New York City Department of Buildings
World Trade Center Building Code Task Force

Findings and Recommendations

February 2003

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1 Executive Summary

The September 11, 2001 terrorist attack and subsequent collapse of the World Trade Center were a national tragedy with an enormous impact on New York City. In light of these events, the Department of Buildings deemed it imperative to establish a Task Force to ensure that requirements, standards and practices in the design and construction of buildings provide safety for occupants of tall buildings. While the Task Force found that the current NYC Building Code contains stringent safety provisions, in a world of unknown and elevated risks we must ensure that our standards are the highest we can make them without compromising our ability to live, work, and build in New York City.

The overall performance of the World Trade Center towers and the surrounding buildings demonstrated a significant ability to protect human life during catastrophic and unforeseen events. As noted in the July 2002 report by the FEMA Building Performance Study Report:

> *The fact that the structures were able to sustain this level of damage and remain standing for an extended period of time is remarkable, and is the reason that many building occupants were able to evacuate safely. Events of this type, resulting in such substantial damage, are generally not considered in building design, and the ability of these structures to successfully withstand such damage is noteworthy.*

However, as with every major failure of a building or structure in New York City, it is incumbent upon the Department of Buildings to review the events and conditions leading to the failure and the associated standards for the construction and operation of buildings. This report outlines its findings and recommendations.

1.1 Scope and Participation

On March 19, 2002 the NYC Department of Buildings convened the World Trade Center Building Code Task Force (Task Force) to review current building design, construction and operating requirements and determine if modifications for extreme events were needed to ensure public safety in new and existing buildings.

The Task Force, made up of an Executive Committee and five Working Groups, represents a broad coalition of stakeholders and experts from the public and private sectors.

1.2 Sources and Deliberation

The Task Force gathered input from other government entities, professional design and engineering societies, the construction industry, private real estate owners associations, private and academic experts, and individuals directly affected by the disaster. Inspection reports, news articles, research reports and, in some cases, empirical test results were also reviewed. A critical source of information regarding the events of September 11th was the FEMA World Trade Center Building Performance Study Report (BPS Report). Its conclusions point to several areas in our current standards and code requirements that may require modification.

Based on the above sources, issues were presented to the Executive Committee and Working Groups for deliberation. Working Groups examined the study issues and formulated both general recommendations and specific proposals for Building Code changes where they were deemed appropriate given the limited amount of technical information available.

The Task Force diligently worked to identify and differentiate where information already exists, where it is currently being developed, and where additional study is required to adequately assess existing building and safety standards and requirements. The National Building and Fire Safety Investigation of the World Trade Center Disaster by the National Institute of Standards and Technology (NIST) will be a critical component of the on-going efforts to update standards, requirements and procedures. Until these results are issued, the Task Force has endeavored to make these recommendations based on currently available information. Nevertheless, the Task Force strongly supports NIST's investigation and has referred to them a number of items that require further investigation.

1.3 Recommendations

The following recommendations are being made by the Task Force:

1. Publish structural design guidelines for optional application to enhance robustness and resistance to progressive collapse.
2. Prohibit the use of open web bar trusses in new commercial high-rise construction over 75 feet in height, pending the development of an appropriate standard recommended by NIST.
3. Encourage use of available impact resistant materials in the construction of stair and elevator shaft enclosures until appropriate standards can be developed.
4. Work with the Department of City Planning to exempt floor area of stairwells above minimum requirements from zoning Floor Area Ratio (FAR) calculations to encourage the inclusion of more stairwells or wider stairwells in buildings.
5. Prohibit the use of scissors stairs in high-rise commercial buildings with a floor plate of over 10,000 square feet.
6. Improve marking of the egress path, doors and stairs with photo-luminescent materials and retrofit existing exit signs with either battery or generator backup power
7. Mandate a full building evacuation plan for non-fire related events.
8. Work with the Department of City Planning to exclude floor area of “fire towers” from Floor Area Ratio (FAR) calculations to encourage their use.
9. Mandate protected vestibules at elevator lobbies in newly constructed occupancy group E buildings greater than 75 feet.
10. Require controlled inspections to ensure that fireproofing is fully intact on all structural building members exposed by subsequent renovations to ensure continued compliance with applicable code requirements.
11. Require all high-rise commercial buildings over 100 feet without automatic sprinkler protection to install a sprinkler system throughout the building within 15 years.
12. Require all occupancy group E buildings to maintain a Building Information Card (BIC) listing a building's vital features.
13. Enhance Fire Department emergency response communications in high rise commercial buildings.
14. Provide additional training for Fire Safety Directors.
15. Limit diameter of fuel oil transfer piping in systems using day tanks.
16. Implement standards for piping that is utilized to distribute fuel oil to equipment without the use of a day tank.
17. Exclude floor drains for elevator vestibule and shafts from being counted as fixtures in calculating normal waste water pipe capacity.
18. Require air intakes in all new construction to be located at least 20' above grade and away from exhaust discharges or off street loading bays.
19. Require controlled inspections of HVAC fire dampers in newly constructed occupancy group E buildings.
20. Wait for the recommendation of Mayoral Commission on adoption of national model code and incorporate Task Force recommendations into any locally specific modifications.
21. Encourage buildings within NYC geographic boundaries and subject to other jurisdictional authority to comply with NYC Building Code through collaborative agreements.

Additional information about the findings and recommendations is outlined in the report.

2 Introduction

The September 11th terrorist attack and subsequent collapse of the World Trade Center twin towers and building number seven (WTC 7) were a national tragedy that had an enormous impact on New York City. Although the typical building designs cannot anticipate or be designed for an event of this type and magnitude, the Department of Buildings felt that it was imperative for it to establish a Task Force to review these events and the New York City Building Code. Understanding the causes of this catastrophe is the first step in determining that our requirements, standards and practices in the design and construction of buildings ensure the highest level of safety for the occupants of tall buildings. The Task Force found that the current NYC Building Code contains many provisions to ensure the integrity of structures, protection from fire, safe evacuation, and the safe installation of mechanical systems. However, in a post September 11th world of unknown and elevated risks we must strive to ensure our standards are the highest we can make them without compromising our ability to live, work, and build in New York City. The Task Force did not attempt to identify specific risks and does not propose designing buildings to make them safe from the impact of aircraft. The goal of the Task Force was to examine the Building Code for areas that could enhance public safety in a practical way.

The overall performance of the World Trade Center towers and the buildings surrounding them demonstrated their ability to protect human life during catastrophic and unforeseen events to a remarkable extent. As noted in the July 2002 report by the FEMA Building Performance Study Report:

> *The fact that the structures were able to sustain this level of damage and remain standing for an extended period of time is remarkable, and is the reason that most building occupants were able to evacuate safely. Events of this type, resulting in such substantial damage, are generally not considered in building design, and the ability of these structures to successfully withstand such damage is noteworthy.*

However, as with every major failure of a building or structure in New York City, it is incumbent upon the Department of Buildings to review the events and conditions leading to the failure and the associated standards and requirements for the construction and operation of buildings to ensure that they adequately protect the life-safety of occupants.

2.1 Task Force Mission and Scope

On March 19, 2002 the NYC Department of Buildings convened the World Trade Center Building Code Task Force (Task Force) to review current building design, construction and operating requirements and to determine if modifications are needed to ensure public safety in new and existing buildings.

The purpose of the Task Force is to review available information regarding the events of September 11th and determine whether changes to existing design, construction and operating requirements are needed prior to the completion of a comprehensive technical evaluation and standards development by NIST. The recommendations in this report were formulated based on a review of existing information and the current New York City Building Code and related Reference Standards and Rules and Regulations.

The following principles and conditions guided the task force in completing its mission:

- New York City is a unique environment because of its tall buildings, high density and historical pattern of physical development;
- Strengths and successes of the current Building Code should be noted where no changes are necessary;
- Safety and economic viability need to be appropriately balanced, but neither should be compromised;
- The Task Force should endeavor to make specific recommendations but may refer issues or concerns for further study where sufficient information is not available.

The Task Force recognizes that buildings cannot be designed and built for all eventualities, just as building codes cannot regulate every detail of building design, construction or operation. While the Task Force discussed various risk scenarios, it could not establish a uniform set of specific risks to address. It agreed, however, that the scope of consideration has necessarily been widened by the events of September 11. Recommendations made by the Task Force must strike a balance between the physical impact of a catastrophic event, the assurance of life safety under normal, everyday circumstances and the livability, usability and cost of buildings.

2.2 Task Force Structure and Participation

The Task Force was made up of an Executive Committee and five Working Groups, bringing together a broad coalition of experts from the public and private sectors. It gathered input from other government entities, professional design and engineering societies, the construction industry, private real estate owners associations, private and academic experts, and individuals directly affected by the events of September 11th, including emergency services personnel and victims' families. The Task Force heard presentations from eyewitnesses and experts and reviewed inspection reports, news articles, research reports, national standards, and, in some cases, empirical test results.

2.2.1 Executive Committee

The following organizations were asked to participate as part of the Executive Committee:

- NYC Department of Buildings
- Fire Department of New York
- NYC Office of Emergency Management
- NYC Department of Design & Construction
- Real Estate Board of New York
- Building Trade Employers Association
- Architects Council of New York
- New York State Society of Professional Engineers

All recommendations were adopted by the entire Executive Committee prior to inclusion in this report.

2.2.2 Working Groups

Working Groups were established to investigate four major areas that affect building performance and occupant safety during emergency events. An additional working group was established to review the enforcement of building requirements by the DOB, the City's primary design and construction regulatory body, and the enactment of recommendations of the Task Force.

The five Working Groups were:

- Structural strength
- Fire protection
- Emergency evacuation
- Mechanical systems
- Department of Buildings operations

Only members of the Executive Committee could lead Working Groups and all Executive Committee members were invited to attend any Working Group meetings. The Working Group leaders invited experts to participate in discussion by submitting reports, attending meetings and making presentations. Experts addressing issues that overlapped Working Group areas made presentations to a combination of those Working Groups or to the entire Task Force. Permanent members of Working Groups were sponsored by Executive Committee members.

2.2.3 Public Forum

The Department of Buildings held a Public Forum on August 13, 2002 to ensure that the Task Force received input from all groups affected by the events of September 11th and any group potentially affected by possible changes to the Building Code. The general public was invited to submit requests to present testimony. Selection of speakers was based on the proposed presentation relative to the working group areas of focus as well as creating a representative sample of interested individuals and groups. Those who could not attend were encouraged to send written submissions to the Task Force. Materials not able to be presented at the forum were also accepted and reviewed by the Task Force.

2.3 Methodology

Information regarding the specific events of September 11th was largely taken from the FEMA World Trade Center Building Performance Study Report (BPS Report) as the best available single source of information. Other information collected through inspection reports, expert assessment, or eyewitness testimony did not substantially contradict the findings of this report. As a result, the specific events and findings of the BPS Report will not be reiterated in this report.

Study issues were identified by the Task Force and by the Working Groups through consultation of written reports, as well as presentations made by agencies, organizations and individuals involved in analyzing the disaster, including public forum testimony. Study issues from these sources were assigned to the Working Groups by area of focus. Issues that involved more than one discipline were considered by all appropriate groups. Oftentimes one group acted as lead examiners with other Working Groups contributing as needed.

Issues that came to the Working Groups for deliberation were either:

- studied and no action was taken,
- studied and referred for further examination by an appropriate agency or organization,
- studied with a general recommendation made, or
- studied, with a specific proposal created.

Within the relatively short period of eight months of deliberation, Working Groups examined, as systematically as practicable, the study issues and formulated both general recommendations and specific proposals for Building Code changes.

The Task Force has diligently worked to identify and differentiate where information already exists, where it is currently being developed, and where additional study is required to adequately review existing building and safety requirements. The National Building and Fire Safety Investigation of the World Trade Center Disaster by the National Institute of Standards and Technology (NIST) will be a critical component of this continuing effort to update our standards, requirements and procedures.

The Task Force recognizes NIST's on-going research and development program will "provide the technical basis for improved building and fire codes, standards and practices." Until results are issued, the Task Force has endeavored to make its own recommendations based on currently available information. Nevertheless, the Task Force strongly supports NIST's involvement and has referred a number of items that require further investigation.

2.4 Organization of this Report

Findings and recommendations of the Task Force are organized by subject area, as discussed by the Working Groups, and reflect the Working Groups' analysis and deliberation of study issues. Task Force recommendations seek to treat significant findings in general or specific ways, respectively.

3 Sources of Information

3.1 FEMA Building Performance Study Report

The Building Performance Study (BPS) Report, written by the Building Performance Assessment Team (BPAT), made a number of preliminary conclusions regarding the events of September 11th. Significantly, the steel framing system, egress stairways and their marking, and evacuation training were all cited as contributing to the successful evacuation of most building occupants. Several design features, however, were identified as needing more detailed evaluation in order to understand their contribution to the performance of the WTC buildings and how they may perform in other buildings.

These included:

- the overall strength of the floor truss system;
- the susceptibility of fire proofing to blasts and impacts;
- the inability of stairway enclosures to resist impacts;
- and the concentration of emergency stairways in the central building core.

Several other issues were found to be critical to building performance in one or more of the WTC buildings and the surrounding structures:

- The redundancy and/or robustness of structural framing systems.
- Adherence of fireproofing under impact and fire conditions.
- Performance of structural connections under impact and fire loads.
- The reliability of water supply to sprinklers.
- Capacity and robustness of egress systems when building damage occurs.
- Robustness of structural transfer systems during fires.

The BPAT concluded that these features should be evaluated in detail to determine how they affect the performance of the World Trade Center buildings and how they might perform in other buildings and situations. In addition to detailed technical analysis, the study team felt that extensive technical, policy, and economic examination of these concepts should be conducted prior to making specific building code revisions.

In the absence of sufficient data to determine the likelihood of any particular threat, the study team also recommended that individual building owners consider their own level of risk and investigate possible ways to enhance the redundancy and robustness of their structures. Indeed, the marketplace has already recognized this need and begun to voluntarily take additional precautions in instances of high risk.

3.2 Public Forum

The following is a summary list of topics presented at the Public Forum.

Structural Strength

- progressive collapse guidelines
- steel connection robustness
- truss systems
- fire performance of structural elements
- hardening elevator and stairwell enclosures

Evacuation

- full building evacuation
- smoke proof stairways
- elevators for evacuation
- design specifications for egress
- areas of refuge
- location of stairwells
- education and training
- evacuation for people with special needs

Fire Protection

- emergency response communication
- sprinkler retrofitting in high rises
- fireproofing methods and inspection
- building information for emergency responders
- elevator use for fire fighting

Mechanical

- smoke proof stairways
- protection of mechanical systems from water
- HVAC systems

DOB Operations

- universal compliance with building code
- skyscraper safety unit
- inspection
- model codes

3.3 Other Sources of Information

A number of other books, publications, and presentations were also reviewed. They include:

Publications:

Building Regulations 1991. *Approved Document A: structure*. London. HMSO, 1991.

Easter Seals, *s.a.f.e.t.y. fist: Working Together for Safer Communities*, 2002.

Institution of Structural Engineers. *Safety in Tall Buildings and Other Buildings with Large Occupancy.* London. July 2002.

National Conference of States on Building Codes and Standards, National Alliance for Building Regulatory Reform in the Digital Age. *A Proposed Secure Nationwide State-Managed Database of Building Designs and Evacuation Plans for Critical.* http://www.ncsbcs.com/

National Institute of Standards and Technology. *National Building and Fire Safety Investigation of the World Trade Center Disaster*, 2002

National Research Council. *Protecting Buildings for Bomb Damage: Transfer of Blast-Effects Mitigation Technologies from Military to Civilian Applications.* Washington, D.C. 1995.

Port Authority of New York/New Jersey. *Steps Taken to Enhance Evacuation Efficiency.*

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health. *Guidance for Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks.* May 2002. DHHS (NIOSH) Publication No. 2002-139

Presentations:

ARUP, ArupFire. Study of Full Evacuation Procedures (computer modeling and high rise test).

Donald Burns. Survivor testimony

Easten Paralyzed Veterans Association, Accessible Means of Egress/Emergency Evacuation for Persons with Disabilities, 2002.

Gage – Babcock Associates, Inc. Analysis of performance based codes with computer modeling of smoke incident.

Perkins Eastman Architects, P.C., 330 Jay Street: Hardened Building Components.

4 Findings and Recommendations

4.1 Structural Strength

4.1.1 Progressive Collapse

The current NYC code provisions for resistance to progressive collapse (see Appendix A) were drafted in response to the collapse of a concrete panel and slab construction in Ronan Point England in 1968. The NYC Building Code progressive collapse provisions were adopted by rule into the current code on August 2, 1973. However, they are considered cumbersome to read and difficult to use by the engineering community. The Structural Strength Working Group developed a draft progressive collapse guideline to clarify these rules. Because it was unable to test these guidelines against actual buildings under design, these guidelines will be published in this report for further development and testing.

The draft provisions, which take much of their substance and methodology from the British Standard and Building Regulations Approved Document A, outline three methods of designing a structure for improved resistance to progressive collapse. The British Standard served as a model for this group because of its simplicity and nearly thirty years of satisfactory performance in various exceptional events. It should be noted that the performance of this standard is solely based on empirical evidence.

Because the existing rules remain effective, these guidelines are meant to augment the professional's ability to achieve a robust design for buildings at risk of extraordinary events. They are to be considered one possible approach. The Task Force recommends the development of coherent and rational standards through the analysis of economic impact and coordination with the NIST research and development effort, using review procedures similar to those that guided the development and adoption of the seismic code.

Recommendation

1. Publish structural design guidelines for optional application to enhance robustness and resistance to progressive collapse.

4.1.2 Use of Lightweight Structural Members

Of major concern to the Structural Strength Working Group was the ability of fireproofing to adequately perform on lightweight structural members, specifically, open web bar trusses, the type of trusses used in the WTC towers. As the weight (mass) of the bar diminishes, typically so too does the surface area to which the fireproofing is applied. The adherence of spray on fireproofing, that most often used in conjunction with these trusses, has been called into question by initial investigations of the towers. To cover a lightweight element, one that has an already lower resistance to fire due to its size, with fireproofing of dubious performance is unwise at best. A standard discussed by the group which uses a ratio of weight (mass) to surface area calculation to produce a minimum allowable size factor was not adopted because the group could not determine with the information available to it what would ultimately constitute a "safe" minimum size.

In lieu of formulating an appropriate performance standard for this type of construction, a determination the group thought would be better undertaken by NIST, and in light of the near absence of this type of high-rise construction in New York City, the Structural Strength Working Group has recommended a temporary prohibition of the use of open web bar trusses in new commercial high-rise construction over 75 feet in height, pending the development of an appropriate standard recommended by NIST.

> **Recommendation**
>
> 2. Prohibit the use of open web bar trusses in new commercial high-rise construction over 75 feet in height, pending the development of an appropriate standard recommended by NIST.

4.1.3 Hardening of Stairwell and Elevator Shaft Enclosures

At the request of the Mechanical Systems, Evacuation and Fire Protection Working Groups, the Structural Strength Working Group further examined the question of hardening of stairwells and elevator shafts.

Currently, stairwells and elevator shafts are required to meet the ASTM 2-hour rating standard, one which includes a fire test followed by a hose stream test. However, anecdotal information from the Fire Department indicates that materials that meet these standards in test trials do not successfully resist a fire fighter's hose stream in the field. The Task Force recommends that ASTM and NIST study impact loading for stair and elevator shaft enclosures to determine whether further hardening should be required and if so, to develop a testing method that ensures that materials and assemblies used can achieve this. Until this is determined, the committee notes that there are several materials currently available on the market that provide greater resistance to impact and recommends their use for stair and elevator shaft enclosures be considered.

> **Recommendation**
>
> 3. Encourage use of available impact resistant materials in the construction of stair and elevator shaft enclosures until appropriate standards can be developed.

4.2 Evacuation and Egress

Successful evacuation of building occupants requires appropriate and effective egress systems. The Emergency Evacuation Working Group focused on five interrelated areas of concern highlighted in the findings:

- capacity and location of stairwells
- clarity of the egress pathway
- planning and training for evacuation
- auxilliary systems, technologies and construction (such as fire towers, protected elevator vestibules and "phase III" elevators)
- evacuation of those with special needs (temporary and permanent disabilities)

4.2.1 Capacity and Location of Stairwells

In most areas related to egress capacity, further information and empirical investigation is required to warrant introduction of new standards into the code. Despite having limited empirical and modeling documentation, further evidence of a need for stair capacity increase on lower floors would have to be provided to make a specific recommendation. The Task Force looks to NIST for a more comprehensive study of this issue. However, the goal of increased capacity, in absence of new workable design criteria could be addressed immediately with a change in the way developed space is calculated. To encourage the inclusion of more stairwells or wider stairwells in buildings, the Task Force recommends that the floor area of stairwells above the minimum requirements be excluded from total Floor Area, in the calculation of a building's potential maximum developable floor area. This recommendation would require a change in the Zoning Resolution including environmental review and City Planning Commission Approval.

Remote location of stairwells was also a concern to the Task Force, given the Building Performance Study conclusions. Currently, number and size of stairways, as well as remote location, are dictated by occupant load, determined by floor size and travel distance. The logic behind separating stairwells and placing them at a prescribed distance is predicated on redundancy (a lesson learned from many building tragedies), given the possibility of a catastrophic event isolating a portion of a floor. A building core organizes circulation, mechanical services, plumbing and power utilities, allowing for the necessary efficiency of an office floor "plate". Design of a building's core is not generic, but highly specific to a building, and thus, stair quantity and location should be evaluated for the idiosyncrasies of individual building design and risk profile. In reality, high-rise building design depends on this type of core construction. The Task Force believes that this issue should be examined by NIST.

An additional building design efficiency includes the use of scissors stairs, two stairwells that adjoin one another and share a common shaft, but are separately enclosed. Such stairs are little used except in buildings with small floor plates, but allowable by the current code. The Task Force recommends that this design be limited to high-rise commercial buildings with a floor plate square footage under 10,000 square feet.

Recommendation

4. Work with the Department of City Planning to exempt floor area of stairwells above minimum requirements from zoning Floor Area Ratio (FAR) calculations to encourage the inclusion of more stairwells or wider stairwells in buildings.

5. Prohibit the use of scissors stairs in high-rise commercial buildings with a floor plate of over 10,000 square feet.

4.2.2 Clarity of Egress Pathway

The clarity or "readability" of the egress path is essential for a successful evacuation. When fire or another threatening condition impedes sensory perception, decision making for evacuees should be facilitated by systems that offer heightened comprehensibility. The Working Group concluded that improvements to the marking of the egress path, doors and stairs be implemented and that existing buildings' exit signs should be retrofitted with either battery or generator backup power. It also concluded that overall lighting level was sufficient and that color coding stairwells could confuse the current requisite identification scheme.

Recommendation

6. Improve marking of the egress path, doors and stairs with photo-luminescent materials and retrofit existing exit signs with either battery or generator backup power

4.2.3 Planning and Training for Evacuation

The current NYC building and fire code requirements for occupancy group E, relative to evacuations in the event of a fire, has consistently protected the safety of New Yorkers over the decades. With regard to fire related emergencies, present evacuation requirements will remain unchanged. However, the possibility of other unforeseen catastrophic events must be addressed relative to evacuation.

The Working Group discussed and determined there was a need for mandated, non-fire related full evacuation plans. Currently partial evacuation plans and fire drills are required. This type of planning and training will also help to confirm the use and availability existing egress paths such as doors, stairs and roofs. Many building owners and managers have already begun full evacuation planning and training. The Task Force recommends a requirement that all high rise office buildings (occupancy group E) have full evacuation plans for non-fire related events.

Recommendation

7. Mandate a full building evacuation plan for non-fire related events.

4.2.4 Auxiliary Systems

Auxiliary egress systems and technologies that support and reinforce customary systems were also discussed. Included in considerations were built systems such as fire towers and protected vestibules at elevator lobbies along with new technologies such as so-called "Phase III" elevators.

The use of fire towers, an option in the current NYC Building Code, is in practice, discouraged because the fire tower's floor area must be included as a part of the floor area ratio (FAR), a calculation of a building's maximum floor area. A fire tower's area is counted as floor area, like occupied space. To make the option of constructing fire towers more appealing, the Task Force recommends a FAR "subtraction" for fire towers. Buildings that include a fire tower should be allowed to discount the floor area of the fire tower in the FAR permitted for development. This recommendation would require a change in the Zoning Resolution and would have to be made in conjunction with the Department of City Planning.

The mandating of protected vestibules at elevator lobbies was viewed favorably by the Emergency Evacuation Working Group. Proposed legislation is included in the appendix.

Elevator evacuation is counter to the current standard restricting the use of elevators during an emergency. Fire fighters and rescue personnel use elevators, during both fire and non-fire emergencies. New technologies currently under development to build "Phase III" (waterproof and smoke proof elevators suitable for use during emergencies) were discussed. Making recommendations for the use of this nascent technology now, or in the near future, was seen as premature by the Working Group. NIST will be studying this issue.

Recommendation

8. Work with the Department of City Planning to exclude floor area of “fire towers” from Floor Area Ratio (FAR) calculations to encourage their use.
9. Mandate protected vestibules at elevator lobbies in newly constructed occupancy group E buildings greater than 75 feet.

4.2.5 Evacuation of People with Special Needs

Attention to evacuation for those with special needs was addressed, and groups representing this constituency submitted information or made presentations during Working Group deliberations.

People with disabilities (both temporary and permanent) would benefit along with the general population from code revisions recommended by the group, however, the largest impact would be felt from the conscientious development and use of Fire Safety Plans, the primary locus of evacuation information and procedures for individual buildings. The development of "Phase III" elevators will have a significant impact on this issue.

4.3 Fire Protection

Active and passive fire protection systems are a significant part of any building design. The Fire Protection Working Group studied their design, construction and operating requirements and other related issues. They also reviewed two important agency operational issues: the delivery of building information to first responders and the assurance, through controlled inspection, that passive fire control systems remain intact.

The issues studied by the Fire Protection Working Group can be divided into the following general categories:

- passive and active fire protection systems
- enhanced emergency communication
- fire safety personnel and operations

4.3.1 Passive and Active Fire Protection Systems

Passive fire protection can only work properly when it has remained intact on the building elements to which it was applied. Fire proofing can be compromised or dislodged over time due to local renovations, alterations, or other construction activities. As spaces in buildings are being renovated, the Task Force recommends requiring a controlled inspection to ensure that all fireproofing is fully intact on all structural members exposed by the renovation. The controlled inspection shall be signed and sealed by either a licensed architect or engineer and shall be filed with the NYC Department of Buildings prior to the issuance of a Building Permit. This new requirement would be applicable to buildings in occupancy group E and can be adopted into the present Chapter 16: Inspection of Existing Structures During Construction Operations.

The retrofitting of sprinklers in high rise commercial buildings is an issue of great importance to the Department of Buildings, Fire Department of New York (FDNY) and Public Forum participants. Experiential evidence suggests that compartmentation and smoke alarms do not provide the same level of fire protection as compared to fully outfitted sprinkler systems in high-rise buildings. The Task Force recommends all high-rise commercial buildings 100 feet or more in height, that are without automatic sprinkler protection on the effective date of the local law, be required to install a sprinkler system providing complete coverage throughout the building within 15 years of the law's passage. The procedure for retrofitting would include an implementation timeline, with benchmarks/milestones at which a prescribed percentage of work completed must be attested to and implementation plans for outstanding work must be submitted. Implementation of these plans would be monitored annually by the FDNY's High Rise Inspection Unit. A committee, composed of representatives of the Commissioners of the Department of Buildings and FDNY and a representative of the Real Estate Board of New York, would review requests for time extensions based upon extreme hardship.

Recommendation

10. Require controlled inspections to ensure that fireproofing is fully intact on all structural building members exposed by subsequent renovations to ensure continued compliance with applicable code requirements.
11. Require all high-rise commercial buildings over 100 feet in height without automatic sprinkler protection to install a sprinkler system throughout the building within 15 years.

4.3.2 Enhanced Emergency Communication

An effective response to emergency situations requires getting information about the situation and the building context to responders and providing them with an operable means of communication for on-site use.

Computerization of building information to be used by emergency personnel to assess site conditions was considered. However, the Task Force has recommended a more modest, immediately implementable system. The Task Force recommends a Building Information Card (BIC), listing all of the building's vital features, be required for occupancy group E buildings within six months. The BIC would be located at the Fire Command Post, accessible to responding fire units and Chiefs.

Improving communications in high-rises is one key component in the successful management of emergency situations. To enhance emergency response communications, the Task Force recommends adding or enhancing the use of auxiliary communications technologies where appropriate in occupancy group E buildings. Specific technical solutions should reflect research and information gathered by the NIST Investigation.

Recommendation

12. Require all occupancy group E buildings to maintain a Building Information Card (BIC) listing a building's vital features.
13. Enhance Fire Department emergency response communications in high rise commercial buildings.

4.3.3 Fire Safety Personnel and Operations

Public Forum participants recommended additional training for Fire Safety Directors to include use of fire pumps and static pressure devices as well as requiring a "dedicated" fire safety director at all times.

The Task Force recommends additional training be incorporated into existing Fire Safety Directors' courses to reflect new evacuation requirements.

> **Recommendation**
>
> 14. Provide additional training for Fire Safety Directors.

4.4 Mechanical Systems

Mechanical systems support building use and are found throughout a building's infrastructure, transforming a barren building structure into a functioning environment able to support occupant safety under normal and emergency conditions.

More than in any other group deliberations, the effect of the discrete elements of a system on its whole, shaped and steered group discussion. Systems were examined in a methodical way, broken down into their elemental parts and re-assembled. The major areas of focus were:

- fuel oil storage and transfer/distribution piping
- emergency power generators
- elevators
- heating, ventilation and air conditioning (HVAC)

4.4.1 Fuel Oil Storage and Transfer/Distribution Piping

The need for emergency energy generation is a substantial one for all buildings but has become essential to the large number of industries that function on a 24-hour, seven-day-a-week basis.

The advent of the electronic age has resulted in offices becoming dependent upon computers and communications systems. All of these systems require a reliable, uninterrupted supply of electricity. New York City's preeminent position as the world capital for business, finance, and communication, is dependent on office space with these secure facilities. This has led businesses of many types (telecommunications, finance, banking, corporate administration, etc.) to install emergency electrical generating plants. These generating plants have become an integral part of office operations.

Traditionally, fuel oil day tanks, placed on individual floors of a building, were sufficient to generate enough energy to see a building through an interruption of normal service from a power supplier. For many building uses, this is no longer the case. The current code limits the amount of fuel oil stored in day tanks and the number of tanks that can be placed on a floor. As a result, there has been an increase in the use of oversized transfer piping to the day tank, with diameters beyond what is necessary from an engineering standpoint being installed. These pipes create a reservoir capacity that exceeds the day tank limit, which, while not strictly creating a non-compliance, disregards the intention of the code -- to set safe limits on the amount of stored fuel oil. The group recommends that the diameter of transfer piping be limited to a size appropriate to its function of transferring oil, not holding it in reserve.

The size of fuel oil tanks ("day tanks") above the lowest level of a building is currently limited to a capacity of 275 gallons by the Building Code. In some instances, 12-inch diameter fuel oil transfer piping has been installed to provide reservoir capacity in excess of the 275 gallon limitation. Because this size piping can quickly introduce an increased amount of fuel over multiple floors fuel oil transfer piping to day tanks should be limited in diameter.

In most cases, individual tenants install dedicated emergency generating plants consisting of multiple engine/generator sets. These electrical generating plants are necessarily located in proximity to the tenant space they serve. Re-circulating fuel oil systems are used to pump oil from a tank on the lowest level of the building to a header that allows each of the engines/generators to take the needed amount of fuel oil with the rest returning to the tank. Currently, nothing in the Building Code regulates the assembly and use of these systems. As with day tanks, the Building Code should strike a balance between the amount of fuel oil that can safely circulate through a building and that needed for appropriate emergency energy generation. It is recommended that when fuel oil re-circulating systems are used to provide fuel oil to emergency generators on upper floors, fuel oil headers not exceed 12 inches. Such headers shall be limited to the length required for the specific emergency generator installation, with diameter limits placed on the header and the supply and return lines to and from the fuel tank. Additionally, pipe material, connection location, emergency shut off valve, and joint welding specifications have been made.

In some instances oversized piping is used for distribution of oil to emergency generators. Modern equipment design often relies on the recirculation of fuel oil in these distribution pipes for cooling making them necessary for emergency generation. The following standards are proposed where piping is utilized as a means of distributing fuel oil to equipment, without the use of a day tank (to be inserted into Article 17 27-829(b) "exceptions."):

- All piping shall be suitably supported so as to not allow overstressing of piping and shall be suitably isolated from rotating equipment.
- All piping shall be schedule 40 steel.
- Connections to main header (supply or return) shall be via the top of the pipe.
- All fittings to header pipe and equipment shall be welded.
- Fittings for immediate shut off valves to equipment shall be screwed or flanged.
- Where air vents or vacuum breakers are required they shall be designed for the required use.
- All air vents and vacuum breakers shall be hard piped to a local 55 gallon drum, with a leak sensor alarm tied into a central alarm monitoring location.

Recommendation

15. Limit diameter of fuel oil transfer piping in systems using day tanks.

16. Implement standards for piping that is utilized to distribute fuel oil to equipment without the use of a day tank.

4.4.2 Elevators

Water damage to elevators and elevators with advanced controls were discussed by the Mechanical Working Group.

The predominant reasons elevators are not usable during emergencies are power failure and damage due to water. Their mechanical systems are often times shut down by water that penetrates elevator shafts. To encourage the development and use of drainage systems to catch sprinkler and fire hose runoff in elevator shafts and near elevators, the Task Force recommends excluding components of these systems from being counted as "fixture units."

The mechanical group reviewed ways in which elevator controls could be engineered for more effective use in emergency situations. However, much like the evacuation group's discussion of "Phase III" elevators, the emerging technology is still at the research and development stage. No satisfactory conclusions could be made.

Recommendation

17. Exclude floor drains for elevator vestibule and shafts from being counted as fixtures in calculating normal waste water pipe capacity.

4.4.3 Heating, Ventilation and Air Conditioning (HVAC)

Due to heightened security concerns, or the increased likelihood of an attack on building occupants through the use of HVAC systems, the mechanical group decided that even though air intakes for these systems are typically located above grade, that a standard should be set to require this practice. It was determined that air intakes should be located at least 20' above grade in all new construction and not in proximity to exhaust discharges or off street loading bays.

HVAC systems can be designed to serve entire buildings or individual tenant spaces. Both design approaches are currently used in New York City and are allowed under current Building Code. The Mechanical Systems Working Group discussed, at the suggestion of FDNY representatives, the issue of fire spreading through a system's ductwork. It was pointed out that individually planned systems rely less heavily on ducts passing through other tenant occupied spaces than do centrally planned systems, theoretically lessening the spread of fire. The group agreed that only allowing the use of individually planned systems, which would not be economically viable, was not appropriate. It did suggest making the inspection of fire dampers a controlled inspection item, to enhance the enforcement of the current code.

No recommendations were made regarding the use of HVAC systems to defend against biological-chemical attack due to the lack of practical, cost effective systems at this time.

Recommendation

18. Require air intakes in all new construction to be located at least 20' above grade and away from exhaust discharges or off street loading bays.

19. Require controlled inspections of HVAC fire dampers in newly constructed occupancy group E buildings.

4.5 DOB Operations

The Operations Working Group played a dual role. It considered study issues regarding internal DOB operations and lent guidance to other groups drafting recommendations and proposals, in particular advising them on the appropriate implementation vehicle and timeline to get the greatest benefit from proposals for possible code changes.

The issues of most interest to this group were:

- Utilization of a regularly updated model code
- Compliance with NYC Building Code of all buildings in New York City

4.5.1 Utilize Regularly Updated Model Code

In November 2002, Mayor Bloomberg announced the formation of a commission to study the feasibility of adopting a national model code. The Commission, formed in cooperation with the City Council's Committee on Housing and Buildings and chaired by the Department of Buildings Commissioner is required to make a report by the beginning of April. The Task Force recommends awaiting the recommendation of the Mayoral Commission on adoption of national model code and incorporating Task Force recommendations into any locally specific modifications.

Recommendation

20. Wait for the recommendation of Mayoral Commission on adoption of national model code and incorporate Task Force recommendations into any locally specific modifications.

4.5.2 Compliance with NYC Building Code

While not necessarily required to comply with NYC Building Code, buildings within New York City geographical boundaries such as diplomatic missions, federal government buildings and those of other quasi- governmental authorities, should ensure that their facilities meet NYC Code requirements. This can be accomplished through a memorandum of understanding or other types of inter-governmental collaboration.

Recommendation

21. Encourage buildings within NYC geographic boundaries and subject to other jurisdictional authority to comply with NYC Building Code through collaborative agreements.

5 Appendix

5.1 Rules of the City of New York: Resistance To Progressive Collapse Under Extreme Local Loads (Current Provisions)

From: NYC Building Code - Appendix A: Selected Rules of the Department of Buildings

CHAPTER 18 RESISTANCE TO PROGRESSIVE COLLAPSE UNDER EXTREME LOCAL LOADS

§18-01 Considerations and Evaluation.

(a) *General considerations*. Unless all members are structurally connected by joints capable of transferring 100% of the members' working capacity in tension, shear, or compression, as appropriate, without reliance on friction due to gravity loads, the layout and configuration of a building and the interaction between, or strength of, its members shall provide adequate protection against progressive collapse under abnormal load, where progressive collapse is interpreted as structural failure extending vertically over more than three stories, and horizontally over an area more than 1,000 square feet or 20 percent of the horizontal area of the building, whichever is less. These criteria shall be satisfied while the building is subjected to its own weight D plus a superimposed load [resulting in an equation] of (1.0D + 0.25L), where D is computed according to Article 2 of Subchapter 9 of Chapter 1 of Title 27 of the Administrative Code and according to Reference Standard RS 9-1 of the same Code and L is computed according to Article 3 of Subchapter 9 of Chapter 1 of Title 27 of the Administrative Code and according to Reference Standard RS 9-2 of the same Code without allowance for the live load reduction permitted in Article 4 of Subchapter 9 of Chapter 1 of Title 27 of the same Code. A wind load of 0.2 W shall be assumed to act in combination with 1.0D + 0.25L, where W is computed according to Article 5 of Subchapter 9 of Chapter 1 of Title 27 of the Administrative Code and according to Reference Standard RS 9-5 of the same Code. These criteria shall be satisfied in accordance with structural analysis based on the Plastic Design or Ultimate Strength method, representing conditions at incipient failure and shall be considered as an independent check of a building designed in accordance with the usual procedures for Working Stress, Plastic Design, or Ultimate Strength design pursuant to Subchapters 9, 10, and 11 of Chapter 1 of Title 27 of the Administrative Code and all applicable Reference Standards thereto.

(b) *Methods of evaluation*.

Resistance to progressive collapse shall be determined by one of two methods:

(1) *The Alternate Path Method.*

(2) *The Specific Local Resistance Method*.

The specific local resistance method shall only be used if the alternate path method is not feasible.

(i) The Alternate Path Method.

Proof shall be provided, by analysis and/or physical simulation, that the following condition is satisfied while the building is subjected to the loads stipulated in the criteria:

(A) Should any one of the following combinations of structural elements at any one story lose its ability to carry load, there shall be no collapse of the structure more than one story above or below the element under consideration, or over a horizontal area in excess of that stipulated in the criterion:

(a) Any single "wall panel or nominal length thereof."

(b) Two adjacent "wall panels or nominal lengths thereof" forming an exterior corner to the building.

(c) One or more elements forming a "nominal extent of flooring".

(d) One column.

(e) Any other one element of the structural subsystem which is judged to be vital to the building's stability.

(B) The following definitions specifically apply to Method (b)(1):

(a) The designation "wall panel or nominal length thereof" is the smaller of the following lengths as appropriate to the design in question:

(1) The length between adjacent lateral supports.

(2) The length between a free edge and the nearest lateral support.

(3) A length equal to 2.25 times the clear height of the wall panel in those circumstances where the top and bottom attachment of the panel to the floor or roof will not fail under a force smaller than 3 kip per linear foot acting perpendicular to the wall in either direction.

(b) As used above, "lateral support" is considered to occur at:

(1) A substantial partition perpendicular to the wall, provided that its attachments to the wall and the partition itself are capable of resisting and transmitting without failure a horizontal force of 3 kip

per foot of clear wall height in either direction in the plane [*sic*] of the partition. A partition may be considered substantial when that partition or a combination of such partitions, one above the floor and one below the floor and substantially in the same plane, is able to resist the following distributed force transmitted by the floor in the plane of the partition and in an upwards or downwards direction:

$$0.18 \frac{S}{B}(2b—S) \text{ kip per foot of clear span}$$

where b is clear span and S is the clear spacing of partitions or the clear distance from a partition to an adjacent free edge of the floor.

(*2*) A strengthened vertical portion of the wall (not exceeding 1/3 story height in the horizontal direction) which will not fail under a load of 3 kip per linear foot of clear wall height acting perpendicular to the plane of the wall in either direction along the interface between the strengthened wall portion and the portion of the wall that lost its load carrying capacity.

(c) The term "nominal extent of floor"denotes the following:

(1) For a floor spanning in one direction, the extent is the clear span. In the perpendicular direction the extent is to be taken as the smaller of the following:

(i) The distance between adjacent "substantial" partitions arranged in the direction of floor span.

(ii) The distance between a free edge and the nearest "substantial" partition arranged in the direction of the floor span.

(iii) In the case where partitions are not "substantial" the extent is to be taken as 2.25 times the clear span.

(2) For a floor spanning in two directions the extent shall be taken as the area bounded by the clear spans in both directions.

(ii) Specific local resistance methods.

Any single element essential to the stability of the structure, together with its structural connections, shall not fail under the loads stipulated in this criterion after being subjected to a load equivalent to that caused by a uniform static pressure of 720 psf. This pressure shall be applied in the most critical manner to the face of the element and to the face of all space dividers supported by the element or attached to it within the particular story. In those cases where the stability of the element depends upon the lateral support provided by the attached space dividers, these space dividers, or a portion of these space dividers which can provide adequate lateral support, must also satisfy requirements of this paragraph.

5.2 Draft Progressive Collapse Guidelines

5.2.1 Guidelines

(a) General Considerations

Progressive collapse is the propagation of collapse to an extent disproportionate to the initiating zone of damage and is interpreted as structural failure beyond the point of initial damage extending vertically over more than three stories and horizontally over an area greater than one structural bay or 20 percent of the horizontal area of the building, whichever is less. ASCE 7-98[1] cites three design alternatives for providing structural resistance to progressive collapse, including the indirect design approach, the direct design alternate path and the direct design method of specific local resistance. The indirect approach is a prescriptive consideration of resistance to progressive collapse through the provision of minimum levels of strength, continuity and ductility. The direct design alternate path method allows local failure to occur but provides alternate load paths to bridge over the damage and avert collapse. The direct design method of specific local resistance provides sufficient strength to resist failure. If the design cannot accommodate the prescriptive design and detailing requirements of the indirect method, the alternate path approach can be used to quantify the extent of ductile detailing required for new construction. Where neither the indirect nor the alternate path approaches can be accommodated or where project specific threats are identified, the individual members can be locally hardened and detailed to develop the full resistance of each key element against unanticipated load without failing the connections or supporting members framing it. When the building contains materials that pose a high risk including high fuel loads, combustible/flammable liquids explosive materials, toxic gases, etc. the effects of fire must be considered by separate analysis. This balanced approach develops the full resistance available to the key members and provides comprehensive resistance to progressive collapse. The load path of the structure should be taken in consideration in determining the appropriate method of evaluation.

Where the Direct Design Alternate Path Method, or the Direct Design Specific Local Resistance method are utilized, licensed professional engineer(s) should demonstrate by analysis that the design is resistant to progressive collapse when exposed to credible threats including fire. To protect against a reduction in capacity and differential thermal expansion that may result in progressive collapse from extended exposure to fire, the structural members and components should be designed and have a fire resistance rating appropriate to their designed function. These structural members and components should be appropriate for associated hazards/threats and credible fire loads, the predicted fire intensity and duration of these fire loads, the height and the use/occupancy of the specific building or space, established goals, objectives, and level of risk acceptable to the stakeholders, fire and life safety features provided, and proximity to adjacent structures and properties so as to limit the potential for progressive collapse.

Transfer structures should be continuous over several supports with substantial structure framing into these members to create a two-way redundancy that provides an alternate load path in the event of a localized failure. The column connections, which support the transfer structures, should provide sustained strength despite inelastic deformations and designed as full moment connections. Transfer structures and the columns that support the transfer members should be hardened to the requirements of the specific local resistance. These guidelines also apply to transfer systems and to all elements that have no redundancy, such as tension hangers and tension ties in trusses. These elements should have connections that develop the full axial strength of the member (A_gF_y). All elements of a transfer system will be designed for the lowest strength reduction factor used in the design of any supported, supporting or transfer element. The transfer system and non-redundant key members are to be designed to sustain extended exposure to fire corresponding to the burn out of the floor on which it is located.

(b) Definitions

<u>Key Members</u> are defined as those structural elements at any one story whose loss results in a collapse of the structure more than one story above or below the element under consideration, or over a horizontal area in excess of that stipulated in the criterion. These critical load-bearing members correspond to:

(1) Any single "wall panel or nominal length thereof."

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[1] American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures, Revision of ANSI/ASCE 7-98, Section C1.4 General Structural Integrity

(2) Two adjacent "wall panels or nominal lengths thereof" forming an exterior corner of the building.
(3) One or more elements forming a "nominal extent of flooring".
(4) One column
(5) Any other one element of a structural subsystem that is judged to be vital to the building's stability.

Nominal Length of Wall Panel is the smaller of the following lengths as appropriate to the design in question:
(1) The length between adjacent lateral supports.
(2) The length between a free edge and the nearest lateral support.
(3) A length equal to 2.25 times the clear height of the wall panel.

Lateral Support is considered to occur at:
(1) A substantial partition perpendicular to the wall.
(2) A strengthened vertical portion of the wall (not exceeding 1/3 story height in the horizontal direction).

Substantial Partition is defined as having an average weight of not less than 30 pounds per square foot, tied with connections that are capable of resisting a force of 2.1 or $0.7+0.14N_s$ in units of Kips per foot height of wall (which ever is less), and Ns is the number of stories in the structure.

Nominal Extent of Floor denotes the following:
(1) for a floor spanning in one direction, the extent is the clear span. In the perpendicular direction, the extent is to be taken as the smaller of the following:
i. the distance between adjacent "substantial" partitions arranged in the direction of the floor span.
ii. The distance between a free edge and the nearest "substantial" partition arranged in the direction of the floor span.
iii. In the case where partitions are not "substantial" the extent is to be taken as 2.25 times the clear span.
(2) for a floor spanning in two directions, the extent should be taken as the area bounded by the clear spans in both directions.

(c) Methods of Evaluation.

(1) The Indirect Method: If all members are structurally connected by joints capable of transferring the specified capacity in tension, shear, or compression (as appropriate) without reliance on friction due to gravity loads or when additional tie members are provided as specified below, then the layout and configuration of the building and the interaction between (or strength of) its members should be deemed to provide adequate protection against progressive collapse under abnormal load.

The structure must be able to withstand at a minimum, a horizontal load of 1.5% of each floor's weight applied simultaneously on all floors, checked separately from the effects of seismic or wind.

The structure must also include effective ties for the key structural elements. These consist of peripheral ties, internal ties, horizontal ties to columns and walls and vertical ties. The tie force, F_t, should be the lesser of 4.1 or $1.4+0.27N_s$ in units of Kips per foot width and N_s is the number of stories in the structure. The specified capacity of such ties should be no less than the capacities indicated for the different types of construction, as described below:

A) In reinforced concrete structures, the reinforcement provided for other purposes may be regarded as forming part of, or the whole of, these ties and should conform to the requirements of RS9___ (ACI-318 Section 7.13 Requirements for Structural Integrity). In addition, the building should be checked for the presence of the following ties. The same reinforcing may be used to satisfy both requirements. Bars may be considered anchored to another tie at right angles if the bars extend beyond all the bars of the other tie for an effective anchorage length (based on the force of the bars) beyond the center-line of the bars. The ties must be adequately anchored where substantial changes in construction or reentrant corners interrupt the continuity of the ties.

1. Internal ties should be at each floor and roof level in two perpendicular directions. The ties should be effectively continuous throughout their length and anchored

to the peripheral ties at each end. The ties may, in whole or in part, be spread evenly in the slabs or may be grouped at or in beams, walls or other appropriate structural elements. The spacing of the ties should not be greater than $1.5L_r$ where L_r is the spacing of the columns, frames or walls supporting any two adjacent floor spans in the direction of the tie. In walls, the ties should be within 1-foot of the top or bottom of the floor slabs. In each direction, the ties should be capable of resisting a tensile force equal to the greater of F_t or $(2F_t)(DL+LL)(L_a/5)$ per unit width[(2)].

2. At each floor and roof level an effectively continuous peripheral tie should be provided, capable of resisting a tensile force of $3.3F_t$ located within 4-feet of the edge of the building or within the perimeter wall. Each external column and, if the peripheral tie is not located within the wall, the load-bearing external wall should be anchored or tied horizontally into the structure at each floor and roof level with a tie capable of developing a force equal to the greater of $6.6F_t$ (or $0.8hF_t$ if less) and 3% of the total design ultimate vertical load carried by the column or wall at that level, where h is the floor to ceiling height in feet. Where the peripheral tie is located within the wall, a positive connection should be provided between the internal and peripheral ties.

3. Corner columns should be tied into the structure at each floor and roof level in each of two perpendicular directions with ties each capable of developing a force equal to the greater of $6.6F_t$ (or $0.8hF_t$ if less) and 3% of the total design ultimate vertical load carried by the column or wall at that level, where h is the clear height in feet.

4. Each column and each wall carrying vertical load should be tied continuously from the lowest to the highest level. The tie should be capable of resisting a tensile force equal to the maximum design ultimate dead and live load received by the column or wall from any one story. Where a column or a wall at its lowest level is unsupported by an element other than a foundation, a general check for structural integrity should be made to ensure that there is no inherent weakness of structural layout and that adequate means exist to transmit the dead, live and wind loads safely from the highest supported level to the foundations.

B) In precast and composite structures, the ties should be effectively continuous. The ties should be effectively anchored, such that the anchorage is capable of carrying the dead weight of the member to that part of the structure which contains the ties. The ties should conform to the requirements of ACI-318 section 16.5 governing Structural Integrity. In addition, the building should be checked for the presence of the following ties. The same reinforcing may be used to satisfy both requirements.

1. The integrity of a bearing is dependent on an overlap of reinforcement in reinforced bearings and a restraint against loss of bearing through movement. The net bearing width should be the greater of 1.75-inches and the design ultimate support reaction per member divided by the product of the effective bearing length and the design ultimate bearing stress. The net bearing width of isolated members should be 0.75-inches greater than for non-isolated members. The effective bearing length should be the least of the bearing length per member, one half the bearing length per member plus 4-inches or 24-inches. The design ultimate bearing stress should be based on the weaker of the bearing surfaces and is calculated as follows:
   i. $0.4f'_c$ for dry bearing on concrete
   ii. $0.64f'_c$ for bedded bearing on concrete
   iii. $0.8\,f'_c$ for contact face of a steel bearing plate cast into a member or support with each dimension less than 40% of the corresponding concrete dimensions

2. Ties should satisfy one of the following conditions:
   i. A bar or tendon in a precast member should be lapped with a bar in cast-in-place connecting concrete bounded on two opposite sides by rough faces of the same precast member.
   ii. A bar or tendon in a precast concrete member lapped with a bar in cast-in-place topping or connecting concrete anchored to the precast member buy enclosing links. The ultimate resistance of the links should not be less than the ultimate tension in the tie.

[2] DL and LL are expressed in Kips/Square Foot (KSF)

iii. Bars projecting from the ends of the precast members may be joined by lapping of bars, reinforcement grouted into apertures, overlapping reinforcement loops, sleeving, threading of reinforcement or welding of bars.

iv. Bars lapped with cast-in-place topping or connecting concrete to form a continuous reinforcement with projecting links from the support of the precast floor or roof members to anchor such support to the topping or connecting concrete.

3. Joints transmitting compression should be designed to resist all the forces and moments implicit in analyzing the structure as a whole and in designing the individual member to be joined.

4. Joints transmitting shear in-plane may be assumed effective if the joint is grouted with a suitable concrete or mortar mix and should not require restraint if the design ultimate shear stress in the joint does not exceed 34-psi.

5. Joints transmitting shear under compression in all design conditions may be assumed effective if the joint is grouted with the sides or ends of the panels forming the joint have a rough as-cast finish and the design ultimate shear stress does not exceed 67 psi

6. Joints transmitting shear may be assumed effective if the shear stresses due to ultimate loads is less than 192-psi calculated on the minimum root area of a castellated joint. Separation of the units normal to the joints should be prevented by either steel ties across the ends of the joint or by the compressive force normal to the joint under all loading conditions.

7. Joints transmitting shear may be assumed effective if reinforcement is provided to resist the entire shear force due to design ultimate loads. The shear force should not exceed $0.5F_b \tan\alpha_f$ where F_b is the lesser of $0.95f_yA_s$ or the anchorage value of the reinforcement, A_s is the minimum area of reinforcement and α_f is the angle of internal friction between the faces of the joint. The values of α_f for concrete connections are 0.7 for a smooth interface, 1.4 for a roughened or castellated joint without continuous in situ strips across the ends of the joints and 1.7 for a roughened or castellated joint with continuous in situ strips across the ends of the joints.

C) In steel frame structures, horizontal ties should be arranged in continuous lines wherever practical, distributed throughout each floor and roof level in two perpendicular directions.

1. Every steel member should act as a horizontal tie, and their connections should be capable of resisting a tensile force equal to its end reaction under factored loads (or the larger end reaction if they are unequal), which need not be considered additive to other loads.

2. The horizontal ties anchoring all columns should be capable of resisting a factored tensile load, acting horizontally in any direction, equal to the greater of the end reactions under factored loads or 2% of the maximum factored vertical dead and live load in the column adjacent to that level. Where multiple members frame in one direction, no connection should be less than 1% of the column load.

3. If columns are not continuous then the frame should be detailed to provide full continuity to the columns.

4. Each column splice should be capable of resisting a tensile force equal to the largest factored vertical dead and live load reaction applied to the column at ten floor levels located immediately below that column splice or 2/3 of the column capacity whichever is smaller.

5. Braced bays or other systems for resisting lateral loads should be distributed throughout the building.

D) In masonry structures:

1. Peripheral horizontal ties, should be provided along the whole perimeter within 4-feet of slab edge, and anchored at reentrant corners. The design capacity is $3.3F_t$.

2. Interior horizontal ties should be provided both ways either uniformly or in strips no farther apart than 20-feet or in walls no farther than 1.6-feet from floor or roof. The design strength along the width is the greater of F_t or $(2F_t)(DL+LL)(L_a/5)$ per unit width[(2)], where DL and LL are the dead and live load expressed in ksf, L_a is lesser of the

largest span between columns in tie direction or 5h, and h is the clear story height expressed in feet.

3. Exterior horizontal ties should be provided from perimeter columns and walls to floor slabs. Tie corner columns both ways. Tie walls uniformly, or not farther than 18-feet apart and within 9-feet of wall ends. Design strength should be at least the lesser of $6.6F_t$ (or $0.8hF_t$ if less) in units of Kips at columns and $2F_t$ (or $0.12hF_t$ if less) Kips/foot at walls, where h is the story height expressed in feet.

4. Vertical ties should be provided floor to floor at load bearing walls 6-inch minimum thickness, masonry strength 725-psi and maximum slenderness (clear height/thickness) of 20. Tie every 16-feet maximum and 8-feet from unrestrained end of wall. Design tie capacity for the larger of $(12.7A)(h_a/t)^2$ Kips or 6.85-Kip/foot of wall or per column, where A is the horizontal cross-sectional area in square inches of the column or load-bearing wall including piers, h_a is the clear wall height and t is the thickness of column or wall.

(2) The Alternate Path Method: Wherever the design cannot accommodate the prescriptive design and detailing requirements of the indirect method, each such key member should be notionally removed, one at a time, to determine that its removal would allow the rest of the structure to bridge over the missing member. These criteria should be satisfied while the building is subjected to its own weight D plus a superposed load of 0.25L and a wind load of 0.2W assumed to be acting in combination. D is computed according to Article 2 of Subchapter 9 of Chapter 1 of Title 27 of the Administrative Code and according to Reference Standard RS 9-1 of the same Code. L is computed according to Article 3 of Subchapter 9 of Chapter 1 of Title 27 of the Administrative Code and according to Reference Standard RS 9-2 of the same Code without allowance for the live load reduction permitted in Article 4 of Subchapter 9 of Chapter 1 of Title 27 of the same Code. W is computed according to Article 5 of Subchapter 9 of Chapter 1 of Title 27 of the Administrative Code and according to Reference Standard RS 9-5 of the same Code.

Proof that the alternate path method is satisfied while the building is subjected to the loads stipulated in the criteria can be provided by the analysis and/or physical simulation. These criteria should be satisfied in accordance with structural analysis based on the Plastic Design or Ultimate Strength method, representing conditions at incipient failure and considered as an independent check of a building designed in accordance with the usual procedures for Working Stress, Plastic Design or Ultimate Strength Design pursuant to Subchapters 9, 10 and 11 of Chapter 1 of Title 27 of the Administrative Code and all applicable Reference Standards thereto.

(3) The Specific Local Resistance Method: Any single element essential to the stability of the structure, together with its structural connections, should not fail under the loads stipulated in this criterion after being subjected to a project specified abnormal or extreme local loading condition. The structure should be detailed to permit load reversals and the connections should be designed to develop the capacity of the members. If an extreme local loading condition is not specified for the project, the key elements should be detailed to develop the ultimate capacity of the materials in shear, flexure and axial load by means of confinement and continuity of reinforcement for reinforced concrete construction and encasement or stiffeners for rolled steel construction. For a column or other compression element, the interaction between flexure and axial load must be considered when establishing the capacities. In those cases where the stability of the element depend upon the lateral support provided by the attached space dividers, these space dividers, or a portion of these space dividers which can provide adequate lateral support, must also satisfy requirements of this paragraph. These essential elements may respond inelastically to the abnormal or extreme local loading conditions; however it must be demonstrated through appropriate analytical methods that these elements can continue to carry the gravity and lateral loads they support.

5.2.2 Commentary

General Considerations

These guidelines are intended to enhance the probability that if localized damage occurs as the result of an abnormal loading event, the structure will not progressively collapse or be damaged to an extent disproportionate to the original cause of the damage. The initiating damage may be the result of an accidental impact or overload, misuse or structural alteration, fire or explosive event. Each of these unintended loading conditions or reductions in structural capacity, that may originally be localized, may leave the structure vulnerable to a much more extensive structural collapse unless measures are taken to mitigate that possibility. The guidelines for general structural integrity, robustness and resistance to disproportionate collapse are based on a preliminary understanding of recent events and existing guidance from other jurisdictions, such as the U.K. Standards and Regulations, where structures designed to these standards demonstrated desirable performance when subjected to abnormal loading.

The intent of these guidelines is to alert the engineer to conditions that may initiate progressive collapse. Recent events suggest that extended fire exposure, a relatively common hazard, can impact a building's ability to resist its load. These experiences indicate that building designs should consider resistance to collapse resulting from extended exposure to fire just as they are designed to resist collapse when exposed to other loading conditions (i.e. gravity, earthquakes, wind, etc.). By considering resistance to fire induced collapse these guidelines may increase the safety of occupants and emergency personnel, decrease the damage to neighboring buildings and people, and reduce the financial losses associated with collapse. The behavior of the structural system under fire should be considered an integral part of the structural design process. Registered Fire Protection Engineers can assess anticipated fuel loads and identify the potential fire hazards. This will determine a range of thermal changes and temperature sensitive parameters to which the structural members may be subjected. A registered Structural Engineer can assess the impact of these calculated thermal changes to the structural members and determine the ability of the structure to resist progressive collapse. These conditions may include buildings that have an unusual fire load that may be associated with unusual occupant characteristics, building characteristics, content/fuel load characteristics, and other specific risks. For high-risk conditions, the engineer should consider the behavior of the building and its ability to resist progressive collapse.

Fire can expose multiple elements throughout a space to high temperatures, thus the potential thermal impact on all the affected elements should be determined. The possibility of the loss of multiple structural components should be assessed in relation to the multiple related events, such as an earthquake or explosion, which may cause a fire to start.

Fire produces a differential thermal expansion, reduces the modulus of elasticity, and reduces the yield strength of steel. In a fire the expansion of the different elements of the structure is dissimilar due to its heat capacity, conductivity, mass, insulation and proximity to the fire. The full scale fire testing on an 8-story building at the Building Research Establishment (BRE) [(3)], conducted at Cardington U.K., demonstrated the adequacy of specific steel buildings to a given set of fire scenarios. The successful performance of these structures was in part due to their connections having a sufficient amount of tension capacity to absorb the load transfers. The performance of concrete buildings under fire is dependent in part on the cover/protection of the reinforcing steel, the thermal insulation provided by the concrete, and its ability to resist spalling. Hence, when undertaking analyses for concrete buildings, the effect of heat on spalling and the reduction in protection of reinforcing steel should be assessed. At a minimum, the analysis should verify that the structure remains standing; however, additional performance criteria regarding the level of tolerated damage and the extent of its ability to continue to be serviceable should be established by the stakeholders. A simplified linear analysis may at times be possible by assuming a temperature, an elastic modulus and yield strength for the structural elements exposed to the fire. There is a significant body of published information about structures under fire that should be reviewed when undertaking these types of analyses.

In the case of overload, accidental impact or blast, the protection of structures to resist progressive collapse may be achieved by either allowing for multiple load paths or by hardening the vulnerable structural elements to be resistant to a postulated abnormal loading condition. The desired detailing may either be

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[3] Kirby B.R. British Steel data on the Cardington fire tests. Technical Report, British Steel, 2000.

specified using a prescriptive indirect design approach or specified based on the results of a performance based alternate path analysis.

The guidelines for general structural integrity are in the form of prescriptive requirements for minimum joint resistance, continuity and inter-member ties that will provide a robust, stable and economical design. The alternate path calculation, which explicitly determines the resistance to progressive collapse when a primary load-bearing member is removed, considers the most likely dead, live and wind load combinations along with the inelastic response (both material and geometric non-linearity) of the damaged structure. Both of these approaches will result in continuous tied reinforcement for concrete frame structures and stronger connections for steel frame structures to allow the structural elements to develop more of their capacity (either in flexure or membrane action) when subjected to abnormal loading and support conditions. Loads that were once supported by the damaged portions of the structure will be redistributed to undamaged elements.

While the alternate path approach is not associated with any specific threat that might cause the damaged state and therefore gives the appearance of being threat independent, it is limited in its applicability to abnormal loading conditions that would fail only one load-bearing member. Alternatively, the critical elements may be identified and strengthened to be resistant to the identified threat, thereby averting the loss of the member. Strengthening (specific local resistance) may be preferable to alternate load paths in situations where more than one key element could be damaged by the considered hazard. In these cases, where loss of multiple key elements could overwhelm an alternate load path system intended to address loss of only one key element, the specific local resistance design approach provides more protection than a design based on the alternate path method.

For most building systems, the Indirect Method require little more than providing a minimum amount of continuous tied reinforcement. At any location where these prescriptive requirements cannot be accommodated, the structure may be designed to satisfy the requirements of the Alternate Path Method. At those locations where the Alternate Path Method can not be accommodated, due to building irregularities and discontinuities, or where structural elements are exposed to a greater risk due to accidental loading or explosion, a combination of Indirect Method ties throughout the building and Specific Local Resistance at the most exposed and/or sensitive key elements is recommended.

Recent experiences suggest that engineers should be alert to transfer girders and the columns supporting transfer girders which may be particularly vulnerable to abnormal loading, including the effects of fire. Transfer girders typically concentrate the load bearing system onto fewer structural elements. This system runs contrary to the concept of redundancy that protects structures from abnormal loading conditions. Typically, the transfer girder spans a large opening, such as a loading dock, or provides the means to shift the location of column lines at a particular floor. Damage to the girder may leave several lines of columns, which terminate at the girder from above, totally unsupported. Similarly, the loss of a support column from below will create a much larger transfer span. Transfer girders therefore create critical sections whose loss may result in a progressive collapse. If a transfer girder is required and if this girder may be vulnerable to an abnormal load, then it is desirable that this girder be continuous over several supports. It is further recommended that there be substantial structure framing into the transfer girder to create a two-way redundancy and thereby an alternate load path in the event of a failure. The column connections, which support the transfer girders, are to provide sustained strength despite inelastic deformations. As such, these joints are to be designed as full moment connections.

Indirect Method

When using the indirect method it is recommended that both the connections are designed and detailed to develop the specified capacity of the members and the connection designs are consistent with the member deformations. The indirect approach corresponds to prescriptive requirements, e.g., ACI 318, Section 16.5.

Alternate Path Method

A structure's response to redistributed loads following the sudden loss of a primary load-bearing member is dynamic and inelastic. Linear elastic analyses cannot account for the redistribution of forces, P-Delta instability, nonlinear material properties including rate effects, and the development of membrane modes of resistance. Therefore, the use of linear elastic analysis approaches requires engineering judgment and an independent check for P-Delta instability after the initial design is complete. The elastic analysis does not account for the greater capacity resulting from plastic hinge/yield line formation, membrane action or enhanced strength due to rate dependent material properties.

The Alternate Path Approach assumes a hypothetical damage state that ignores all other damage to the structure that may accompany the removal of critical column support. It assumes a girder spanning a single bay is transformed into a girder spanning two bays. The transition from the original structural configuration to the damaged state is assumed to be instantaneous, exposing the structure to a dynamic effect. Because it is not reasonable to require a structure to respond elastically to the effects of an instantaneous column removal, structures are permitted to develop plastic hinges and sustain significant inelastic deformations when subjected to these extreme-loading conditions. This enables the structure to dissipate significant amounts of energy that would otherwise impose much greater dynamic loadings to the individual members.

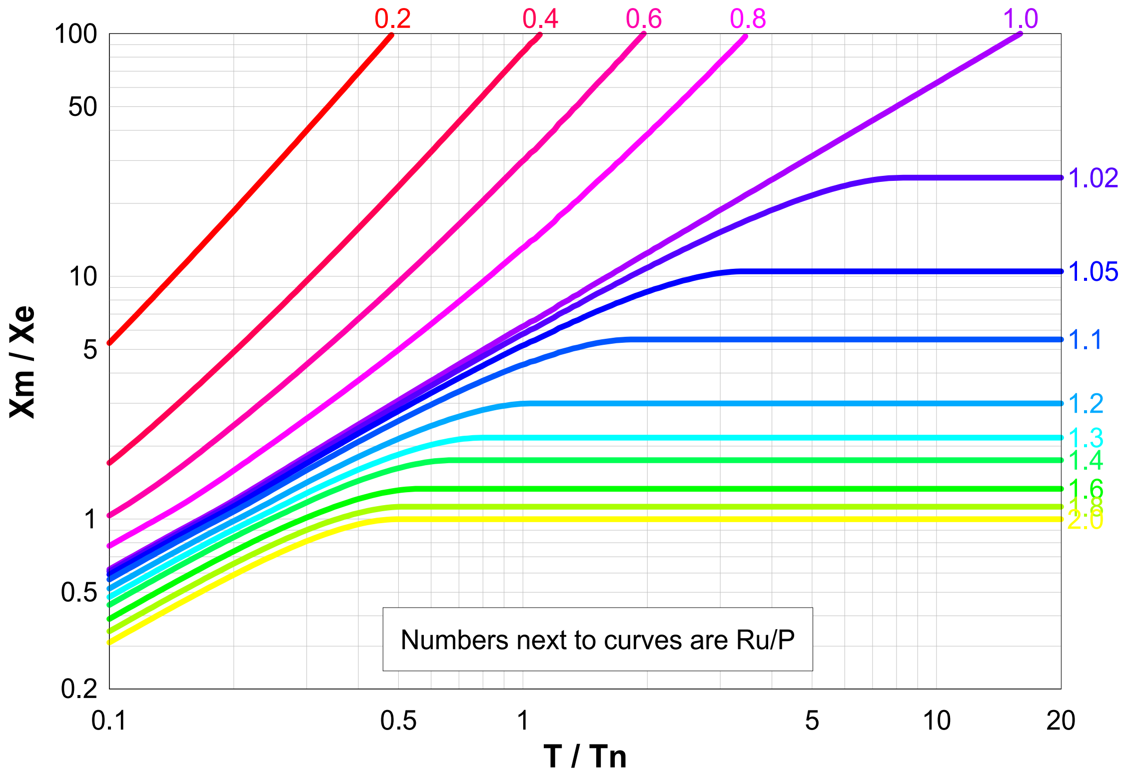
The inclusion of geometric non-linearity resulting from large deformations can account for the redistribution of loads as a column is removed and the structure attempts to re-equilibrate to the larger spans through a change in behavior from a flexural response to a membrane response. The members that originally spanned a single bay must now span two bays and the center span will be at the location of the damaged column, where the connection details may have limited capacity to develop positive moments. The inclusion of geometric non-linearity will enable the designer to account for the tension-membrane stiffening of the slabs and spandrel beams as they sag and develop catenary resistance. These membrane forces must be compared to the tensile capacity of the members and their connections to make sure they are capable of developing the axial forces.

The effect of this dynamic phenomenon is depicted in the attached figure. This figure shows the response characteristics of the standard elastic-plastic single-degree-of-freedom spring mass system typically used to represent the dynamic behavior of a structural element. The loading represented in this figure is a suddenly applied step pulse, which corresponds to the instantaneous removal of a column and corresponding transfer of the gravity load to the double-bay span. Because the transition is assumed to occur instantaneously and its duration is prolonged, the behavior to the step pulse is represented by large ratios of T/Tn (duration of loading relative to the fundamental period of the structure) along the horizontal axis.

The extent of inelastic deformation relative to its elastic limit is represented by the ductility, Xm/Xe, along the vertical axis. As the ductility increases, the structure sustains larger inelastic deformations that dissipate more energy. Both steel and reinforced concrete structures may be detailed to sustain a ductility ranging from 10 to 20 in response to an extreme loading condition.

The third scale shown next to the curves represents the required capacity (ultimate resistance) of the structural element (prior to developing the plastic hinge) as a ratio of the applied step load (Ru/P). For a ductility of 1.0, which corresponds to an elastic response, the required capacity must be twice the applied step load in order to account for the dynamic behavior (this is represented by the bottom curve that asymptotes to a unit value of ductility at large ratios of T/Tn). This is the most conservative dynamic amplification factor, which ignores the considerable amount of inelastic deformation that will accompany the redistribution of loads.

A less conservative idealization of the redistribution of loads is represented by the thick black line drawn at a ductility of 2.5 (a modest amount of inelastic deformations by most accounts). This line is intermediate between the 1.2 and 1.3 Ru/P curves and represents the dynamic effect of the step load of infinite duration that is suddenly applied to the inelastic structure, which requires the structure to support 1.25 times the magnitude of the step load. This more physically meaningful amplification factor accounts for the dynamic redistribution of loads to the undamaged portions of the structure without introducing unwarranted conservatism into the analysis. This corresponds to the increase from yield to ultimate strength that is not reflected when using the Plastic Design or Ultimate Strength methods.



Maximum Deflection of Elasto-Plastic Single-Degree of Freedom System for Rectangular Load.

The structure will be permitted to develop inelastic hinges when subjected to the removal of the vertical load-carrying member while supporting the factored loads. However, the extent of ductility that will be permitted will depend on the type and materials of construction. The analysis should include the nonlinear geometric stiffening that results when membrane effects are considered as well as the inelastic stress hardening that results when materials are permitted to deform inelastically. These effects, based on the type of construction and materials, may be represented in equivalent force-displacement or moment-rotation relations that can be used to develop the permissible limits of ductility and the corresponding demand capacity ratios. This approach may be used to establish the criteria, on a structure-by-structure basis, for evaluating the potential for progressive collapse.

In addition, when performing an alternate path analysis, consideration should be given to the relative advantages and disadvantages of a strong diaphragm that ties the floor plate together as compared to a weak diaphragm that would allow the damaged portion of the structure to break away from the remaining structure. This is particularly important for relatively narrow structures that are incapable to resisting the large lateral loads that may be imposed by floor systems that rely on catenary action to span over a missing primary support. Structural analyses that consider the geometric stiffness effects, which accounts for the coupling of vertical and lateral forces as large displacements are developed, are required to determine the vulnerability of the lateral resisting system to these large diaphragm forces. Unless the structure can accept the loading patterns that result from an alternate path analysis, the damaged portion of the structure should be isolated from the adjacent bays. Also, because catenary action is ineffective at corner bays, except for wall panel construction, moment connections on both sides of the first inner column should be considered for corner bays.

Specific Local Resistance

The analysis of a structure's response to an extreme loading that may initiate damage mechanisms requires advanced analytical techniques. The specific local resistance method requires numerical simulation or empirical data to demonstrate a key structural element's ability to withstand a design level threat. The successful simulation of structural response to extreme loading, as compared to the explosive testing of columns, walls, beams and slabs have been achieved using analytical methods that account for the nonlinear dynamic behavior of the members. These methods are generally computationally intensive, however, they need only be applied to an individual part of the structural system at one time and the resulting models are relatively small and efficiently analyzed. To increase the overall performance of the structure, the Specific Local Resistance Method should be supplemented with ductile redundant detailing associated with the prescriptive Indirect Method. For concrete structures, this detailing entails the use of continuous bottom reinforcement over supports, confinement at joints, adequate ties to allow for load transfer, peripheral ties at the spandrels, internal ties through floor slabs and beams, horizontal ties to columns and walls, vertical ties along perimeter structure and tension ties for precast concrete construction. For steel structures, this detailing may sometimes entail the use of a moment resisting frame at perimeter of the building and either moment resisting splices at first floor perimeter columns or establishing column lengths to avoid first-floor splices. Either appropriate calculations or relevant empirical data may be used to demonstrate the adequacy of members to resist the specified threats. Where no specific threats are identified, the key elements should be designed so that the full resistance of the key element against unanticipated load can be developed without failing the connections or supporting members framing to it. The capacity of the key elements and the associated connection forces may be most accurately determined through the use the advanced analytical techniques described above. However, where no specific threats are identified, these capacities may be estimated using conventional design and analysis methods considering the ultimate material strengths (e.g. LRFD approach with 'phi' = 1) and at a minimum, load bearing walls must be capable of resisting a uniform static pressure of 720-psf. This balanced approach activates the full resistance available in the key members, maximizing their ability to deal with unforeseen hazards without having to redistribute loads. As a result, this balanced approach precludes a progressive collapse that might be triggered by the limiting capacity of an individual key element.

5.3 Draft Retroactive Sprinkler Requirements

All high-rise commercial buildings 100 feet or more in height, that are without automatic sprinkler protection on the effective date of the local law shall be required to install such a sprinkler system providing complete coverage throughout the building.

The Building shall be completely protected within fifteen years of the effective date of the local law. The sprinkler system shall be installed throughout the building as leases of individual tenants expire and the space is renovated for new tenants.

The owners of buildings that are already fully sprinklered shall file an affidavit attesting to fact that the building is already in compliance with this local law. Said affidavit shall be filed with the NYC Department of Buildings within one year of the adoption of this law.

Within 3 years of the adoption of this local law, owners of those buildings that have at least 15% of the building covered by sprinklers shall file an affidavit with the NYC Department of Buildings documenting those areas of the building that are already sprinklered. The owners shall also submit, at the same time, an implementation plan detailing when and how the remaining portions of the building will come into compliance with the requirements of this law. Implementation of the plan will be monitored annually by the Fire Department of New York's High Rise Inspection Unit.

Within 5 years of the adoption of this local law, owners of those buildings with less than 50% of the building covered by sprinklers shall file an affidavit with the NYC Department of Buildings documenting those areas of the building that are already sprinklered. The owners shall submit, at the same time, an implementation plan detailing how when and how the remaining portions shall come into compliance. Implementation of the plan will be monitored annually by the Fire Department of New York's High Rise Inspection Unit.

A committee, composed of representatives of the Commissioners of the Department of Buildings and FDNY and a representative of the Real Estate Board of New York, would review requests for time extensions based upon extreme hardship.

5.4 Draft Proposal – Controlled Inspection of Fireproofing on Structural Building Members

In all buildings classifed in Section 27-253 of the Building Code as occupancy group E, as spaces in buildings are being renovated, a controlled inspection shall be required to ensure that all fireproofing is fully intact on all structural building members exposed by the renovation. The controlled inspection shall be signed and sealed by either a licensed architect of engineer and shall be filed with the NYC Department of Buildings prior to the issuance of a Building Permit.

This new legislation can be adapted into the present Section 16-01 of the Building Code. Implementation timetable would commence three (3) months after the adoption of this law.

5.5 Draft "Building Information Card" Proposal and Sample

The owner or other person having charge of a building classified in Section 27-253 of the Building Code as occupancy group E shall provide a concise but comprehensive Building Information Card which must be available at the Fire Command Station for use by the Fire Department. Both the Fire Protection Plan and Fire Safety Plan are required by current Building Code. However, FDNY Chiefs feel that these required plans are voluminous and are of little use during a rapidly expanding fire or emergency. There is a critical need for vital building information beyond CIDS information and less detail than the Fire Protection Plan and Fire Safety Plan. A one or two page laminated 8" X 14" Building Card, located at the Fire Command Post, requiring the attached information will be of tremendous assistance to responding fire units and chiefs.

The Building Information Card can be easily proposed as an addendum to Section 27.228.2a of the Building Code regarding Fire Protection Plans and/or Section 6-01(f) of the Rules of the City of New York. Implementation timeline shall have full compliance within (6) six months of the passage of the new law.

FIRE DEPARTMENT, CITY OF NEW YORK
BUILDING INFORMATION CARD

BUILDING INFO:
Address: ______________________________
Aka: ______________________________
Date Constructed: ________________________
Office Floors:___________________________
Retail Floors:___________________________
Residential Floors:________________________
Building Population: ______________________
Day: ________ Night:________ Weekend: ________
Location of Disabled Persons ________________

BUILDING STATISTICS:
Height: ________________
Width: ________________
Type of Construction: ______________________
Type of Fire Proofing: ______________________
Stories: __________
Truss Systems Locations:____________________
Fire Tower: ______________________________

ELEVATORS:

Bank Designation	Car Numbers	Floors Served
____________	_________	_________
____________	_________	_________
____________	_________	_________

Location of Freight Elevators: ________________
Sky Lobby Locations: _______________________

STAIRWAYS:

Designation	Floors Served	Pressurized	Standpipe
________	_________	________	_______
________	_________	________	_______
________	_________	________	_______

Access /Convenience Stair Located Between Floors:
________ _________ ________ _______
Roof Access Provided by Stairways:
________ _________ ________ _______

COMMUNICATIONS:

Repeater System: ______________
Number of Radios for FDNY Use: ___________
Communications for FDNY Use: ___________

BUILDING FIRE SAFETY INFO:
(including Emergency Contact numbers)

Fire Safety Director: _____________________
Work: ( )-___-____
Cell: ( )-___-____
Building Engineer: _________________________
Work: ( )-___-____
Cell: ( )-___-____
Managing Agent: ____________________
Work: ( )-___-____
Cell: ( )-___-____

WATER SUPPLY:
Standpipe Locations: ______________________
S/P Isolation Valve Locations:________________
Fully Sprinklered: __________________________
Partially Sprinklered: Floors ____ ____ ____ _____
Fire Pump Locations: _______________________
Flow Restrictors on S/P? Floors ________________

UTILITIES:
Fuel Oil Tank Location: ____ ____ ____ ____
Fuel Oil Tank Capacity: ____ ____ _____ ____
Natural Gas Service: ________________________
Emergency Generator Location: ________________

TEMPORARY CONSIDERATIONS *(TO BE FILLED IN WITH ERASABLE MARKINGS)*
Examples—Construction in building, OOS systems

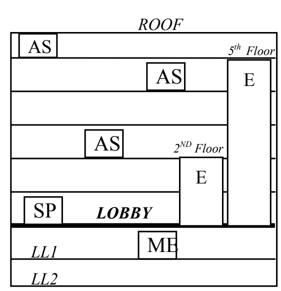
HAZARDOUS MATERIALS & LOCATIONS:

NAME OF PRODUCT	LOCATION
_______________	_________
_______________	_________
_______________	_________
_______________	_________

VENTILATION:
HVAC Zones: ___________________________
Smoke Removal Capacity: ____________________

INDICATE ON BUILDING SCHEMATIC (NEXT PAGE) **THE LOCATION OF FOLLOWING CRITICAL ITEMS USING THE APPROPRIATE SYMBOL**

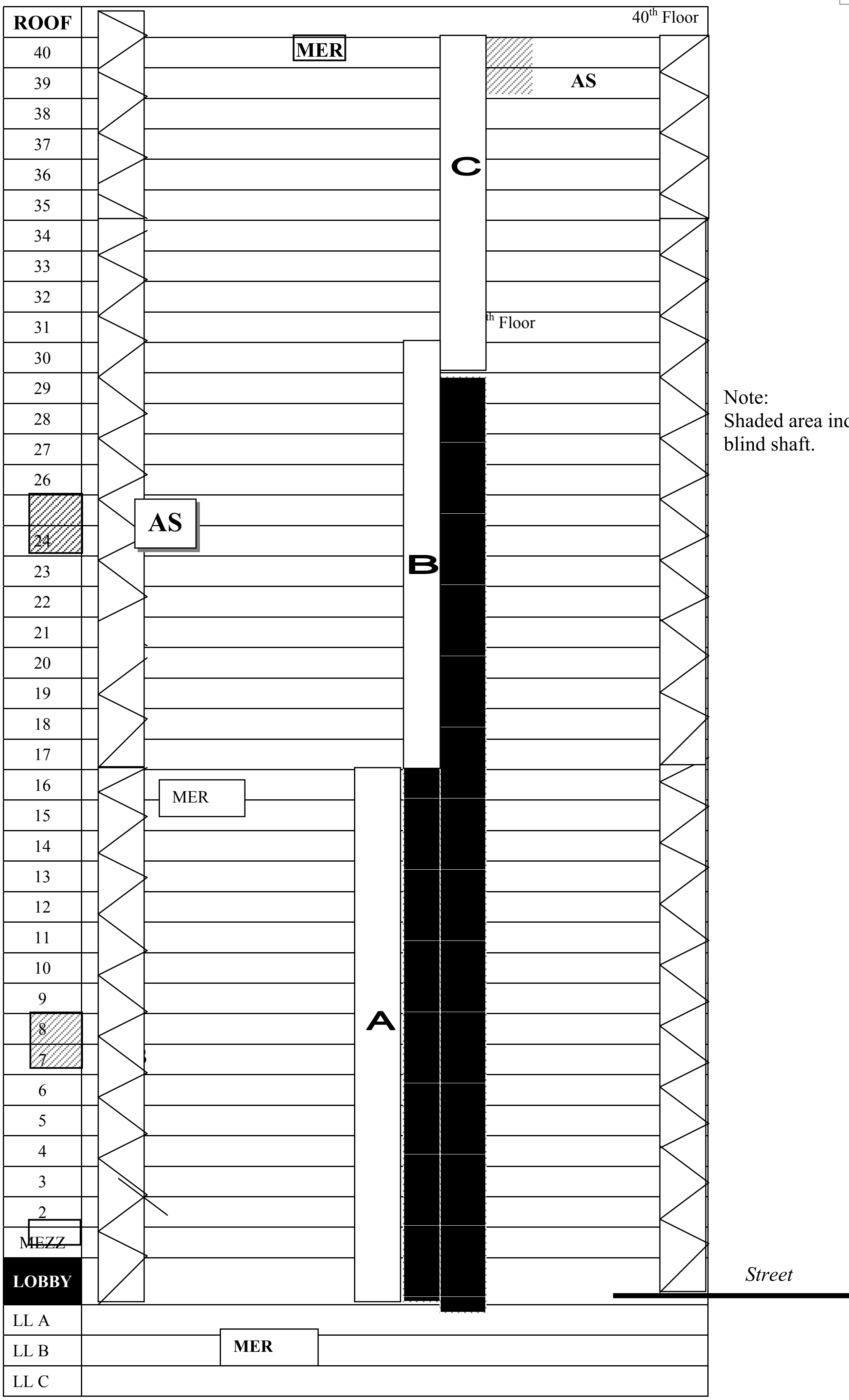
E ELEVATORS
MER MECHANICAL ROOMS
AS ACCESS STAIRS
SP STANDPIPES



FDNY: August 2002

FIRE DEPARTMENT, CITY OF NEW YORK
BUILDING INFORMATION CARD

BUILDING SCHEMATIC



Note:
Shaded area indicates blind shaft.

INDICATE ON BUILDING SCHEMATIC THE LOCATION OF THE FOLLOWING CRITICAL ITEMS USING THE APPROPRIATE SYMBOL

E ELEVATORS **MER** MECHANICAL EQUIPT. ROOMS **AS** INTERIOR ACCESS STAIRS **SP** STANDPIPES

5.6 Proposed Requirements for Fuel Oil Storage and Supply of Emergency Power Systems

5.6.1 Fuel Oil Transfer Piping to Day Tanks

Requirement:

Fuel oil transfer piping to day tanks should be limited in diameter.

Commentary:

The size of fuel oil tanks ("day tanks") above the lowest level of a building is limited to a capacity of 275 gallons. There have been reports of 12 inch diameter fuel oil piping installed to tanks on upper floors in buildings. One foot of 12 inch diameter pipe has a volumetric capacity of about 5.8 gallons. Thus, 47 feet of 12 inch pipe would equal 275 gallons. Obviously the use of a 12 inch pipe is intended to provide reservoir capacity in excess of the 275 gallon limitation. Unfortunately, the Building Code, as presently written, would not prohibit the use of such oversized fuel oil transfer piping.

5.6.2 Proposed Requirements on Fuel Oil Header Pipe Installations

To be inserted into Article 17 27-829 (b) "exceptions."

Piping used for distribution of oil to fuel burning equipment.

Where piping is utilized for means of distributing fuel oil to equipment, without the use of a day tank, and where the piping is upsized to provide a storage capacity, the following requirements shall apply.

1. All piping shall be suitably supported so as to not allow overstressing of piping and shall be suitable isolated from rotating equipment.
2. All piping shall be schedule 40 steel.
3. Connections to main header (supply or return) shall be via the top of the pipe.
4. All fittings to header pipe and equipment shall be welded.
5. Fittings for immediate shut off valves to equipment shall be screwed or flanged.
6. Where air vents or vacuum breakers are required they shall be designed for the required use.
7. All air vents and vacuum breakers shall be hard piped to a local 55 gallon drum, with a leak sensor alarm tied into a central alarm monitoring location.

5.7 Proposed Revisions to Fire Protection and Egress Requirements

5.7.1 Exit Signs

Section 27-228.05 of article 26 of subchapter 1 administration and enforcement of chapter one of title twenty-seven of the administrative code is identified as paragraph (a) and new paragraph (b) is added as follows:

§[C26-125.1] 27-228.05 General Requirements.

(b) Owners of all existing buildings which are required to comply with paragraph (c) of section 27-383 (exit signage) shall file with the department a report prepared by a registered architect or professional engineer certifying to the installation of the required exit signage no later than one year from the effective date of this law.

Section 27-383 of article 7 of subchapter 6 means of egress of chapter one of title twenty-seven of the administrative code is amended to read as follows:

§27-383 Egress Requirements

(a) Except in occupancy groups J-2 and J-3, the location of every exit on every floor and every opening from a room classified in occupancy group J-1 and containing cubicles shall be clearly indicated by exit signs. Such signs shall be placed at an angle with the exit opening if such placement is required for the signs to serve their purpose. In long corridors, in open floor areas, and in all other situations where the location of the exit may not be readily visible or understood, directional signs shall be provided to serve as guides from all portions of the corridor or floor.

(b) In addition to the above requirements and the applicable requirements set forth in article 9 of this subchapter, exit signs in high rise buildings classified in Occupancy Group E shall comply with the following:

(1) Illuminated exit signs complying with section 27-386 shall be placed in stairwells with horizontal extensions to indicate the transition from vertical to horizontal direction and at turns along the horizontal path.

(2) A supplementary sign complying with sections 27-394 and 27-395, except that the lettering and numerals shall be at least one inch (25.4 mm) high, indicating the location of a recessed re-entry door shall be securely attached on the wall of the landing that faces the evacuee on the stairs.

(3) In stairs where there is no entry or exiting from such stair for more than four (4) floors, a sign complying with sections 27-394 and 27-395, except that the lettering and numerals shall be at least one inch (25.4 mm) high, shall be securely attached at the beginning of the descent into such portion of the stair on the wall of the landing that faces the evacuee on the stairs stating the location of the next re-entry or exiting floor. On each floor within such portion of the stair a sign complying with sections 27-392 and 27-395 shall be securely attached to the wall of the landing that faces the evacuee on the stairs approximately five feet (1.525 m) above the floor indicating the floor number.

(4) Signs shall be readily visible from the egress direction.

5.7.2 Elevator Vestibules

Section 27-232 of article 2 of subchapter 2 definitions of title twenty-seven of the administrative code is amended to read as follows:

ELEVATOR VESTIBULE - A room or space enclosed with noncombustible smoke barrier partitions with smoke stop doors conforming to subdivision (c) of section 27-371. Except for such smoke stop doors, openings to elevators and to exits shall be the only other door openings permitted in the enclosing partitions.

However, such vestibules, when located in buildings classified in Occupancy Group E, may have other penetrations provided smoke dampers as defined in Reference Standard RS 13-1 protect such penetrations. The requirement for smoke dampers shall not apply to package pass through and communication openings not to exceed one (1) square foot (0.0929 m^2) in area.

SMOKE BARRIER - Any continuous noncombustible construction, vertical, horizontal or otherwise, such as a wall, floor, or ceiling assembly, that is designed and constructed to restrict the spread of smoke. A smoke barrier may or may not have a fire resistance rating. Smoke barriers may have openings that are protected by automatic closing devices, adequate to inhibit movement of smoke through the opening. The smoke barrier may be constructed of heat-strengthened or tempered glazing or the equivalent and protected by sprinkler heads constructed in accordance with subchapter 17 of this chapter and installed a maximum of 6'-0" (1.830 m) on center on each side of the barrier. If the smoke barrier is constructed of glass, the portions of the smoke barrier located within two feet (610 mm) of the door opening and within five feet (1.525 m) of the floor shall be constructed of tempered glass. Glass panels having an area in excess of nine square feet (0.8361 m^2) with the bottom edge less than 18 inches (457 mm) above the floor shall likewise be constructed of tempered glass.

Portions of glass smoke barriers within six feet (1.830 m) horizontally of the vertical edge of an opening shall be marked in accordance with the Rules of the Board of Standards and Appeals.

Article 5 of subchapter 5 fire protection construction requirements of chapter one of title twenty-seven of the administrative code is amended by adding a new section §27-353.02 Smoke Protection for Elevators to follow §27-353.01 Smoke Protection for Elevators and Escalators as follows:

§27-353.02 - Smoke Protection, Elevators

(a) Elevators in buildings classified in "Occupancy Group E" (Office Buildings) where elevators serve more than three (3) floors and in existing office buildings where a new shaft is constructed to contain two (2) or more elevators shall meet the following requirements:

(1) At every floor above the main entrance floor where the fire command station is located, all elevators shall open into an enclosed elevator vestibule. The elevator vestibule shall be separated from the building occupancy by smoke barriers extending from floor slab to floor slab and where there are openings, the doors shall be self-closing or automatic closing upon smoke detection.

(2) Access to an exit on any floor through the enclosed elevator vestibule shall be permitted if the occupied areas on that floor have access to at least one other required exit that does not require passing through the elevator vestibule.

(3) In buildings with a small footprint, the commissioner may accept alternate means or an exemption from the requirements (i) and (ii) listed above, and from the smoke damper requirements contained in the applicable definitions in section 27-232.

Paragraph (c) of section 27-371 of article 5 of subchapter 6 means of egress of chapter one of title twenty-seven of the administrative code is amended to read as follows:

§27-371 Doors.

(c) Smoke Stop Doors. - Smoke stop doors shall be … unless the doors are also used as horizontal exits in which case they shall comply with the provisions of section 27-373 of this article. Smoke stop doors may be constructed of tempered glazing or the equivalent and be protected by sprinkler heads constructed in accordance with subchapter 17 of this chapter and installed a maximum of 6'-0" (1.830 m) on centers on each side of the opening. Smoke stop doors may be double-acting but shall close the opening completely with only such clearance as is reasonably necessary for proper operation. Smoke stop doors shall normally be in the closed position, except that they may be left open if they are arranged to close automatically by an approved device which is actuated by an interior fire alarm system meeting the requirements of subchapter seventeen of this chapter [.] or upon smoke detection. Tempered glass smoke stop doors shall be marked in accordance with the Rules of the Board of Standards and Appeals.

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