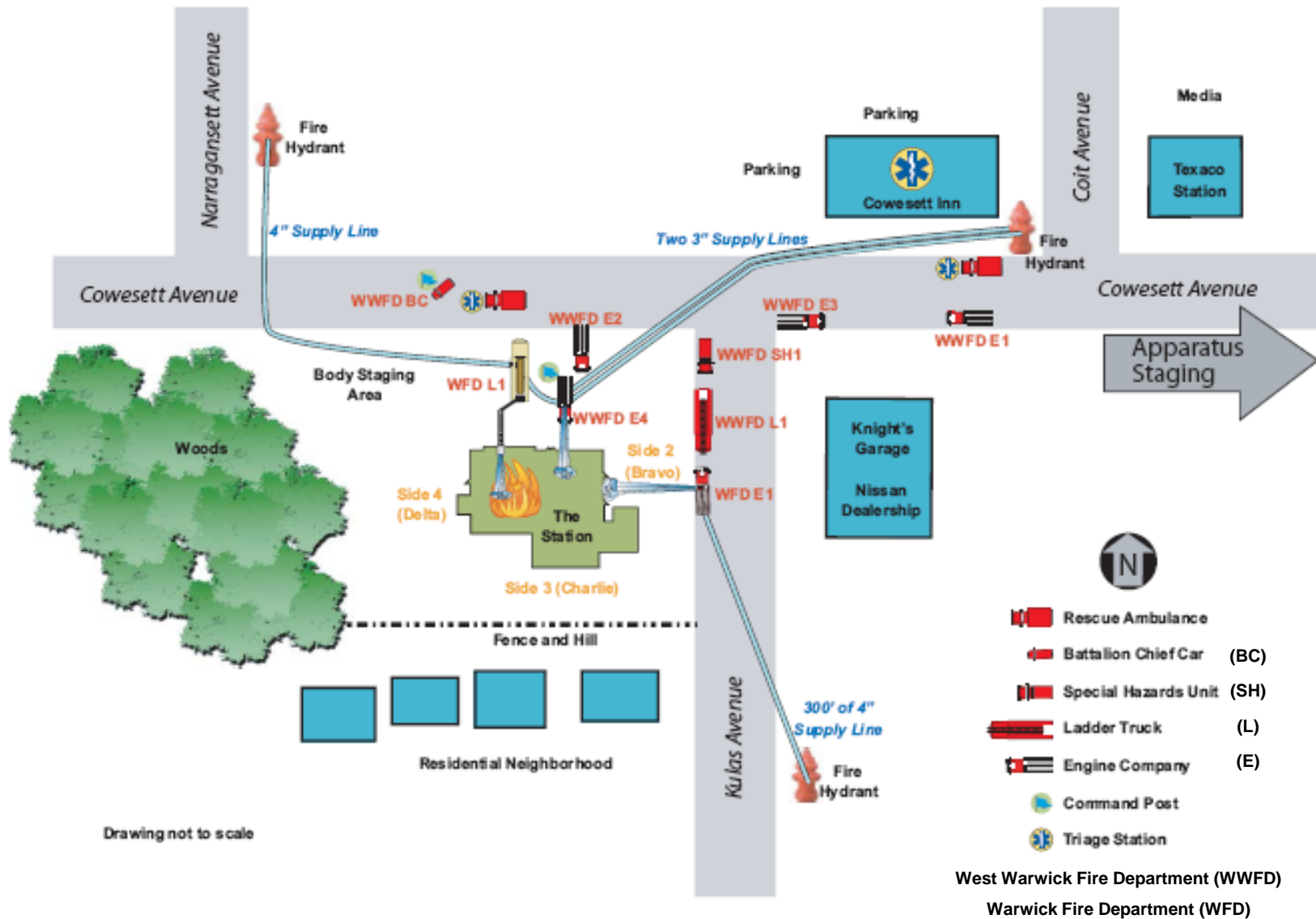


Figure 3-1. Schematic of primary apparatus deployment

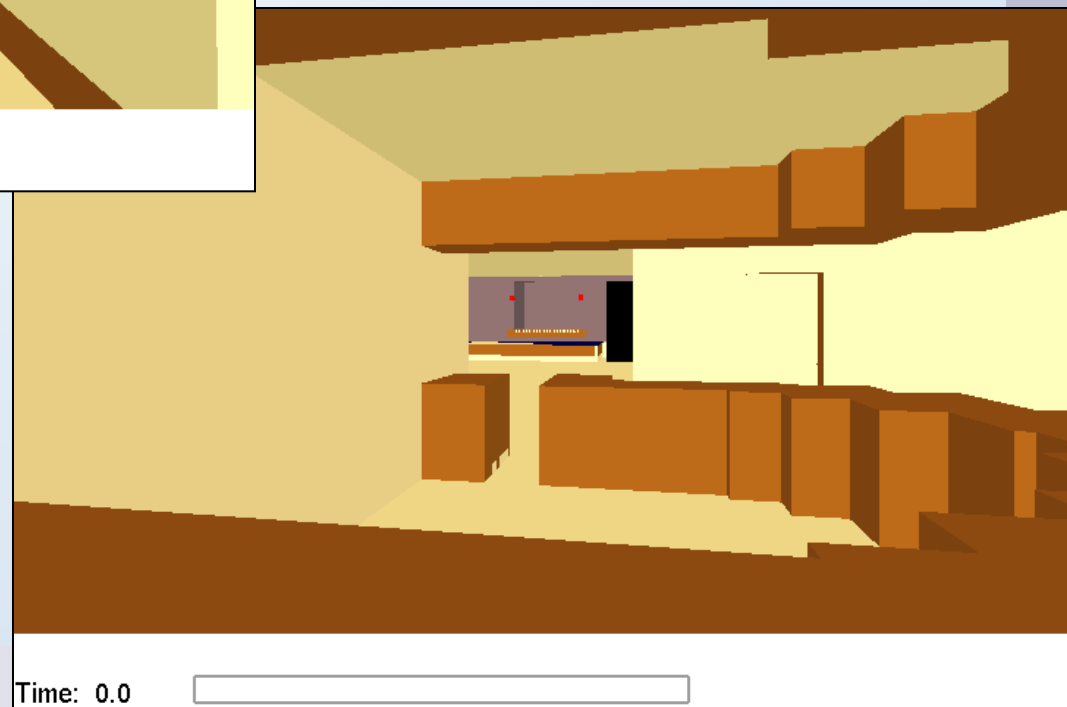
Computer Simulation of The Station Fire



View of fire from near entrance to front vestibule (near floor)

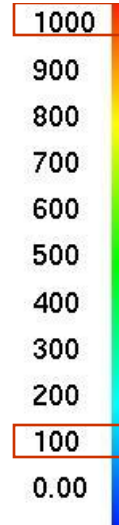
Time: 0.0

View of fire from far side of main bar (head height)



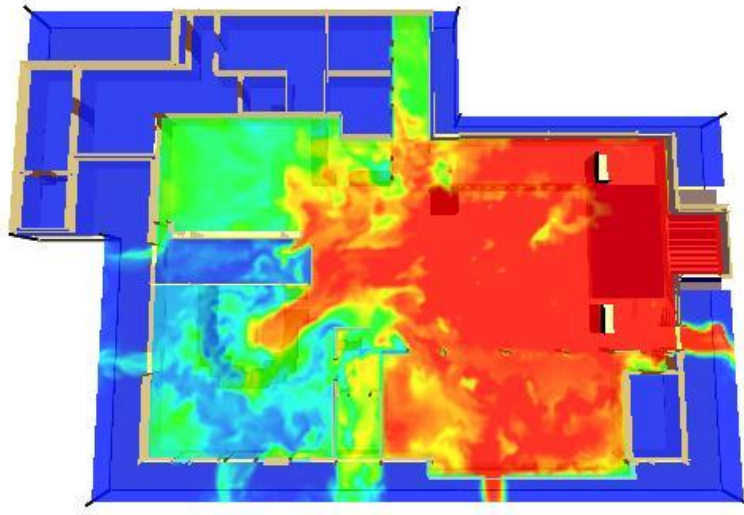
Time: 0.0

temperature
°C



Temperatures in The Station at 90 seconds

(from computer simulation)



NIST

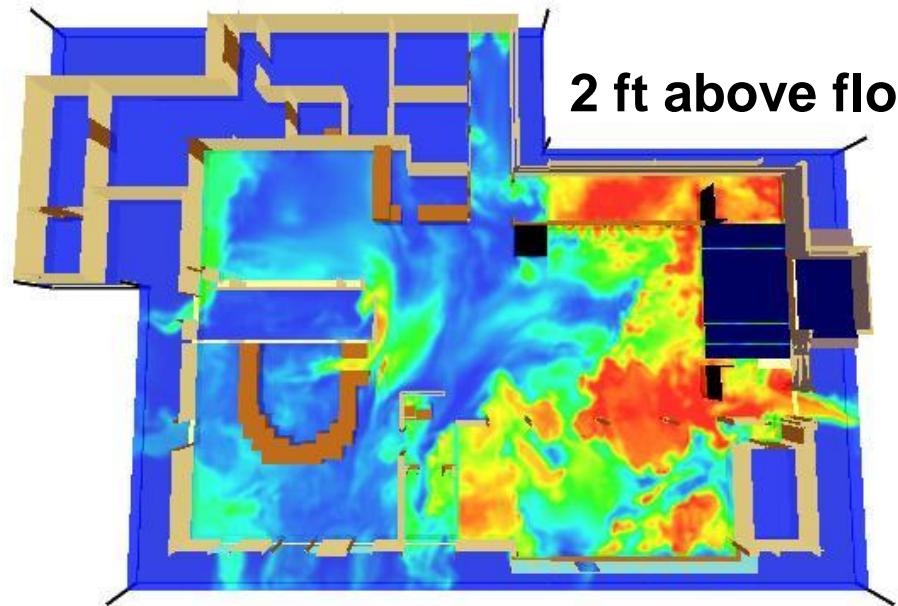
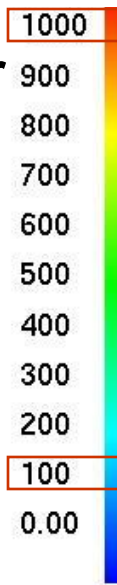
5 ft above floor

Time: 90.0

Peak temperatures in red exceed 1000 °C (1832 °F)

Light blue indicates temperatures around the boiling point of water (100 °C, or 212 °F)

temperature
°C



2 ft above floor

Time: 90.0

Direct contributors to substantial loss of life in The Station fire

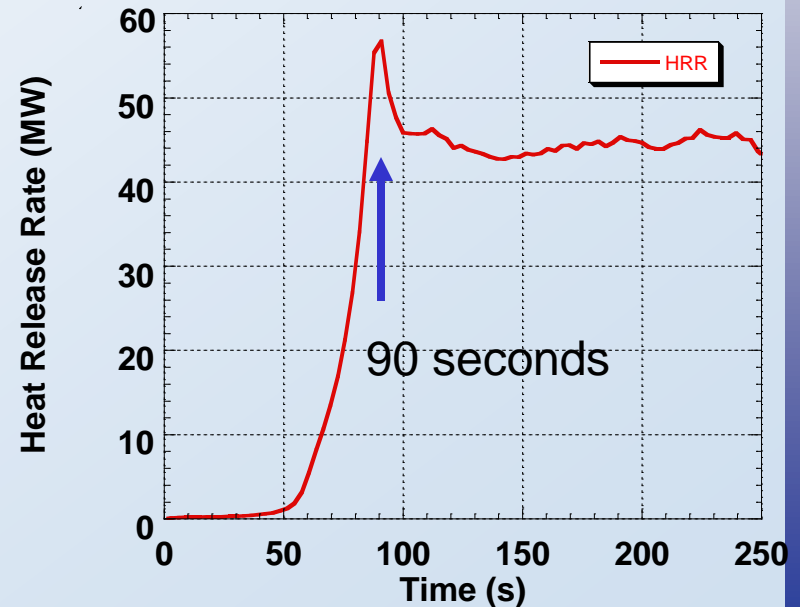
- Hazardous mix of building contents
- Inadequate capability to suppress fire during its early stage of growth
- Inability of exits to handle all of the occupants in the short time available for such a fast growing fire

Major Conclusion

- Strict adherence to 2003 model codes available at the time of the fire would go a long way to preventing similar tragedies in future.
- Changes to codes subsequent to fire made them stronger.
- By making some additional changes – and state and local agencies adopting and enforcing them – we can strengthen occupant safety even further.

Key Findings Regarding Building Contents

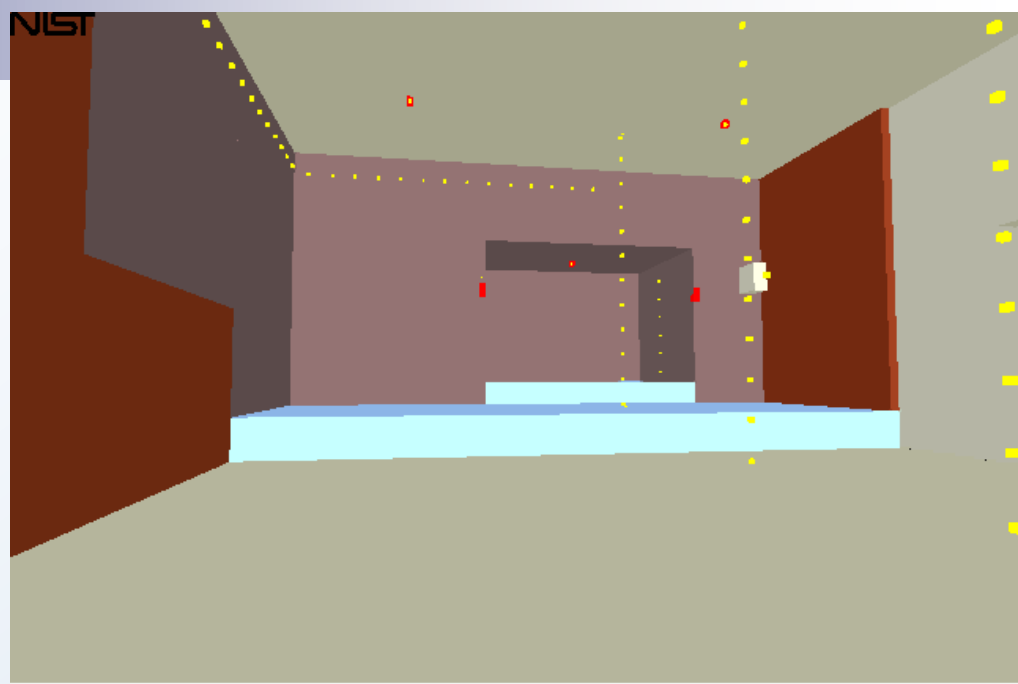
- Non-fire retarded foam sample purchased by NIST ignited within 10 seconds when exposed to a pyrotechnic device; under similar condition, fire retarded foam sample did not ignite.
- Computer simulation of the nightclub fire shows that flames spread rapidly over foam finish material, igniting the wood paneling adjacent to the foam and generating intense heat in the first 90 seconds.
- Fire transitioned to more traditional, ventilation-limited wood frame building fire in about 2 minutes.



Key Findings Regarding Fire Protection Systems

- Experiments conducted at NIST demonstrated that a sprinkler system installed in test room in accordance with NFPA 13 was able to control a fire initiated in non-fire retarded polyurethane foam panels.
- Sprinklers were not installed in The Station, nor would they have been required for such existing structures under 2003 editions of the model codes
- A heat detection/fire alarm system was installed in the building and was activated (sound and strobe) by the fire 41 seconds after the fire started.

Computer simulation of platform area mock-up with sprinklers



Time: 0.0



Key findings regarding emergency egress

- First patrons recognized danger 24 seconds after ignition of foam; bulk of crowd began to evacuate around time band stopped playing (30 seconds).
- Up to 2/3 of occupants may have attempted to leave through main entrance; many were unsuccessful.
- Prior to 90 seconds, a crowd-crush occurred at main entrance which disrupted flow through front exit.
- Event precipitating crowd crush likely related to arrangement of single interior door with merging streams of traffic and pressure to escape rapidly deteriorating conditions in nightclub.

Key findings regarding emergency egress (cont.)

- Measurements in a fire test of a reconstructed portion of the platform and dance floor produced, within 90 seconds, conditions well in excess of accepted survivability limits.
- Computer simulation of the full nightclub fire suggested that conditions around the dance floor, sunroom, and assembly area behind kitchen would have led to severe incapacitation or death within about 90 seconds after ignition of the foam.

Areas of recommendations for improvements to model building & fire codes, standards and practices in nightclubs

- Adoption/enforcement by state/local jurisdictions of model codes
- Strengthening requirements for sprinklers
- Increasing factor of safety on time for occupant egress
- Tightening restriction on use of flexible polyurethane foam as an interior finish product
- Further limiting use of pyrotechnics
- Conducting research to underpin recommended changes

Recommendation 1

Model Code Adoption and Enforcement

All state and local jurisdictions

- a) adopt building/fire code covering nightclubs based on model codes (as a minimum requirement) and update local codes as the model codes are revised;
- b) implement aggressive and effective fire inspection and enforcement programs that address:
 - (i) all aspects of those codes;
 - (ii) documentation of building permits and alterations;
 - (iii) means of egress inspection and record keeping;
 - (iv) frequency and rigor of fire inspections, including follow-up and auditing procedures; and
 - (v) guidelines on recourse available to the inspector for identified deviations from code provisions

Recommendation 1 (cont.)

All state and local jurisdictions

c) ensure that enough fire inspectors and building plan examiners are on staff to do the job and that they are professionally qualified to a national standard such as NFPA 1031 (*Professional Qualifications for Fire Inspector and Plan Examiner*).

Recommendation 2

Sprinklers

Require sprinkler systems for all new nightclubs regardless of size, and for existing nightclubs with occupancy limit > 100.



Computer simulation of The Station fire had sprinklers been installed

Recommendation 3

Building contents and finish materials

- (a) specifically forbid non-fire retarded flexible polyurethane foam, and materials known to ignite and propagate flames as easily, from all new and existing nightclubs;
- (b) provide more explicit guidance to building owners, operators, contractors, and authorities having jurisdiction for when large-scale tests that are covered in NFPA 286 are required to demonstrate that materials (other than those already forbidden above) do not pose an undue hazard for the use intended
- (c) modify ASTM E-84, NFPA 255, and NFPA 286 to ensure that product classification and the pass/fail criteria for flame spread tests and large-scale tests are established using best measurement and prediction practices available.

Recommendation 4

Indoor use of pyrotechnics

- (a) Ban pyrotechnic devices from indoor use in new and existing nightclubs not equipped with an NFPA 13 compliant automatic sprinkler system.
- (b) Modify NFPA 1126 to include a minimum occupancy and/or area for a nightclub below which pyrotechnic devices should be banned from indoor use, irrespective of the installation of an automatic sprinkler system.
- (c) Increase clearance between building contents and range of pyrotechnic device.

Recommendation 5

Occupancy Limits and Emergency Egress

Increase factor of safety on time to egress by

(a) establishing the threshold building area and occupant limits for egress provisions using best practices for estimating tenability and evacuation time; and, unless further studies indicate another value is more appropriate, use 1-1/2 minutes as the maximum permitted evacuation time for nightclubs similar to or smaller than The Station;

(b) computing number of required exits and permitted occupant loads assuming at least one exit will be inaccessible in an emergency evacuation.

Recommendation 5 (cont.)

- (c) increasing minimum capacity of main entrance (for nightclubs with one clearly identifiable main entrance) to accommodate 2/3 of maximum permitted occupant level (based upon standing space or festival seating, if applicable) during an emergency;
- (d) eliminating trade-offs between sprinkler installation and factors that impact the time to evacuate buildings;
- (e) requiring staff training and evacuation plans for nightclubs that cannot be evacuated in less than 1-1/2 minutes; and
- (f) providing improved means for occupants to locate emergency routes for when standard exit signs become obscured by smoke.

Recommendation 6

Portable Fire Extinguishers

Perform a study to determine minimum number and appropriate placement (based upon time required for access and application in fully occupied building) of portable fire extinguishers for use in new and existing nightclubs, and level of staff training required to ensure their proper use.

Recommendation 7

Emergency Response

Ensure effective response to rapidly developing mass casualty events by adopting and adhering to existing model standards on communications, mutual aid, command structure and staffing, such as NFPA 1221, NFPA 1561, NFPA 1710, and NFPA 1720

Recommendation 8

That research be conducted to better understand human behavior in emergency situations, and to predict impact of building design on safe egress in emergencies.

Recommendation 9

That research be conducted to understand fire spread and suppression better in order to provide the tools needed by the design profession to address above recommendations.

Recommendation 10

That research be conducted to refine computer-aided decision tools for determining costs/benefits of alternative code changes and fire safety technologies, and to develop computer models to assist communities in allocating resources.

Actions Already Taken by Rhode Island

- Require the use across the board of up-to-date fire safety codes (elimination of grandfather clause) and coordinated administration of fire safety building codes
- Prohibit use of pyrotechnics in places of assembly such as nightclubs, and strictly regulate use in other large venues.
- Mandate sprinklers in nightclubs with occupancy of >150 in all class A and B places of assembly, with some exceptions.
- Provide greater enforcement powers to fire marshals to ensure ability to make inspections, to require immediate abatement of threats to public safety, and to increase access.
- Establish comprehensive planning requirements to identify future weaknesses in RI's approach to fire safety.

For Further Information:

Web site to view final report: <http://www.nist.gov/ncst>

NIST Building and Fire Research Laboratory:
<http://www.bfrl.nist.gov>

NIST Fire Research – Data, Models, Reports:
<http://www.fire.nist.gov>