EVALUATION WORKSHEET FOR HIGH-RISE RESIDENTIAL BUILDINGS USER'S GUIDE

Developed by the Residential Fire Safety Advisory Committee

The Evaluation Worksheet (Worksheet) is a tool used to compare the relative level of life safety from fire to a level that is considered acceptable to the authority having jurisdiction (AHJ).

This guide serves to assist in the completion of Tables 1 through 8 of the Worksheet, provides expanded information and descriptions of various items, assists the user with definition or interpretation questions, and is structured to progressively follow the format of the worksheet.

- Complete the information at the top of the cover sheet, including the facility or building name, the fire compartment(s) evaluated, the evaluator's name (licensed design professional), the evaluation date, and the purpose.

- There are eight tables to complete. Each table contains risk parameters and a corresponding fixed value. The evaluator must determine the value based upon his/her inspection of the building and enter that value into the red boxes on each table.

- After the values have been entered on the worksheet, Table 8 will determine whether or not the building's fire safety level is acceptable (pass) or not (fail).

Fire Compartment

A fire compartment, referred to as a zone in this guide, is separated from all other spaces by floor assemblies, horizontal exits, or smoke barriers. Where a story is not subdivided by horizontal exits or smoke barriers, the entire story is considered to be the zone.

Selection of Fire Compartment Zones to Be Evaluated

A story that is not subdivided by horizontal exits or smoke barriers is considered a single zone. The entire facility shall be divided into zones. There shall be no area that is not in a zone.

For a complete evaluation, each zone in the building shall be individually assessed.

Most high-rise residential buildings have repetitive arrangements so that a complete picture may be developed by evaluating typical zones until all combinations are assessed. The selected zone should include the following:

- Type of mobility, density, or attendant ratio, as specified in Table 1
- Type of construction, finish, or protection system
- Occupancies other than a residential occupancy

Maintenance

Any protection system, requirement, or arrangement that is not maintained in a dependable operating condition or is used in such a manner that the intended fire safety function or hazard constraint is impaired, shall be considered defective and receive no credit in the evaluation.

Table 1: Occupant and Fire Fighter Risk Parameters

In establishing a system for evaluating occupancy risk, the following facts are recognized:

- There is a basic level of risk inherent in every high-rise residential building.
- Fuel characteristics of furniture, equipment, and supplies may vary with time.
- The arrangement of items within the available space may vary with time.

Consequently, these three factors are not included as parameters in a safety equivalency measurement. To account for these factors the occupancy risk baseline is set at the inherent risk level with the presumption that furniture, equipment, and supplies are the most combustible and adversely located (from a fire safety standpoint) of those items normally found in these buildings.

A. Resident Evacuation Capability

An important factor controlling risk in an evaluation is the degree to which residents require assistance in taking the necessary actions for their safety. The level of capability from residents who, if informed or directed, are able to take self-protecting actions to those residents who are unable to move or take the simplest actions to safeguard themselves. In the measurement of occupancy risk factors, the least mobile category of residents expected in the fire compartment determines the risk factor for that zone. The rationale for this approach is that if a zone accepts any resident with reduced mobility status, it might accept other such residents at any time. The impact of this approach is that most residential occupancies should be rated in the “Require Assistance” risk parameter value category.

1. Resident Mobility Status

   Resident mobility status is based on the capability of each resident to take actions necessary for self-protection. The three options are defined as follows:

   a. Normal Mobility

      Capable of readily rising from bed and taking self-protecting actions at approximately the same rate as a healthy adult. To be classified as mobile, the resident must not need assistance in getting out of bed and be able to open a closed or locked door. Persons shall be considered to be mobile if they are not restrained or limited in response capabilities so that the type of arousal mechanism that normally would awaken an adult is not effective.

   b. Require Assistance

      Residents who are incapable of removing themselves from danger exclusively by their own efforts.

      Examples include persons who are totally bedridden; who need assistance getting out of bed or moving; and who are restrained, locked in their rooms, or otherwise prevented from taking complete emergency self-protection evacuation actions without assistance.

   c. Not Movable

      Residents who are incapable of being moved from the room in which they are housed.

      Examples include residents attached to life support systems or involved in medical or surgical procedures that prohibit their immediate relocation without extreme danger of death or serious harm.

      One not movable resident in the building equals a not movable determination.

2. Determine the mobility status category and enter the risk parameter values in the red box.

   Example: If the fire compartment has normal mobility, then enter the "Occupant Risk Factor (01)" of 1.50 in the "Enter (01)" red box and the "Fire Fighter Risk Factor (FF1)" of 1.60 in the "Enter (FF1)" red box.

B. Occupant Load

The occupant load (number of residents within the zone) measures the inherent increase in the maximum fire death potential that occurs as the number of residents in a zone increases and the problems involved for first responders in handling larger numbers of residents during an emergency.

Residents

The number of residents who could potentially be housed in that zone. The resident count should be based on the occupant load as calculated in accordance with the applicable building code.

Determine the number of residents in that zone and enter the corresponding risk parameter values in the occupant risk factor and the fire fighter risk factor in the red box.

C. Zone Location

1. This risk parameter relates to the fire department's accessibility to a fire. The rating system recognizes the inherent advantages for the first story zone. It also recognizes the problems of evacuating residents from higher stories and the virtual impossibility of using external fire fighting efforts above the sixth story in any building.

2. Floor: The measured zone's location shall be considered to be on the first story if the story has direct access to the exterior at or within less than one-half story height above or below grade. If a building is on a sloping grade, each story that has such exterior access shall be considered a first story for the purpose of measuring fire zones on those stories. The measured zone shall be considered to be on the second to third story range and the fourth to sixth story range, based on the height of the zone above the nearest at-grade story. The zone shall be considered to be above the sixth story if it is more than six stories above the nearest at-grade story. The risk factor value for zones in basements is the same as at or above the seventh story. The problems involved in emergency internal access in fire fighting and rescue and the inability to make external attack in basements are approximately equivalent to those in the upper stories of buildings.

3. Determine the zone's location and enter the corresponding risk parameter values in the occupant risk factor and fire fighter risk factor in the red box.

Table 2: Risk Factor Calculations

These factors, including the Occupant Risk Factor (ORF) and the Fire Fighter Risk Factor (FFRF) are automatically determined based on the risk parameter values entered in Table I.

Tables 3A and 3B: Building Status

These values are automatically determined based on the risk parameter values entered in Table 1.

Table 4: Fire Safety Parameter Values

Safety parameters are a measure of those building factors that bear on or contribute to the safety of those persons (residents, visitors, and others) who may be in a particular zone at the time of a fire. Each of the safety parameters were analyzed. Where the current building requirements recognize several different approaches to the parameter, the most important alternatives were specified. Conditions likely to be encountered in situations failing to meet the prescribed code requirements and exceeding those required by the code, but available for increased protection, were also specified.

A. Construction Type

Construction types are classified in accordance with the definitions of the current adopted building code:

1. Where the facility includes additions or connected structures of different construction, the rating and classification of the structure shall be based on one of the following:

    a. Separate buildings, if in accordance with the International Building Code, Section 510

    b. The lower safety parameter point score involved

2. The story used to determine the parameter value is the story of the fire/smoke zone being evaluated. The building's construction type for all stories is based on the lowest construction type anywhere in the building. The story or zone is specified relative to and beginning with the exit discharge level.

3. Where the zone is on a story below the exit discharge level, the construction value shall be based on the distance of that story from the exit discharge level, i.e., one story below the exit discharge level equals "second"; two stories below the exit discharge level equals "third"; three or more stories below the exit discharge level equals "fourth and above."

B. Interior Finish (Corridor and Exits)

The classification of interior finish materials shall be in accordance with Section 10.2 of National Fire Protection Association (NFPA) 101. The flame-spread classification shall be based on the most combustible surface after deleting the trim. No allowance is made in the safety parameter values for interior finish materials that fail to be classified as a minimum of Class C. It is not anticipated that such materials will be used in residential occupancies. In the rare case that such high fame-spread interior finish materials are involved, an individual fire hazard assessment outside the capability of this evaluation system will be required. Interior wall and ceiling finish materials tested in accordance with NFPA 265 or NFPA 286, as permitted by Section 10.2 (NFPA 101) and meeting the criteria established in the building code for those test standards, shall be scored as Class A interior finish materials (flame spread ≤25).

C. Corridor and Dwelling Unit Separation Walls

For the purpose of this evaluation, the fire-rated partitions are as defined in the building code.

Regarding dwelling units, this item evaluates the separation of dwelling units from the corridor and the separation between individual dwelling units.

All elements of the partition, except the door (considered as a separate element in this evaluation), must be included in the determination of its time-rated fire resistance classification according to American Standard Test Method E119, Standard Test Methods for Fire Tests of Building Construction and Materials. An exception to the general rule of evaluating doors separately from walls occurs where one or more rooms have no doors (see Fire Safety Parameter “Doors to Corridors”). In this instance, it is considered that the worth of the fire resistance capabilities of the corridor partition wall is so reduced that the wall should be graded as having no fire resistance. (See Worksheet 4.7.6.)

Corridor partitions shall be graded as “≤1⁄2 hour,” “>1⁄2 hour but ≤ 1 hour,” or “≥ 1 hour” only where the partitions extend to the underside of the floor or roof construction above in accordance the building code.

For locations where there are no interior corridors only exterior egress balconies, use 4 points, regardless of wall type.

D. Doors to Corridor

The classification of doors and opening protectives to the corridor shall be based on the minimum quality of any door in the zone, and the classification shall be determined in accordance with NFPA 252 or NFPA 257. Doors for protection of vertical openings and hazardous areas that are covered separately in Sections 4.6.7 and 4.6.8 are not included in this evaluation.

Doors that do not latch and doors with louvers shall not be considered in classifying doors to corridors if those doors open to toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible materials.

1. No Door

   A room shall be considered as not having a door if there is no door or window in the opening or if there is some other mechanism that prevents the door from closing or otherwise leaves a significant opening between the resident room and the corridor. Doors with louvers or ordinary glass lights shall be classified as “no door.” (Ordinary glass lights shall not be considered as making a partition incomplete in locations where both sides of the glass light are fully protected by automatic sprinkler systems.) Doors that have been propped open by door stops, chocks, tiebacks, or other devices that necessitate manual unlatching or releasing action to close the door shall be classified as “no door.” Also, doors that are not provided with a latch shall be classified as “no door.”

2. Doors of less than 20-Minute Fire Protection Rating (<20 min FPR)

   Doors and windows that are not deficient, as described for “No Door” but do not meet the requirements of Doors of 20-Minute or More FPR (≥20 min FPR), shall be classified as < 20-minute FPR.

3. Doors of 20-Minute or More FPR (≥20 min FPR)

   Doors and windows shall be considered as having a 20-minute or greater FPR when labeled as such, are of 1-3⁄4 inches thick, solid, bonded wood core construction, or any other arrangement of equal or greater stability and fire integrity. The thermal insulation capability of the door or window need not be considered. Hollow or sheet steel doors therefore meet the 20-minute requirement.

4. Twenty-Minute or More FPR and Automatic Closing (≥20 min FPR and Auto Close.)

   Automatic-closing devices shall be considered to be present if the door has an arrangement that holds it open in a manner such that it is released by a smoke detector-operated device (e.g., a magnetic or pneumatic hold-open device) prior to the passage of significant smoke from a room of fire origin into the corridor or from the corridor into a room not involved in the fire. Smoke detectors for operation of such doors shall be permitted to be integral with the door closers, mounted at each opening, or operated from systems meeting the requirements for two or more points of credit under Section 4.6.12. The requirement for 20-minute FPR is the same as in Section 4.6.5.3.

5. All doors must meet the respective category requirements; one door not meeting a specific category requirement will equal to that parameter score.

E. Exit Access

Evaluate exits as either an interior corridor or as an exterior egress balcony, as applicable. If interior corridors are present in the zone being evaluated, i.e., a mixture of egress balconies and interior corridors on a given floor, then that zone shall be evaluated using the interior corridor values.

The length of a corridor “dead end” shall be measured from the point at which a person egressing from the dead end would have an option of egressing in two separate directions.

In assessing the values for this parameter, a single value shall be chosen based on the worst safety level in the zone. For example, if an interior corridor has one or more dead ends in excess of 50 feet (15 meters) but not more than 100 feet (30 meters), the parameter value for dead ends (-6) shall be applied regardless of the actual corridor lengths.

Since dead-end corridors and single emergency movement routes (see parameter 10) each confine the occupant(s) of a fire zone to a single means of egress, the effect of these two factors on the parameter value is not cumulative. As indicated by Note B to Worksheet Table 4, the parameter value for dead-end corridors shall be 0 instead of either -2, -4, or -6 in the special case where a value of -8 is assessed under Item 9 for single emergency movement routes.

F. Vertical Openings

These values apply to vertical openings and penetrations, including exit stairways; ramps; other vertical exits of the type recognized by the Building Code of the City and County of Honolulu; pipe shafts; ventilation shafts; duct penetrations; and laundry and incinerator chutes. Enclosures shall be constructed of materials that have a fire resistance rating no less than that prescribed for vertical openings (see Safety Parameter 6 of Table 4). In addition, they shall be equipped with fire doors or acceptable protection of openings into the shafts, designed and installed to provide a complete barrier to the vertical spread of fire or smoke.

A vertical opening or penetration shall be considered open if it has any of the following characteristics:

- It is not enclosed.
- It is enclosed, but does not have doors or opening protectives.
- It is enclosed, but has openings other than doorways.
- It is enclosed with cloth, paper, or similar materials without any sustained flame-stopping capabilities.

Where vertical openings are located outside the fire/smoke zone and the separation between the zone and the vertical opening is of one hour or greater fire resistance rating and is of higher fire resistance rating than the protection of the vertical opening itself (for example, an open shaft separated from the zone by a two-hour fire resistance-rated partition with one and one-half-hour fire protection-rated self-closing fire doors), the rating of this factor for the zone being measured shall be based on the higher of the two fire resistance categories.

Example: A safety parameter value of 3 would be given for the two-hour fire resistance rating. Where this occurs, however, the space with the vertical opening cannot be considered an exit route or refuge area for that zone when evaluating the egress route parameter 9.

A vertical opening shall be considered open for more than three stories if there is unprotected penetration of four or more stories on the same shaft without an intervening slab or other cutoff (also see same area as an unprotected penetration in Section 4.6.13). If a shaft is enclosed at all stories, except one, and this results in an unprotected opening between the shaft, and only one, fire/smoke zone, the parameter value assigned for that shaft opening in the fire/smoke zone where the unprotected opening occurs shall be 0.

G. Hazardous Areas

Hazardous area protection is determined in accordance with Section 8.7 of NFPA 101. This determination may also be based upon the status or findings from the building's fire inspection report.

1. The term adjacent zone, as used in the evaluation form, means any zone, either on the same story or the story immediately below, that physically abuts the zone being evaluated and not separated by two-hour fire resistance-rated construction.

2. The term outside zone, as used in the evaluation form, means any place within the building other than the fire/smoke zone being measured and not separated by two-hour fire resistance-rated construction.

3. In assessing the parameter value for hazardous areas, only one value shall be chosen. It shall be the most severe value corresponding to the deficiencies present.

    a. A double deficiency can exist only where the hazard is severe, and the space is not sprinkler-protected. Double protection consists of a fire-rated enclosure and automatic fire sprinkler protection of the hazardous area. If both of these protections are lacking in a severe hazardous location, the double deficiency value shall be chosen. If double deficiencies exist within and outside the zone, the higher value (-11) for the condition inside the zone shall be chosen. The values are not cumulative, regardless of how many hazardous areas are present.

    b. Where the hazard is not severe, the maximum deficiency that can occur is a single deficiency which shall be permitted to be countered by either of the following means:

        (1) A fire resistance-rated enclosure

        (2) Automatic extinguishing equipment and enclosure by smoke partitions

        A single deficiency situation is also considered to exist where a severe hazard is protected by either of the following means, but not by both:

        (1) A fire resistance-rated enclosure

(2) Automatic extinguishing equipment and enclosure by smoke partitions

H. Smoke Management

The smoke management score is based the absence or presence of smoke-proof enclosures; exterior stairs or exit access; smoke-proof enclosures for all exits; and the presence of mechanical smoke control or smoke compartments on the floor.

I. Egress Routes

A movement route is any means of egress meeting the requirements for such means specified in the Building Code of the City and County of Honolulu.

1. Fewer Than Two Routes

The means of egress from a zone is classified as fewer than two routes if there are no less than two remote movement routes serving the zone. Movement routes shall be permitted to be outside the physical limits of the zone.

2. Multiple Routes

The egress route is multiple if zone occupants have the choice of two or more distinctly separated movement routes from the zone.

Deficient. The choice of parameter value for deficient egress routes is independent of any values determined in Item 6 Vertical Openings:

a. An egress route is deficient if the door widths or corridor widths do not conform to the minimum requirements of the Building Code of the City and County of Honolulu.

b. Egress routes shall also be considered deficient if they fail to meet the requirements of Chapter 10 of the Building Code of the City and County of Honolulu.

c. Egress routes shall be considered deficient if the capacity of the exits serving the story containing the zone being evaluated is insufficient for the calculated occupant load of the story.

J. Fire Alarm System (FAS)

Credit shall be given for FASs that conform to NFPA 72, including audibility.

K. Smoke Detection

A detection system as used herein is one based on the use of automatic smoke detectors installed in accordance with NFPA 72. No recognition is given for thermal detectors; however, credit is given for the use of quick-response fire sprinklers per the double asterisk on Item 11 of Table 4. The detection system categories are described as follows:

1. None. There are no smoke detectors in the zone or, if present, they are not included in any of the categories below:

2. Corridor Only. Smoke detectors are installed throughout the corridors of the zone involved.

3. Total Smoke Detection Throughout. Total space provision of detectors includes detector coverage of all spaces, except noncombustible building voids that contain no combustible materials. The total space credit is to be given if the zone measured meets this criterion, regardless of the presence or lack of detectors in other portions of the building.

L. Automatic Fire Sprinklers

Fire sprinkler systems shall be provided with supervision. Each sprinkler fire system shall be interconnected electrically with the FAS, and fire sprinkler control valves shall be supervised electrically so that a local alarm shall sound in a constantly attended location when a valve is not in the fully open position.

In evaluating sprinkler protection within the zone, the protection or lack of protection of hazardous areas is considered separately and covered under Item 7. For all other areas in the zone, sprinklers shall be graded based on the categories below:

1. None. No credit is applied if there are no sprinklers or if sprinklers, though present, are not sufficient to qualify for one of the other categories specified.

2. Corridor and common areas

3. NFPA 13R for the Entire Building. Total space automatic fire sprinkler protection is to be credited only if the entire structure is protected by automatic fire sprinklers.

4. NFPA 13 for the Entire Building. Total space automatic fire sprinkler protection is to be credited only if the entire structure is protected by automatic fire sprinklers.

M. Smoke Alarms

Self-explanatory

N. Standpipe System

Self-explanatory

O. Elevators

Self-explanatory

P. Emergency Lighting and Exit Signs

Self-explanatory

Ten-Step Process for Completing the Evaluation Worksheet for High-Rise Residential Buildings

Step 1

Complete the cover sheet information, including the facility/building name, fire compartment (zone) evaluated, the evaluator's name, and the date of evaluation. The purpose may also be stated here.

Step 2

Ascertain the ORF and the FFRF parameters by determining the risk parameter values in the respective categories.

Enter the appropriate risk parameter value. The applicable risk parameter values in the same column must be used.

Step 3

The worksheet will automatically determine the ORF and FFRF in Table 2.

Step 4

The worksheet will automatically determine the ORF and FFRF in Tables 3A and 3B.

- The adjusted value for the ORF will be transferred to columns in Table 5 for the Egress Fire Safety (S3) and General Occupant Fire Safety (S4) and divided into the subtotals for Egress Fire Safety and General Occupant Safety to determine the value for S3 and S4. Those values then appear in the appropriate cell for S3 and S4 in Table 7.

- The adjusted value for the FFRF will be transferred to the column for Table 5 for General Fire Fighter Safety (S5) and divided into the subtotal to determine the value for S5. That value then appears in the cell for S5 in Table 7.

Step 5

Determine Safety Parameter Values using Table 4. Select the safety value for each safety parameter in Table 4 that best describes the conditions in the zone. Choose only one value for each of the 16 parameters. If two or more values appear to apply, choose the one with the lowest point value.

Step 6

The spreadsheet will compute Individual Safety Evaluations in Table 5.

The resulting values for S1, S2, S3, S4, and S5 are transferred to the corresponding blocks in Table 7.

Step 7

Determine the Mandatory Safety Requirement Values using Table 6.

Step 8

Determine the Zone Fire Safety Equivalency using Table 7.

Step 9

Determine the conclusion.

Step 10

Conclude whether or not the level of life safety is acceptable to the AHJ.