Evacuation Systems for High-Rise Buildings

The protection of occupants of high-rise buildings must be made a part of every full-service total fire safety program. Regardless of building construction, sophisticated fire-detection system, fire protection, and fire-fighting apparatus used, a building is only as "people safe" as the building owners, managers, and tenant spokesmen want it to be.

People cause fires by their acts of commission and omission, furnishings feed fires, and panic results in needless loss of lives and injuries. Fire prevention, fire protection, adequate evacuation programming and planning, and complete "rehearsal for survival" are needed to make sure losses will be minimal in the event of fire.

Panic of occupants of high-rise buildings during the early stages of a fire is a danger that can contribute to high casualty losses. Smoke, gases, and super-heated air make it imperative that an emergency evacuation program be established for all high-rise buildings (a high-rise building, by popular definition, is a completed, occupied structure for which the roof access level exceeds the maximum height of rescue capability from street level by the fire department).

This data sheet points out recommended procedures to be followed to help evacuate persons safely from high-rise buildings in the event of fire, bomb threats, or other emergencies.

The record of fires in high-rise building occupancies, with resultant fatalities, and heavy financial losses emphasizes the urgent need for instituting an effective evacuation program immediately. The potential for high human losses makes it imperative that evacuation programs be reviewed and updated as necessary. Uncontrolled evacuation complicates emergency situations.

Because of differences in design, construction, fire-resistant qualities, height, floor layout, usage, and occupancy, each building presents unique problems in emergency evacuations. For this reason, information contained in this data sheet should be considered a guide to an evacuation program rather than a specific program standard for any one particular building. State or provincial and local codes and regulations concerning fire and emergency evacuation should be checked, and, where variances exist, the more applicable measures should be adopted. Fire control and evacuation authorities (fire department, consultants, insurance company) should be consulted for suggestions relating to a particular building.

Efficient Evacuation

Successful and efficient evacuation depends on complete preplanning, organization, and supervision. Planning should include at least these basic principles:

1. Building evacuation organization;
2. Evacuation policy and plans;
3. Detection and reporting (of fire or hazard);
4. Evacuation program coordination (of movement and evacuation);
5. Communication to direct movement and evacuation;
6. Inspection and evaluation.

Building evacuation organization and fire safety program

Written plan   As soon as building occupancy begins, a written plan of fire and other emergency procedures should be agreed upon by building management and responsible representatives of each building tenant.

The emergency evacuation plan should include:

1. An outline of the emergency evacuation organization plan and agreed-upon priorities, including responsibilities and authorities. Building and tenant representatives should agree upon these.

2. Detection, emergency warning systems, and reporting procedures for fire and other hazards should be provided.

3. Coordination of central building emergency evacuation control with assigned floor emergency evacuation teams should provide for the orderly movement of persons. Pre-planning and "fire in progress" chain-of-command instructions should be detailed, and each tenant should be required to acknowledge and comply.

4. In addition to a suitable and effective fire-detection system (both automatic and two-way voice communications), an adequate and effective system for two-way communications should be provided for every floor. The communication system will be used to direct the work assigned to floor evacuation teams and to assist in communications between buildings communications control center and fire department personnel using the system during fire-fighting and evacuation emergencies.

5. Building management and tenants should cooperate in an education and training program for all emergency floor-evacuation teams, employees, and building visitors. This should include a system of personal instruction for all building inhabitants and

proper posting of instructions, placards, and evacuation diagrams at strategic locations on every floor. Emergency fire procedure information should be prominently posted in corridors.

6. One individual should be designated to establish a program, including proper documentation for regular inspections and follow-up to maintain the detection and communication system in the best operating condition.

7. An evacuation drill program should be established that will include periodic practice of movement of occupants to refuge areas. The frequency of these drills – monthly, quarterly, etc. – would depend upon the employee turnover in the area. The schedule should be maintained and documented. The drill should include the progressive movement of personnel to areas of safety. The purpose of "progressive movement" should be explained to the tenants at this time – to keep all tenants a safe distance from the fire hazard without evacuating the building all at once.

Evacuation policy and plans

Policy and plans – When leases are signed by tenants occupying high-rise buildings, a document describing the building's emergency evacuation policy and plans should be provided by the building management and agreed upon by the tenant. This document should describe fire detection and fire reporting systems and the emergency evacuation plans and communication system provided by the building. Tenants should agree to furnish assigned emergency evacuation teams and a responsible representative to act for them in all matters of fire control and personal evacuation. (In the event that two or more residential tenants occupy a floor of a multipurpose high-rise building, the tenants should designate a floor evacuation representative and alternate who would report to the building coordinator.

Evacuation routes – Drawings, diagrams, evacuation routes, and similar information should be included in the building's emergency evacuation plans. Furthermore, the document should include those elements of this data sheet adopted as standard procedures. Floor numbering and direction of travel should be indicated in stairwells.

Imminent danger – The building's emergency evacuation plan should define "imminent danger" situations and provide for immediate temporary action by responsible persons assigned to emergency floor evacuation teams.

Central control – The building's emergency evacuation plan should indicate how central control will function in the event of fire and the need to move and evacuate persons.

Floor evacuation teams – The building's emergency evacuation plan should include the duties and responsibilities of emergency tenant floor evacuation teams (see the accompanying "Self-Evaluation Checklist" for details).

Information to tenants – The building's emergency evacuation plan should describe evacuation training to be provided and copies of written information furnished to occupants. Fire and emergency evacuation information should be posted at strategic locations on every floor and elevator.

Evacuation drills – The building's emergency evacuation plan should include a schedule of programmed fire and evacuation drills. (Partial building skill drills and full-dress "rehearsal for survival" should be planned.)

Detection and report

It is not the intention of this data sheet to describe fire, smoke, and similar emergency detection systems. Detection, automatic alarm systems, or automatic sprinkler systems should be a part of the total fire protection preparedness program. However, if fire is detected or the start of a fire is witnessed, it should be reported immediately. Delays in reporting fires because of heroic but ineffective fire-fighting can result in needless time loss and allow a simple fire to get out of control. Fire-reporting systems must be handy, direct and not subject to any delay. Reporting by telephone or personal contact should be discouraged when faster means are available.

Evacuation Program Coordination

Movements of occupants to a refuge location, as well as total evacuation, require the utmost coordination of assigned emergency evacuation floor teams and central evacuation control.

Decision to evacuate – Chain-of-command preplanning should determine those vested with authority to move persons and evacuate emergency areas as well as under what circumstances emergency temporary authority for immediate removal is provided to assign floor evacuation control teams. Central building evacuation control should take over command from floor evacuation control teams immediately. Similarly, central evacuation control should be relinquished to the fire department officials upon their arrival.

Evacuation communication – Movement and evacuation should be controlled through communication. Communication between central control and affected areas is of prime concern. In addition to two-way communication between the emergency area and central control, all other occupants should be instructed properly about procedures to follow for movement to refuge areas and evacuation disciplines (or not to evacuate until further notice).

Evacuation priorities – Generally, immediate evacuation will be from the floor where a fire or explosion emergency occurs and the two floors immediately above, and the two floors immediately below the emergency floor. These occupants will be directed to a

refuge area and will be given movement priority. Thereafter, movement and evacuation priorities will be determined on the basis of particular fire and smoke conditions reported by emergency evacuation floor control teams and fire department personnel. These persons will direct evacuation disciplines, assisted (as necessary) by trained building evacuation control teams.

Preplanning and evacuation – Preplanning, evacuation priorities and proper skill drills help eliminate mistakes and misunderstanding. Plans should include possible alternate routes when particular circumstances warrant rerouting of occupants because of hazards (such as smoke, heat, and gasses) in the evacuation route. (Note: a blocked-open door can render an evacuation movement on a stairwell dangerous. Alternate routes should be planned and directed to be used until the cause of danger is removed and the stairwell is safe for use.)

Means of evacuation – Building central evacuation control should determine the safest and most efficient means of evacuation, depending upon the nature of the emergency and scope of damage. This decision should be made known to floor evacuation control teams and personnel on those floors affected, based on the order of priority.

Evacuation priorities – There should be a positive means of selectivity notifying occupants to evacuate. Definite priority must be given to those floors directly involved and floors immediately adjacent to the emergency. On the emergency involved floor, evacuation should be to the nearest available exit to a safe area three floors below or street level.

Exiting – Provisions should be made, and direction provided by assigned floor evacuation control teams, to make sure that traffic flows out and away from the building at all exit terminal points.

Use of stairwells – During fire emergencies, evacuation must be by means of fire stairwells. Specific information of this nature should be conveyed by the building control to individually selected floors, or to all floors, depending on the extent of the emergency and the need for evacuation at specific areas. (Local police and fire departments should be consulted to determine adequacy of the plan.)

Bomb-threat emergencies – Generally, a bomb threat emergency will follow the procedures established for fire emergency movement and evacuation, except elevator evacuation may be considered. The decision to move occupants or to evacuate them will be determined by police, bomb squads, or fire department authorities. This is a complex decision based on many variables. It is a job for the experts. Again, speed in reporting and preplanning is absolutely necessary, especially when involving recognized authorities and determining "chain-of-command." Communication channels must be established to provide accessible, direct, and no-delay reporting.

Communication for directing movement and evacuation

Proper movement of persons to refuge areas or evacuation depends on complete and accurate communications between central control (building and fire authorities) and all assigned floor-evacuation control teams.

1. *Full-time communications* – Communications channels must be available at all times when the building is occupied by any tenant, security, or cleaning people. Direct contact to the chief of each floor's assigned evacuation control team (or designated alternates because the floor captain may be out of the area, ill, or on vacation) must be available at all times. These people must have the authority, responsibility, and training to act for the building tenant on their assigned floors. There must always be a trained substitute to take over in the absence of any fire warden or acting fire warden. A system of alternates should be established so that no floor evacuation team is depleted for even as short a time as a lunch period.

2. *Off-duty-hour communication* – During periods when the building is not occupied, direct signaling to the fire department should be established. At no time should anyone enter the building without his presence being duly noted in writing at a security guard entry location. It will be the security guard's duty to notify and evacuate all "off-hour" occupants in the event a fire or other emergency occurs.

3. *Methods of communication* – Several communication systems are commercially available to ensure full service communications at all times. Personal wireless pagers, loud speakers, and telephones can be used to announce evacuation communication needs and to provide initial contact between the captain (regular or acting) of the floor evacuation control teams and central building evacuation control. Fire-call stations located at strategic intervals on each floor will allow confidential selective notification by two-way communications when it is not desired to sound a "general alarm." However, a selective system of alarm or pager that alerts by floors should notify floor evacuation control teams to "man their stations," including "pulling" the floor box to receive more detailed instructions beyond the general announcements going to the tenants on each floor.

4. *Communications backup* – Whatever system of communication used should be backed up by at least one alternate, independent communication system to use in the event the primary system becomes inoperative.

Education and Training

Who to train? – Education and training of emergency floor evacuation teams and all other occupants of the building should be initiated immediately after occupancy of the quarters. Education and training of all newly hired employees should be included in indoctrination programs. New tenants should receive information on evacuation at time of occupancy. Semiannual refresher training of emergency floor evacuation teams and occupants should

be scheduled. Sustained interest and vigilance on the part of building management and occupants is the price for total fire safety programming. Requirements for multilanguage announcements and instructions should be considered.

Initial emergency evacuation training – Occupancy by two or more tenants requires coordination of all aspects of the fire safety program, which is the responsibility of building management.

Retraining – Where large tenant and occupant turnover is anticipated, pocket-sized diagrams of each floor should be prepared and distributed to all new tenants and their employees. This could be in the form of a card containing the particular floor plan diagram for that tenant, a brief description of emergency evacuation procedures, and the proper method to report a fire or bomb suspicion or threat.

Emergency evacuation floor teams – An emergency floor team should be designated for each floor. The emergency evacuation floor team should include qualified supervisory occupants from each section of each particular floor.

Emergency evacuation floor team alternates – Those selected (and their alternates) should be persons who will be on the premises most of the time. Alternates must be notified any time primary emergency evacuation team captains or team members are away from their appointed stations.

Multishifts – If there is more than one shift, each shift should have its own emergency evacuation floor team.

Training of emergency evacuation floor team – Emergency evacuation floor teams should be trained in the use of the prevailing communication system and in basic methods of crowd control; they must be familiar with refuge areas, evacuation procedures, and the use of emergency illumination. Included in training should be basic knowledge of first aid and firefighting techniques.

Training personnel – Qualified fire control and emergency evacuation professionals should do the training; adequate time for training must be provided.

A printed manual containing details of the building's emergency evacuation program should be provided to all members of the emergency evacuation floor team.

Refresher and review sessions should be provided. These may be scheduled as part of regular business sessions of the tenants. Actual evacuation drills, including movement to refuge areas, should be conducted according to local fire code. If none exists, skill drills should be planned to take place semiannually or quarterly.

Evacuation procedures for physically handicapped – Emergency evacuation floor teams should have a current list of all occupants with physical handicaps, including those

persons who cannot use stairwells or fire escapes because of temporary illness or other impaired physical condition.

Floor search – Each emergency evacuation floor team should appoint "searchers" to make sure that every person on a floor is aware of an emergency evacuation. Depending upon size and occupancy of building, searchers may need a list of tenants and tenant employees' name. Searchers should be trained members of the emergency evacuation team. They should check lavatories and all isolated areas of each floor. Searchers should check for visible presence of occupants rather than a voice response from a possible occupant who might not hear, be temporarily indisposed, or rendered unconscious.

General public – One or more members of the emergency evacuation floor team should be trained and have responsibility of heading the evacuation of visitors, service persons, and other non-tenants occupying the building during an emergency. General public use of the building will determine needs for this part of evacuation procedures and personnel.

Alternate emergency communication – If there should be a breakdown of regular emergency communication systems, messenger-runners from the emergency evacuation floor team should be utilized to ensure communications. (They should be appointed in advance and be properly instructed.)

Crowd control and movement – Crowd control in stairwells and the main lobby should be the responsibility of emergency evacuation floor teams supervised by building central control and the fire department. Teams should be trained to move occupants promptly up or down stairs to refuge areas or to evacuate them from the building.

Inspection and Evaluation

A complete inspection of building and tenant quarters should be made to ascertain regular and special needs of the building and its occupants before establishing an emergency evacuation program. Fire prevention specialists should be consulted, and the program evaluated by means of regular inspection programming. This is also necessary whenever changes are made to physical structures in the building, and for remodeling or renovating of quarters.

Inspection form – It is suggested that an emergency plan inspection form be used for regularly scheduled inspections. A sample of such a "check-off" type form with space for narrative comment under each separate caption follows.

Schedule of inspection – It is suggested that inspections be performed on a regular, scheduled basis. The frequency of inspection is determined by special needs, construction, or occupancy. Inspection reports and the overall evaluation of the emergency evacuation plan should be reviewed on a regular basis with fire authorities.

Inspection reports – Copies of inspection reports should be distributed to:

- Building management;
- Captains of emergency evacuation floor teams;
- Fire safety coordinator;
- Tenants with fire violations or conducting hazardous operations likely to cause a fire.

An inspection and evaluation team should be made up of a representative of the building, an authorized representative of the tenants, and emergency evacuation team captains of the areas being inspected. Rotating guest inspection team members should be invited to provide education and training.

Tenant questionnaires – Periodically, a questionnaire should be distributed to each tenant evaluating occupancy of the building and preparedness for emergencies. These should relate to furnishings, fixtures, electrical changes, etc., and any changes in originally leased disclosures such as storage and use of flammables, explosives, or "exotic" materials that might be a fire or explosion hazard.

Randomly selected groups of employees in tenant occupancies should be given questionnaires relating to their knowledge of: number and location of exits; location of flammables; usage of stairwells instead of elevators during emergencies; names of floor captains, etc. These questionnaires can be distributed by emergency evacuation floor teams or inspection teams and picked-up and evaluated by fire authorities, building management, tenant representatives, and captains of emergency evacuation floor teams. This will serve as a continuing method of evaluating occupancy of the building and preparedness for emergencies.

In Event of Fire

In the event of fire, the building manager or the chief engineer should have the assigned authority to order evacuation of a given floor or several floors of the building. Additional floors may be evacuated at the direction of the local fire department.

Floors to be evacuated

Generally, evacuation will be from the floor on which the emergency has occurred and the two floors immediately below and above the "emergency floor" to a safe point below or above the critical area. (The construction of the building will be an important factor when considering the direction of the evacuation and also to determine the number of floors to be evacuated from the involved area.)

Evacuation should be accomplished by way of fire stairwells. If smoke or fire has penetrated a stairwell, alternate stairwells should be used. In the event of "bomb-threat" emergencies, the evacuation order will be controlled by joint decision of the police and

fire department in consultation with building management and tenants' representatives. Elevators can be used for "bomb-threat" emergencies, but never for fire emergencies.

Building management and maintenance personnel should proceed immediately to fire stairwells and assist in the evacuation of occupants of the involved floor or floors.

Elevator control

Immediately upon recognition of fire emergency, all elevators should be returned to the lobby floor in accordance with the American National Standard *Elevator Code* (see "Sources of Information").

Automatic devices should be installed to allow elevator cars to bypass all fire-involved floors. Under no circumstances should elevators be stopped at the fire-involved floors.

All occupants of the building, including visitors, must be informed that there will be no elevator service to or from emergency floors, and that they must evacuate by way of fire stairwells to refuge areas or beyond.

Physically handicapped occupants should be moved down the fire stairwell to the uppermost floor served by an uninvolved elevator bank, and then be moved by elevator under the direction of fire officials. Seriously handicapped persons should be assisted by assigned floor evacuation team members. Locating the desks of handicapped persons in a work area near an exit will make their evacuation easier.

Control of elevators from the lobby level will be under the command and direction of a fire official. Elevators should be programmed to return non-stop to the lobby level during fire emergency.

Evacuation control

The direction of traffic should be related to the number of persons on each floor, the number of emergency stairwells available, and the number of floors directly exposed to the fire or emergency.

Evacuation priority – There should be a positive means of directly notifying occupants to evacuate. Definite priority must be given to those floors directly involved and floor immediately adjacent to the emergency.

Method of evacuation – Building control will determine the safest and most efficient means of evacuation, depending on the nature of the emergency and scope of damage. This decision should be made known to floor control personnel and those floors affected. Floor control personnel on the endangered floors should be notified first.

To regulate flow, and to control the number of building occupants moving down single stairwells, alternate floors may be assigned different stairwells, thus providing an interval of two full flights between evacuating floors. (Actual floor number, rather than of odd or even, should be used when the building has no 13th floor number.)

On the emergency-involved floor, evacuation should be to the nearest available exit that can be reached safely.

Provisions should be made, and directions provided, to ensure that occupants move away from the building at all exit terminal points to a pre-determined location to facilitate a "head count" inventory of evacuation.

SOURCES OF INFORMATION

American National Standards Institute, 1430 Broadway, New York, NY 110018. *Elevators, Escalators, and Moving Walks* (ANSI/ASME A17 1-1984).

Building Officials and Code Administrators International, 4051 Flossmore Rd., Country Club Hills, IL 60477. *Standard for the design and Installation of the Suppression System for Life Safety*.

National Fire Protection Association, Batterymarch Park, Quincy, Mass. 02269. "Catalog Price List."

National Safety Council, 1121 Spring Lake Drive, Itasca, IL 60143. *Accident Prevention Manual for Industrial Operations*, 8th ed.

Federal Fire Prevention and Control Act of 1974. (Public Law 93-498). Oct. 29, 1974.

Evacuation Preparedness Self-Evacuation Checklist

Note: All questions in this checklist should be answered with "yes," "no," "NA" (not applicable), or "U" (undetermined). For all answers that are not "yes," or "NA," the specific areas needing correction, the persons responsible, etc., should be noted in the "comments" column.	Yes/NA	No	U	Comments
Floor Diagrams:				
Are floor plans prominently posted on each floor?				
Is each plan legible?				
Does the plan indicate every emergency exit on the floor?				
Is a person looking at the plan, properly oriented by an "X" (that is, "you are here now")?				
Are room number identifications for the floor as well as compass directions given?				
Are directions to stairwells clearly indicated?				
Are local and familiar terms used on the diagram to define directions to emergency exit stairwells? For example, are particular areas identified, such as mail room, cafeteria, personnel department, wash rooms and lavatories, etc.?				
Exit paths to stairwells:				
If color coding of pillars and doors, or stripes and markings on floors are used, are they properly explained?				
Is additional clarification needed?				
Are paths to exits relatively straight and clear of all obstructions?				
Are proper instructions posted at changes of direction en route to an emergency exit?				
Are overpressure systems and venting systems operative?				
Elevators:				
Are signs prominently posted at and on elevators warning of the possible dangers in use of elevators during fire and emergency evacuation situations?				
Do these signs indicate the direction of emergency exit stairwells which are available for use?				
Elderly and physically handicapped:				
Are there elderly or physically handicapped persons who will need assistance during a fire and emergency evacuation of premises?				
What provision is made for their removal during an emergency?				
Who will assist? How will the handicapped be moved?				
Emergency exit doors:				
Are all emergency exits properly identified?				
Are exit door location signs adequately and reliably illuminated?				
Do exit doors open easily and swing in proper direction (open out)?				
Are any exit doors blocked, chained, locked, partially blocked, obstructed by cabinets, coat racks, umbrella stands, packages, etc.?				
NOTE: Blockage must be prohibited and removed immediately.				
Are all exit doors self-closing?				
Are there complete closures of each door?				
Are all exit doors kept closed, or are they occasionally propped open for convenience or to allow for ventilation?				
NOTE: This practice must be prohibited.				
Emergency stairwells:				
Are stair treads and risers in good condition?				
Are stairwells free of mops, pails, brooms, rags, packages,				

	Yes/NA	No	U	Comments
barrels, or any other obstruction materials?				

	Yes/NA	No	U	Comments
Emergency stairwells (cont'd): Are all stairwells equipped with proper handrails? Does each emergency stairwell go directly to the grade floor exit level without interruption? Does the stairwell terminate at some interim-point in the building? If so, are there clear directions at that point which show the way to completion of exit? Is there provision for directing occupants to refuge areas out of and away from the building when they reach the ground floor? Are directions provided where evacuees can congregate for a "head count" during and after the evacuation has been complete? Is there adequate lighting in the stairwell? Are any bulbs and/or fixtures broken or missing? Where? Describe locations. Are exits properly identified? Are they illuminated for day, night, and power-loss situations? Are any confusing non-exits clearly marked for what they are? Are floor numbers displayed prominently on both sides of exit doors? **Emergency lighting:** In the event of an electrical power failure or interruption of service in the building, is automatic or manually operated emergency lighting available? If not, what will be used? Where are stand-by lights kept? Who controls them? How would they be made available during an emergency? Is there an emergency generator in the building? Is it operable? Is it secured against sabotage? Is a "fail-safe" type of emergency lighting system available for the exit stairwells that will function automatically in event of total power failure? How long can it provide light? Is the emergency lighting tested on a regular monthly basis with results recorded? Who maintains such records? **Communications:** How should occupants of the building be notified that an emergency evacuation is necessary? Are one or more forms of communication systems available to each tenant floor? (P.A. system, Musak, stand-pipe phones, battery-operated "pagers," etc.) If messengers must be used, have they been properly instructed? Is the communication system in good working condition? Under what emergency conditions is it used and who operates it? Is the communications system protected from sabotage? Do all occupants know how to contact building control to report a dangerous situation? Is the building's emergency communications system tested monthly? By whom and to what extent? Inspection completed by: Name: Title: Date of Inspection:				