Design Fire Scenarios (Revisited June 2009)

We have identified eight design fire scenarios that we propose be used within the framework.

1. Occupancy-specific fire scenarios and design events dependent on purpose group and fire hazard category.
2. A fire located to block a primary means of escape.
3. A fire that starts in a normally unoccupied room that can potentially endanger a large number of occupants in another room.
4. A fire that starts in a concealed space that can potentially endanger a large number of occupants in another room.
5. Smouldering fire in close proximity to a sleeping area.
6. A fire that threatens neighbouring property.
7. A fire external to the building exposing façade materials and potentially leading to significant façade damage and vertical fire spread.
8. A fire involving interior surface linings/finishes.

(**redundancy and robustness scenario** – *we need to decide what we are going to do with this? we may/may not decide this to be a scenario in it's own right, but it is included here for the time being.*)

9. Typical fire originating in the building with any one passive or active fire protection feature being ineffective.

   Additional Comments to Work Group

   (NFPA 5000, Scenario 8 uses a typical fire. This would be less severe than our scenario 1 fire. Is it better to allow less stringent acceptance criteria or less stringent design fire when assessing design robustness? Or both? Taking into account both a system failure and a fire occurrence is a lower probability event in itself.

   For a redundancy scenario –

   We could:

   a. *Drop the safety margin in ASET = RSET + safety margin*
   b. *Drop 'visibility' as a criterion in the detailed tenability assessment, but keep the narcotic and thermal FED's. 'Poor visibility' doesn't injure per se, but delays or prevents escape. Exposure to smoke and heat causes the actual injuries.*

   Safety margin would be included within our FED criteria already. i.e FED = 0.3 vs FED = 1.0 ?

   If we address a sprinkler failure scenario separately, for determination of structural fire resistance (see proposal later in this paper), do we still need a redundancy/robustness test for tenability analysis, given that other non-suppression systems generally does not provide as great a benefit as sprinklers do?

   May still need to provide guidance on need for sensitivity analysis on some parameters.

Fire Scenario 1:

Occupancy specific fire scenarios and design events dependent on purpose group and fire hazard category.

Description of fire threat:
These fires are intended to represent a credible worse case scenario that will challenge the fire protection features of the building.

Performance objective:

- Provide a tenable environment for occupants in the event of fire.
- Meet the reasonable expectations of firefighters to be protected from illness or injury whilst carrying out rescue and firefighting operations.

Design event:

- Design fires will be characterised with t- squared rate of heat release, peak HRR and FLED. Yields will be specified for CO, CO2 and soot/smoke.
- Design fires are intended to represent 'free-burning' fires but may be modified during an analysis (depending on the methodology used) to account for building ventilation and fire suppression effects on the fire.
- Refer to separate tables for details of the design fires.

Performance measure:

- Refer to criteria for 'Occupant Tenability Limits'.
- Refer to criteria for 'Firefighter Expectations'.
- Refer to criteria for 'Structural Fire Performance'.

Expected methodologies:

- We expect there will be calculations of the fire environment in the escape routes that will be evaluated using the tenability criteria.
- We expect there will be calculations of the fire environment for extended periods to evaluate the conditions to which firefighters will be exposed.
- We expect calculations on the amount and availability of firefighting water.

Assumptions:

- Active and passive fire safety systems in the building may be assumed to perform as intended by the design.
- It is assumed that a single fire source shall be utilized to evaluate the protection measures.

Applications:

This fire scenario applies to:

- All buildings

Commentary:

This scenario corresponds to NFPA 5000, Scenario 1 & 6 combined, where S1 is intended to correspond to a "typical fire for the occupancy" whereas S6 is a "most severe fire resulting from the largest possible fuel load". We felt that S6, being the greater challenge would always govern so that S1 was not needed.

<u>Additional Comments to Work Group</u>

A deliberately lit design fire is to be included but is this scenario the right place? Should it be a separate scenario? Should it be the 'exitway' fire in scenario 2?

Fire Scenario 2:

Fire located to block a primary means of escape

Description of fire threat:
The fire is located within or near the primary escape route or exitway that prevents occupants from leaving the building by that route. Fire originating within an exitway may be the result of a deliberately lit fire or be accidental. Fire originating within an escape route in the open path will be considered to be a severe fire applicable to the particular building use as described in Scenario 1. This scenario is intended to address the concern regarding a reduction in the number of available means of escape, due to the fire location causing an escape route to be blocked.

Performance objective:

- Provide a viable escape route from the building for occupants in the event of fire.
- Provide a viable means of access for rescue and firefighting purposes.

Design event:

- Use the same fire characteristics from scenario 1 for the applicable occupancy. The design fire for the escape routes in the open path and for the 'exitway' is different. General free-burning fires from scenario 1 apply to open paths while the limited size deliberately lit fire can be applied within an 'exitway'.

Performance measure:

- Refer to criteria for 'Occupant Tenability Limits'.
- Refer to criteria for 'Firefighter Expectations'.

Expected methodologies:

- Provide alternative escape routes that are tenable.
- This scenario shall be applied to individual rooms in the open path, and to corridors and stairs that are part of the exitway. Escape routes serving less than 50 persons will be permitted to have a single exit. If the escape route serves more than 50 people, then analysis would only be required if only a single escape route is provided in the design.

Assumptions:

- Active and passive fire safety systems in the building may be assumed to perform as intended by the design.

Applications:
This fire scenario applies to:

- Escape routes serving more than 50 people.

Commentary:
The definition of escape routes and exitways shall be the same as C/AS1. This means that 'exitways' refer to those parts of escape routes that are enclosed by fire and/or smoke separations and for which the contents and materials are strictly controlled.

An escape route can also be part of the 'open path' or general spaces within a building.

The analysis for scenarios 1 and 2 could be one and the same. This scenario corresponds to NFPA 5000, fire scenario 2.

Additional Comments to Work Group

This scenario needs to be consistent with the intended philosophy about single means of escape i.e is 'defend in place' a valid approach? The performance objective here does not preclude 'defend in place'.

May lead to single escape routes serving more than 50 people in sprinklered buildings – are we ok with that?

Fire Scenario 3:

A fire that starts in a normally unoccupied room that can potentially endanger a large number of occupants in another room

Description of fire threat:
A fire starting in an unoccupied space may grow to a significant size undetected and then spread to other areas where large numbers of people may be present. This scenario is intended to address the concern regarding a fire starting in a normally unoccupied room and then migrating into the space that can, potentially, hold the greatest number of occupants in the building.

Fire spreading from unoccupied spaces may compromise the ability of firefighters to assess the threat to themselves whilst undertaking rescue and firefighting operations.

Performance objective:

- Maintain tenable conditions on escape routes until the occupants have evacuated.
- Protect against fire spread that could compromise the retreat of firefighters.

Design event:

- Use fire characteristics from scenario 1 for the applicable occupancy.

Performance measure:

- Refer to criteria for 'Occupant Tenability Limits'.
- Refer to criteria for 'Firefighter Expectations'.

Expected methodologies:

- Fire separations or suppression to confine the fire to room of origin
- Automatic detection to provide early warning of the fire in the unoccupied space
- Tenability analysis of escape routes if fire spreads into the occupied space
- Firefighter tenability on access routes

Assumptions:

- Active and passive fire safety systems in the building may be assumed to perform as intended by the design.

Applications:
This fire scenario applies to:

- Buildings with spaces holding more than 50 occupants.

Commentary:
This scenario corresponds to NFPA 5000 fire scenario 3.

<u>Additional Comments to Work Group</u>

Since we are expecting all buildings designed using this framework to be provided with an automatic fire detection and alarm system – does this mean this senario is actually no longer required? ie. it will be satisfied by the early detection system. Can it be argued that within the 'unoccupied' space the detection can be substituted by fire separations?

Fire Scenario 4:

A fire that starts in a concealed space that can potentially endanger a large number of occupants in another room

Description of fire threat:
A fire that starts in a concealed space could develop undetected and spread to endanger a large number of occupants in another room. This scenario is intended to address a concern regarding a fire originating in a concealed space that does not have either a detection system or suppression system that spreads into the room within the building that can, potentially, hold the greatest number of occupants.

Fire spreading in concealed spaces may compromise the ability of firefighters to assess the threat to themselves whilst undertaking rescue and firefighting operations.

Performance objective:
- Maintain tenable conditions on escape routes until the occupants have evacuated.
- Protect against fire spread that could compromise the retreat of firefighters.

Design event:
We are currently unable to identify a suitable quantitative description of the design event, and would expect that traditional solutions would apply – i.e containment, detection or suppression.

Performance measure:
- Refer to criteria for 'Occupant Tenability Limits'.
- Refer to criteria for 'Firefighter Expectations'.

Methodologies:
- Fire separations or suppression to confine fire to concealed space
- Automatic detection to provide early warning
- Tenability analysis with fire spreading into the occupied space
- Firefighter tenability on access routes

Assumptions:
- Active and passive fire safety systems in the building may be assumed to perform as intended by the design.

Applications:
This fire scenario applies to:
- Buildings with spaces holding more than 50 occupants.

Commentary:
There are a range of possible ignition sources, fuel types and size of concealed space, including floor plenums for IT cables, ceiling plenums, service shafts, curtain wall cavities etc.

Need to determine when this scenario applies – i.e all buildings or only buildings with many people?

This scenario corresponds to NFPA 5000 fire scenario 4.

Fire Scenario 5:

Smouldering fire in close proximity to a sleeping area

Description of fire threat:
To address the concern regarding a slow, smouldering fire that causes a threat to sleeping occupants.

Performance objective:
Maintain tenable conditions on escape routes until the occupants have evacuated.

Design event:
Refer to scenario 1 tables for fire characteristics for a smouldering fire.

Performance measure:

- Refer to criteria for 'Occupant Tenability Limits'.

Methodologies:

- Provide automatic smoke detection and no further analysis is required.

Assumptions:

- Active and passive fire safety systems in the building may be assumed to perform as intended by the design.

Applications:

This fire scenario applies to:

- Firecells with sleeping use

Comments:

Originally NFPA 5000, scenario 5 – but with changed emphasis here.

<u>Additional Comments to Work Group</u>

Since we are expecting all buildings designed using this framework to be provided with an automatic fire detection and alarm system – does this mean this senario is actually no longer required?

Fire Scenario 6:

Limit fire exposure to neighbouring property

Description of fire threat:
A large fire within a building may spread to neighbouring buildings as a result of heat transfer (predominantly by radiation through openings in external walls). To reduce the probability of fire spread between neighbouring properties, measures to limit the radiation flux received by the neighbouring building are required.

Performance objective:
Prevent fire spread to other property and adjacent buildings/spaces where people sleep.

Design event:
Use design fire characteristics from scenario 1 to calculate the fire source exposure.

Performance measures:

1. External walls shall be designed to limit the radiation received at a relevant boundary to no more than 30 kW/m² and, to no more than 16 kW/m², at 1m or more beyond a relevant boundary.
2. External walls of buildings, when subjected to the radiant flux of 1) above shall:
    - not ignite (Performance Group IV)
    - not ignite within 30 minutes (Performance Group III)
    - not ignite within 15 minutes (Performance Group I, II)

Methodologies:

1. C/AS1 tabulated data is acceptable – the theoretical basis for the tabulated data in C/AS1 is given in the following paper: *Barnett, C.R. and Wade, C.A. 2002. A Regulatory Approach to Determining Fire Separation between Buildings based on the Limiting Distance Method. Paper presented at the 4th International Conference on Performance Based Codes and Fire Safety Design Methods. Melbourne, Australia. March 2002.*

2. The engineer needs to calculate the fire gas temperatures and the 'emitted radiation' that result from the 'design fire' Heat transfer calculations then need to demonstrate the radiation flux level in performance measure 1. above is not exceeded.

3. Fire tests of external cladding systems using the cone calorimeter apparatus (ISO 5660) or similar demonstrating that performance measure 2 above is met.

Assumptions:

- Fire suppression systems are assumed to be ineffective - is this reasonable?
- Controlling fire spread between buildings is a shared responsibility, and depends both on the radiation emitted from the source building and resistance to ignition provided by the external surfaces of the receiving building.

Applications:
This fire scenario applies to:

- All buildings

Commentary:
The ignition criteria for performance group I and II are same, because the requirement is to limit fire spread to other property – the importance of the other property only matters if a higher level of protection is required.

The above performance measures are the basis of the existing requirements in C/AS1, although the design events differ as they correspond to specific points on the standard time-temperature curve used in fire resistance testing. The existing C/AS1 does not presume sprinkler systems to be fully effective i.e. boundary fire spread requirements still apply to sprinklered buildings (but concessions are permitted).

Could adjust these fluxes upwards for when fire suppression systems are installed

Could delete requirement 2 for PG I – i.e. not worry about ignitability of construction materials provided it does not cause fire spread to neighbour.

Additional Comments to Work Group

Should we also allow a simpler alternative design fire for this scenario described by a time-temperature curve, to match the assumed exposure for C/AS1?

C/AS1 provisions ignore horizontal flame projection from openings, with radiation calcs done using a flat radiator in the plane of the window opening. Can we live with that?

What to do about sprinklered buildings? How do suppression systems affect the design event? In the rare event of a sprinkler failure would it be acceptable to permit fire spread to other property given it is not a life safety issue? If we did that, we could require dual independent water supply. *See the proposed sprinkler failure robustness test described in the proposal at the end of this paper.*

Could adjust the limiting flux upward when fire suppression systems are installed?

Fire Scenario 7:

Fire source external to the building exposing the external wall and leading to significant façade damage and vertical fire spread.

Description of fire threat:
A fire source adjacent to an external wall such as a fire plume emerging from a window opening, or a fire source in close contact with the façade (e.g. rubbish container) that could ignite and spread fire vertically to higher levels in the building.

Performance objective:

- Prevent fire spread to other property and spaces where people sleep (in the same building) and maintain tenable conditions on escape routes until the occupants have evacuated.
- Protect against external vertical fire spread that could compromise the safety of fire-fighters working in or around the building.

Design event:

- PG II & III - Radiant flux of 50 kW/m² impinging on the façade for 15 minutes.
- PG IV - Radiant flux of 90 kW/m² impinging on the façade for 15 minutes.

Performance measure:

1. Prevent façade cladding materials from contributing to flame spread propagation beyond the area initially exposed. Some damage to the area initially exposed will be expected.
2. Limit the vertical flame spread distance (on the facade) to no more than 3.5 m above the flame source. This accepts fire spread via the façade materials may occur to the floor immediately above, but not two floors above.
3. In unsprinklered buildings, prevent fire spread to unprotected areas on upper floors that are within 1.5 m vertically of a window plume fire source.

Methodologies:

1. Follow existing C/AS1 and use:
   a. Large or medium-scale 'façade type' fire tests (eg NFPA 285, ISO 13785, VCT)
   b. Small-scale testing using ISO 5660 or AS/NZS 3837 (cone calorimeter) for homogeneous materials. Limit the maximum HRR from a cladding material to 100 kW/m² when exposed to the design event to ensure flame spread over its surface is unlikely.
2. Use non-combustible materials.
3. Validated flame spread models could be used for some materials.
4. Construction features such as 'aprons' and/or 'spandrels' or 'sprinklers' could be used to meet performance measure 3 above. Window plume characteristics/geometry may be derived from Scenario 1 design fires.

Applications:
This fire scenario applies to:

- Buildings where upper floors contain sleeping occupancies or 'other property'.
- Sprinklered buildings (fire external re-entry at multiple upper levels could defeat sprinkler design) – except performance measure 3.
- Scenario does not apply to PG I buildings.

Commentary:
50 kW/m² is representative of the flux from a window plume projecting from an opening in the façade, although higher fluxes are certainly possible. Current large-scale façade fire tests expose the façade to heat fluxes in the range 50-90 kW/m². C/AS1 allows fire properties of cladding materials to be evaluated at small scale exposing the material to 50 kW/m². Acceptance criteria (say not more than 100 kW/m² peak HRR) is based on achieving a low probability of occurrence of accelerating flame spread over the surface of a combustible cladding. Small-scale testing is not suitable for all materials.

Performance measures 1 and 2 are concerned with the role that combustible claddings play with regard to their contribution to vertical fire spread.

Performance measure 3 addresses functionality that could be provided by aprons, spandrels or sprinklers to prevent external fire spread (due to projecting window fire plumes) between openings at different levels in the building.

This scenario is not concerned with building to building fire spread across a relevant boundary. See Scenario 6.

Fire Scenario 8:

Fire involving interior surface linings & finishes

Description of fire threat:
Flaming fire source located in a wall-corner that ignites room surface lining materials and which subsequently leads to untenable conditions on an escape route.

Performance objective:

- Tenable conditions on escape routes shall be maintained while occupants evacuate.
- Protect against rapid fire spread that could compromise the retreat of firefighters.

Design event:

- Fire source of output 100 kW for 10 minutes followed by 300 kW for 10 minutes, with fire source in contact with a wall-corner element in accordance with ISO 9705.

Performance measure:

1. Flashover shall not occur when surface lining materials and finishes are exposed to the design event, ignoring the effect of any fire suppression or smoke management system that may be present.
2. Performance criteria for lining materials depend on location in the building and occupancy type or performance group.

    a) Time to flashover[1] (under test conditions of ISO 9705) to be not less than 20 minutes and avg. smoke production rate 0 - 20 min < 5 m²/s (applies to exitways; sleeping areas where occupants are detained or under care; and all occupied spaces in PG IV).
    b) Time to flashover (under test conditions of ISO 9705) not less than 10 minutes. and avg. smoke production rate during 0 - 10 min < 5 m²/s (assembly/crowd use spaces; sleeping areas where occupants are not familiar with surroundings).
    c) Time to flashover (under test conditions of ISO 9705) not less than 2 minutes (all other locations, including within household units and detached dwellings).

Expected Methodologies:

1. ISO 9705 room corner fire (e.g. = Building Code of Australia)
2. ISO 5660 cone calorimeter test at 50 kW/m² (e.g. correlated to a full-scale result)
3. Use non-combustible materials
4. Validated flame spread models (if available) could be used for some materials.

Assumptions:

- The main fuel load in exitways is attributed to the materials used to line the walls, ceiling and floor surfaces, while in other spaces the fuel load from the surface linings is usually secondary to the room contents.
- The design event is unaffected by sprinklers.

Applications:
This fire scenario applies to: all buildings, except that the smoke production rate criteria need not apply for sprinklered buildings.

Commentary:
This methodology has been the subject of significant research in Europe and Australia, and more recently here in New Zealand. The current methodology applied in the Building Code of Australia can be adopted as a model. This uses the ISO 9705 method as a reference scenario. AS/NZS 3837 (cone calorimeter) results have been correlated to ISO 9705 and can also be used for most materials. Surface linings are exposed to 100 kW for 10 minutes and then 300 kW for a further 10 minutes and the time to reach flashover (~1MW

[1] In the ISO9705 fire test, 1000 kW (including the burner) is the flashover criteria.

in 3.6 x 2.4 x 2.4 m room) is determined. Materials are classified from Group 1 (best) to Group 4 (worst) based on their measured time to flashover in the fire test.

Group 1 materials = non-combustible or materials with limited combustibility. E.g. plasterboard and similar materials (low hazard) [no flashover in 20 minutes] – these meet the flashover criteria of performance measure 2a above.

Group 2 materials = some fire retardant treated timbers etc [no flashover in 10 minutes] – these meet the flashover criteria of performance measure 2b above.

Group 3 materials = ordinary timber products and similar [no flashover in 2 minutes] – these meet the flashover criteria of performance measure 2c above.

Group 4 materials = exposed polyurethane foams or similar (these are hazardous when installed as room linings and are not acceptable in occupied spaces) [flashover within 2 minutes].

References:

a) Australian Building Codes Board. 2006. Building Code of Australia Specification C.1.10. ABCB, Canberra, Australia.
b) Fire Code Reform Centre. 1998. 'Fire Performance of Wall and Ceiling Lining Materials'. CRC Project 2 – Stage A, Fire Performance of Materials, Project Report FCRC – PR 98-02, Fire Code Reform Research Program (July and September 1998). FCRC, Sydney, Australia.
c) PCR Collier, PN Whiting and CA Wade. 2006. Fire Properties of Wall and Ceiling Linings: Investigation of Fire Test Methods for Use in NZBC Compliance Documents. BRANZ Study Report 160. http://www.branz.co.nz/cms_show_download.php?id=146

Additional Comments to Work Group

Currently scenario does not address floor coverings – I think that for simplicity and (conservatism) floor covering could be treated the same way as wall/ceilings, however this requires further investigation.

PROPOSAL

Structural Fire Resistance Criteria (currently some overlap with firefighter expectations)

1. Prevent fire spread to neighbouring buildings being 'other property. This is covered by Scenario 6, however it may require 'protected areas' of external walls to be provided with fire resistance. Fire resistance is derived from the 'structural design fire'.
2. Prevent fire spread to 'other property' in the same building. In this case fire spread must be prevented for the full duration of the fire and again fire resistance is derived from the 'structural design fire'.
3. Facilitate fire fighting and rescue operations.
   a. In buildings of height not reachable by fire service ladder appliances (say 10 m), provide fire fighters with safe paths allowing access to all levels within the building. Fire resistance of safe paths is derived from the 'structural design fire'.
   b. In buildings of height not reachable by fire service ladder appliances (say 10 m), protect fire fighters and others at ground level and within the building by designing the structure to resist collapse. Fire resistance of the structure is derived from the 'structural design fire'.
   c. In buildings of height accessible by fire service ladder appliances, provide fire fighters with protected routes within the building as necessary, for a sufficient period, to permit search and rescue operations, and avoid unexpected or sudden collapse that would endanger fire service personnel within or near to the building.

The Structural Design Fire

Scenario 1 design fire characteristics will include parameters including the fire load energy density, fire growth rate and heat of combustion, allowing a postflashover structural design fire to be defined.

The engineer can either:
1. construct a HRR vs time structural design fire using these parameters and, taking into account ventilation conditions, use a fire model or energy conservation equations to determine suitable thermal boundary conditions (time/temp/flux) for input to a structural calculation model, or
2. use an 'approved' parametric or time-equivalent formula to calculate the thermal boundary conditions (time/temp) for a structural model or the fire resistance rating directly.

It is expected that the FLED value specified for Scenario 1 would be an 80 or 90 upper percentile value. See attached Table of fire load energy density from Japan including mean and standard deviation.

Sprinklers

Scenario 1 allows the engineer to assume sprinklers or other systems to operate as designed. In the case of a sprinklered building it is proposed that a structural fire analysis for scenario 1 would be unnecessary if the design fire was sprinkler-controlled rather than fully-developed following flashover.

However, we would still require the structural fire resistance criteria to be met using a sprinkler failure robustness test where the FLED value specified for Scenario 1 would be the 50 percentile value (say) instead of the upper 80 or 90%-ile.

The effect of this will be to reduce the duration of the fully developed structural design fire and also to reduce the magnitude of the fire resistance calculated. This would mean in effect, there is a sprinkler trade-off, as is the current situation.

Some further analysis and examples are needed to explore the implications and feasibility of this proposal.

(Extracted from Recommendations on PERFORMANCE BASED FIRE SAFETY DESIGN OF BUILDINGS, Architectural Institute of Japan)

N.1.5 FIRE LOAD DENSITY

Some fire load surveys have been carried out for a certain uses of building spaces[1-4]. The values in Table 1.4 are rounded off from the survey data when they are available. But, the number of buildings and spaces surveyed are very limited. So, the fire load densities for the uses for which surveyed data are not available are presumed from the data for similar spaces.

Reference

1) A research on the standard quantity of combustible for fire resistance design, Building Center of Japan, 1973
2) Nakamura, K. et al. An investigation into quantity of combustible in actual buildings, 1983.
3) Comprehensive design system for building fire safety 4th volume fire protection design, Building Center of Japan, 1989
4) Aburano, T. et al. Survey and analysis on surface area of fire load, Fire Science Technology, Vol.19, No.1, 1999.

Table 1.4 Mean and standard deviation of fire load according to the use of space

Use of building	Use of space	Combustibles density [MJ/m^2]	
		Average density	Standard deviation
Common	Office general office	480	80
	design office	560	120
	administration office	640	120
	Meeting room	160	80
	Reception room	160	80
	Kitchen	240	80
	Auditorium, assembly fixed seating	320	80
	no fixed seating	160	40
	Lobby area with chairs	320	80
	area without chairs	80	20
	Passage corridor	80	40
	stairs	40	20
	entrance hall	80	40
Dwelling house	Bedroom (the storage closet included)	720	160
	Kitchen	320	80
	Living room	480	160
	Dining room	480	160
Hotel, inn	Guest room	160	80
	Assembly room	160	40
	Linen closet	640	160
Retail	Clothing, bedding	320	160
	Furniture	800	240
	Electronic appliance	480	160
	Kitchen, daily commodities	480	80
	Food stuff	320	160
	Jewelry, precious metal	160	80
	Book	800	160
	Supermarket	640	160
	Stock yard	1,600	320
Restaurant	Canteen	160	80
	Restaurant	240	160
	Bar, club, drinking	320	160
Gymnasium	Arena	80	20
	Instrument storage	640	160
Hospital	Sick room	160	80
	Nurse station	320	80
	Exploration room	320	80
	Linen closet	640	160
Theater	Play stage opera, kabuki	320	160
	entertainment, concert	160	80
	Wing stage	320	160
	Stage set warehouse	640	240
	Greenroom	320	80
Education	Classroom	320	80
	Preparation room	480	160
	Staff room Elementary, Highschool	480	120
	University	960	160