# AHC Meeting #7 July 12-13, 2012
# Fire Safety WG Report

## A. 2012 Cycle Approved Code Changes

The following are the **APPROVED** Group A code changes created by the AHC Fire Safety Work Group that were considered at the 2012 Code Development Hearings in Dallas: **G54-12 (AM), G130-12 (AS); M36-12 (AS)**

## B. 2012 Cycle Public Comments

The following are the **DISAPPROVED** Group A code changes created by the AHC Fire Safety Work Group that were considered at the 2012 Code Development Hearings in Dallas: **FS42-12, FS114-12**

Draft suggested public comments have been prepared for these two code changes, as follows:

## CODE CHANGE F42-12 AS SUBMITTED

# FS42 – 12
**710.4**

**Proponent:** John Williams, CBO, Chair, ICC Ad Hoc Committee on Healthcare

**Revise as follows:**

**710.4 Continuity.** Smoke partitions shall extend from the top of the foundation or floor below to the underside of the floor or roof sheathing, deck or slab above or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke. A lay-in ceiling system that is designed to limit the transfer of smoke shall be permitted. Hold-down clips for such ceilings shall not be required where the ceiling tiles will resist an uplifting force of at least one pound per square foot of tile.

**Reason:** This proposal is submitted by the ICC Ad Hoc Committee for Healthcare (AHC). The AHC was established by the ICC Board of Directors to evaluate and assess contemporary code issues relating to hospitals and ambulatory healthcare facilities. The AHC is composed of building code officials, fire code officials, hospital facility engineers, and state healthcare enforcement representatives. The goals of the committee are to ensure that the ICC family of codes appropriately addresses the fire and life safety concerns of a highly specialized and rapidly evolving healthcare delivery system. This process is part of a joint effort between ICC and the American Society for Healthcare Engineering (ASHE), a subsidiary of the American Hospital Association, to eliminate duplication and conflicts in healthcare regulation. Since its inception in April, 2011, the AHC has held 5 open meetings and over 80 workgroup calls which included members of the AHC as well as any interested party to discuss and debate the proposed changes. All meeting materials and reports are posted on the AHC website at: http://www.iccsafe.org/cs/AHC/Pages/default.aspx

Current interpretation of an allowable ceiling system is to be "monolithic." This type of ceiling is not feasible in a hospital setting, because main utility and ductwork lines run in the corridor to keep them out of patient care areas. This would facilitate the need for many access panels which compromise the smoke tight nature of the monolithic ceiling. The construction of the lay-in system would basically mean no open portions or gaps in the ceiling, either as an architectural feature or between items such as louvers. Normal ceiling fixtures such as lights, sprinkler heads, and diffusers and grills (as part of a fully ducted air system) can be considered part of the smoke tight system, as there is no opportunity for smoke to travel straight through them. A tight fitting lay-in grid is defined as one with no gaps in them, which is easily enforced via visual inspection and is therefore simply maintained.

The one pound per square foot weight can handle an updraft concerns because a facility equipped with QRS sprinklers will not generate enough heat to cause the updraft to move the tile. Hold-down clips in this instance would not be necessary, as the weight of the tile itself would be sufficient. Due to the need for access to above ceiling utilities, hold-down clips would interfere with maintenance and operations, which is why an updraft limitation is considered.

Since a fully ducted air handling system is required in the I-2 hospital occupancy, plenum ceilings that compromise the ceiling system are already prohibited.

**Cost Impact:** The code change proposal will not increase the cost of construction.

**FS42-12**

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|---|---|---|---|---|
| Public Hearing: | Committee: | AS | AM | D |
| | Assembly: | ASF | AMF | DF |

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## REPORT OF HEARING FOR FS42-12

**Committee Action:** **Disapproved**

**Committee Reason:** The committee was concerned about enforceability of this proposal. For example, it is not clear how the minimum uplift force is measured. Further, it is not clear how the code official determines if a lay in ceiling limits the transfer of smoke. Lastly, the committee felt that this requirement should be limited to Group I-2 occupancies consistent with the proponent's reason statement.

**Assembly Action:**

**None**

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## SUGGESTED PUBLIC COMMENT

# FS42-12
**710.4**

*Individual Consideration Agenda*

**This item is on the agenda for individual consideration because a public comment was submitted.**

*Public Comment:*

**Name:** John Williams, CBO, Chair, ICC Ad Hoc Committee on Healthcare

**Modify the proposal as follows:**

**710.4 Continuity.** Smoke partitions shall extend from the top of the foundation or floor below to the underside of the floor or roof sheathing, deck or slab above or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke. In Group I-2 hospitals a lay-in ceiling system that is designed to limit the transfer of smoke shall be permitted. Hold-down clips for such ceilings shall not be required where the ceiling tiles will resist an uplifting force of at least one pound per square foot of tile.

**Commenter's Reason:** In response to the committee concerns regarding this proposal, the enforceability of this proposal is accomplished by simple visual inspection for any noticeable gaps in the ceiling membrane. Visual inspection can be done by routine maintenance rounds or even by any staff member in the area. Any gap around light fixtures, sprinkler heads, ducted air registers or similar would constitute

breach of the membrane, and visual inspection can be accomplished without use of ladders, removing ceiling tiles, or opening access hatches. The ceiling assembly is consistent with UL design number J201, which provides for an alternate between hold-down clips and a one-pound per square foot tile weight. This is also consistent with the findings of NBSIR 81-2444 *Smoke Movement Through A Suspended Ceiling System* (by John H Klote, 1982, NBS/VA). During plan review, a cut sheet of the desired ceiling tile (readily available from any manufacturer) can be included in the review package or the one pound per square foot criteria can be listed in the specifications. Also, in response to the concerns of the committee, this proposal is amended to include Group I-2 hospital occupancies only.

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## CODE CHANGE FS114-12 AS SUBMITTED

# FS114 – 12
### 717.5.5 (IMC 607.5.4)

**Proponent:** John Williams, CBO, Chair, ICC Ad Hoc Committee on Healthcare

**Revise as follows:**

**717.5.5 (IMC 607.5.4) Smoke barriers.** A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *smoke barrier*. *Smoke dampers* and *smoke damper* actuation methods shall comply with Section 717.3.3.2.

**Exceptions:**

1. *Smoke dampers* are not required where the openings in ducts are limited to a single smoke compartment and the ducts are constructed of steel.
2. Smoke dampers are not required in ambulatory care facilities and Group I-2 hospital occupancies where the HVAC system is fully ducted in accordance with Section 603 of the *International Mechanical Code* and where buildings are equipped throughout with an automatic sprinkler system in accordance with Sections 903.3.1.1 and equipped with quick response sprinklers in accordance with Section 903.3.2.

**Reason:** This proposal is submitted by the ICC Ad Hoc Committee for Healthcare (AHC). The AHC was established by the ICC Board of Directors to evaluate and assess contemporary code issues relating to hospitals and ambulatory healthcare facilities. The AHC is composed of building code officials, fire code officials, hospital facility engineers, and state healthcare enforcement representatives. The goals of the committee are to ensure that the ICC family of codes appropriately addresses the fire and life safety concerns of a highly specialized and rapidly evolving healthcare delivery system. This process is part of a joint effort between ICC and the American Society for Healthcare Engineering (ASHE), a subsidiary of the American Hospital Association, to eliminate duplication and conflicts in healthcare regulation. Since its inception in April, 2011, the AHC has held 5 open meetings and over 80 workgroup calls which included members of the AHC as well as any interested party to discuss and debate the proposed changes. All meeting materials and reports are posted on the AHC website at: http://www.iccsafe.org/cs/AHC/Pages/default.aspx

Duct smoke dampers at smoke barrier walls in facilities fully protected with electronically supervised, tested and maintained quick response automatic sprinkler systems should be omitted from the I-codes, have not been required by other model codes and have shown a history of success without the additional dampers. In preparation for this proposal the AHC asked Rolf Jensen & Associates (RJA) to review and provide comments on the "Smoke Damper Evaluation for Air Movement & Control Association International, Inc." analysis and dated May 14, 2010. A copy of their summary can be found at www.iccsafe.org.

The supporting information, summarized by RJA for the AHC, describes information gathered in the years since quick response sprinklers (QRS) have been deployed. Untenable conditions are typically measured in amount of heat, obscuration of exit signs, and carbon monoxide levels. The studies summarized these conditions taking approximately 2 hours to 2-1/2 hours to reach untenable levels. Considering non-smoking policies in hospitals, use of Class A materials, and overall reduction of items to fuel a fire, it is highly unlikely to reach the constant burning levels noted in the study. However, even if judged in those timeframes noted in the report, the actual responder timeframe should enter into the equation. The following summarizes emergency responder timeframes:

Alarm is sounded, either by manual pull by the staff or by the automatic smoke detection system (most likely an addressable system)

- Staff employs defend-in-place method, which includes shutting doors to the origin of the fire and relocating patients out of the immediate area (i.e. to the other side of the compartment smoke barrier)

- Within 10 minutes of alarm, the fire department arrives
- In the context of the fire response, doors are opened by the fire department to find the source of the fire. These are the doors that automatically closed upon initiation of the alarm. Any mechanical system is now out of the equation, because of the active use of the doorways in the fire response, or if needed, the patient movement away from the room of origin.

In conclusion, the meaningful time of the fire protection of the building occurs in the first 30 minutes of the fire incident, when decisions are made by fire professionals and the safety staff of the hospital in terms of status of the patients. Quick response sprinklers are more often noted as the most important feature of the overall building fire protection system, and are demonstrated to be effective in containing spread of the fire than dampering of the duct system.

Please note that this proposal deals only with smoke zone barrier walls. It is not proposed to change the requirement for these dampers at shafts or at the air handler units.

The RJA comments are as follows:

Evaluations of recent automatic sprinkler performance data and smoke movement analysis report for smoke dampers revealed the following:

1. In 3,750 fires reported over the years of 2003 – 2006 in hospitals, mental health and substance abuse facilities; one civilian death was recorded. That individual was within the room of fire origin within a mental health facility and started the fire.
2. The overwhelming majority (i.e. 97+%) of fires within these facilities did not extend beyond the room of origin, despite having an automatic suppression system present in only 57% of reported fires.
3. Automatic sprinkler protection in a hospital has higher reliability and better performance than other occupancies. In over 1,600 fires in hospitals spanning 2003 - 2006, when sprinklers were present and the fires were large enough to activate an automatic suppression system, those systems showed a 97% operational reliability and were effective 100% of the time.
4. The requirements for electronically supervised hydraulically designed automatic sprinkler system increases the system reliability
5. Properly documented testing and maintenance improves the reliability of these systems. CMS holds healthcare facility operators accountable for the testing and maintenance requirements of NFPA 25. Verification of this documentation and maintenance records are checked every 1 to 3 years.
6. Tenable conditions are present in the smoke movement analysis for sprinklered buildings with or without smoke dampers.
7. Tenable conditions in non sprinklered configurations can be maintained for test fire duration of 30 minutes beyond room of origin.

Due the required automatic system design requirements, the limited smoke movement in a fully sprinklered building, required testing and maintenance of these suppression systems, the omission of smoke dampers is justified. There are still multiple safeguards to protect the building occupants from a multiple loss of life fire.

The use of smoke dampers between smoke zones in hospitals protected with Quick Response automatic Sprinklers (QRS) is being evaluated based on the reports of fire outcomes in hospitals; automatic sprinkler system reliability, performance, and effectiveness; and an assessment of previous smoke movement work in non sprinklered configurations.

NFPA issued an updated report on automatic sprinkler performance in two different reports [(1)(2)]. The reported data has been reviewed and evaluated for hospital facilities when possible. The failure modes will be reviewed and addressed based on current Building Code and Fire Code requirements.

Jennifer Flynn's report [(2)] shows there were 3,750 fires reported to have occurred over the years of 2003 – 2006 in hospitals, mental health, substance abuse and medical office type facilities. In all those fires, one fatality was reported, and that fatality occurred within the room of fire origin. That one fatality occurred as a result of a mental health patient using flammable liquids and igniting the mattress and other materials within his room.

Of reported 2003-2007 structure fires in health care properties, an estimated 57% showed sprinklers present, with higher percentages for hospitals (71%) and nursing homes (65%) and a much lower percentage for clinics and doctor's offices (28%). Sprinklers were also reported as present in half or more of all reported fires in laboratories (60%), manufacturing facilities (52%), theaters (50%), and prisons and jails (50%). In every other property use, more than half of all reported fires had no sprinklers.

Hospitals have the highest percentage of automatic sprinklers present in all the occupancies analyzed in this report. Despite suppression systems being present in only
57% of health care properties where fires were reported, those fires only extended beyond the room of origin in less than 3 percent of all reported fires. This can be directly attributed to the **R.A.C.E.** training medical staff are mandated to receive annually. The **C** in RACE relates to *confining* the fire. More simply, medical staff are trained to close the doors in rooms where fires ignite, after they **R**escue patients near the fire origin and **A**lert others of the presence of the fire.

For most property use groups and most types of automatic extinguishing equipment, the majority of reported fires were too small to activate operational equipment.
When automatic extinguishing equipment was present, the percentages of fires too
small to activate operating equipment, based on overall reported structure fires, were as follows:

- 65% for all sprinklers,
- 65% for wet pipe sprinklers,
- 70% for dry pipe sprinklers,
- 61% for dry (or possibly wet) chemical systems,
- 43% for carbon dioxide systems,
- 66% for foam systems, and
- 59% for halogen systems.

Sprinklers in the area of fire failed to operate in only 7% of reported structure fires large enough to activate sprinklers. Based on Table A [(1)] , non confined fires larger than the sprinkler design area happened less than 2.0 % of the total non-confined and confined structure fires for healthcare buildings. These fires may affect a large part of a smoke compartment but they rarely happen.

Table 3A [(1)] indicates the percentage of effective operation of sprinklers in 620 fires large enough for sprinkler activation at 87% in all healthcare related facilities. The Flynn report breaks this down by type of healthcare facility. Where sprinklers were present and the fire was large enough to operate the sprinklers in hospitals alone, sprinklers were effective 100 percent of the time.

The assessment of automatic sprinkler failures are summarized in Table 4A [(1)]. However, healthcare or hospitals are not separated as an occupancy type.

| | |
|---|---|
| The System turned off reas | 53% |
| 2. Inappropriate suppression system | 20% |
| 3. Lack of Maintenance | 15% |
| 4. Manual intervention | 9% |
| 5. System component damages | 2% |

In new and existing hospitals, the automatic sprinkler systems require electronic supervision. This supervision will typically address the major (53%) reason for system failure. This analysis is limited to hospitals. Automatic water based suppression is the appropriate means to control fires in this healthcare occupancy. This addresses 20% of the documented failures. Automatic water based suppression systems are required for all new hospitals and all renovations over 4000 square feet. 73%of the failures are addressed by electronically supervised automatic sprinkler systems.

Lack of maintenance is addressed by the CMS enforcement which ensures facilities follow NFPA 25. Existing healthcare facilities are required to document the NFPA 25 inspection, testing and maintenance on all water based suppression systems. Through contracts with state public health and fire marshal's offices that direct periodic surveys, CMS ensures that the needed inspection, testing and maintenance is provided in health care facilities. This work will also identify damaged system components. The required testing and maintenance and damage will address 17% of the documented failures.

Manual intervention is a fire service function. Standard operating procedures recommend determining the fire no longer poses a threat before shutting the system down.

The Hall report [(1)] also notes reasons for ineffectiveness of systems. This category addresses the effectiveness of a system not the failure. These systems still operated but not at the design intent. These have 2 major categories. Extinguishing agent did not reach the fire and not enough extinguishing agent available.

Shielded fires are the first category. These can be addressed by proper design. Small shielded fires under tables or beds are within the design parameters of a NFPA 13 compliant sprinkler system. Missing areas under duct work or within storage racks are the typical issues in this category. These types of items, if missed in the initial design and installation, should be identified in the ongoing testing and maintenance required by NFPA 25.

Insufficient extinguishing agent addresses inadequate water supply and partially closed valves. Proper maintenance and testing will identify a deteriorating water supply. The electronic supervision required for the hospital sprinkler system will send a trouble alarm to the fire alarm panel for partially closed control valves.

The hydraulically designed, electronically supervised, and regularly tested and maintained automatic sprinkler system is substantially more reliable than the current performance data indicate. Fire loss data also shows there has not been a documented multiple loss of live fire due to fire in a fully sprinklered building.

This sprinkler system analysis was done to evaluate the current data and how it relates to hospitals and demonstrates that the probability of a catastrophic failure of the required sprinkler system is remote. The biggest influence on the automatic sprinkler performance is the fire services for a properly designed, installed and maintained sprinkler system.

**SMOKE DAMPER EVALUATION – ADDITIONAL CONSIDERATIONS**

This portion of the reason statement evaluates an analysis prepared by Koffel Associates, Inc. (KA) titled "Smoke Damper Evaluation for Air Movement & Control Association International, Inc." and dated May 14, 2010. The purpose of our evaluation is to closely examine the details, assumptions, and conclusions related to the KA analysis to quantify the severity of hazardous conditions expected given the smoke spread predicted in the analysis for the scenarios with and without smoke dampers.

The KA analysis utilized a CONTAM computer model to predict smoke movement throughout a representative building under various conditions. The primary variables considered in this comparative analysis were whether the fire was sprinklered or unsprinklered and whether smoke dampers were included or omitted from the model. Data from a study titled "Fire Experiments of Zoned Smoke Control at the Plaza Hotel in Washington DC" by John H. Klote at the National Institute of Standards and Technology (NIST), 1990, was used as a basis for modeling smoke in the CONTAM model. Specifically, the KA analysis assumed a smoke concentration of $5.66 \times 10^{-5}$ lb/ft$^3$ in the compartment of origin for the unsprinklered fire scenario and a concentration of $1.89 \times 10^{-6}$ lb/ft$^3$ for the sprinklered fire scenario which is reportedly based on the fire test data contained in the Klote study.

The Klote study involved real fire tests conducted in the Plaza Hotel, a seven-story masonry structure. The Plaza Hotel tests were intended to evaluate the effectiveness of zoned mechanical smoke control systems. While not specified in the KA analysis, it appears that data from Plaza Hotel Test 1 and/or Test 5 was used for the unsprinklered fire scenario and data from Test 10 was used for the sprinklered fire scenario. Each of these three fire tests involved burning a 300 lb wood crib in a second floor corridor of the Plaza hotel with no mechanical smoke control systems active and all windows closed. Table 1 and Table 2 below summarize the select relevant data presented in the Klote study and KA analysis. This data shows movement away from the area of fire origin with and without smoke dampers installed in the model.

**Table 1: Klote Study Results**

| | Tests 1 and 5 | Test 10 |
|---|---|---|
| Fuel Load | 300 lb Wood Crib | 300 lb Wood Crib |
| Test Duration | 30 min | 30 min |
| Sprinkler Interaction | No Sprinklers | Quick Response Sprinkler above Wood Crib |
| Peak Optical Density on Fire Floor (Fig. 24, 25) | 3 $m^{-1}$ @ 4 $mins^{1}$ | 0.1 $m^{-1}$ @ 3 mins |
| Peak CO Concentration on Fire Floor (Fig. 21) | ~6,000 ppm | ~200 ppm |

The maximum optical density from Tests 1 and 5 was not reported in the Klote study. This optical density value is estimated based on the CO concentrations, which show a factor of 30 differential between the sprinklered and unsprinklered fire scenarios. This factor of 30 was applied to the maximum optical density value that was reported in the sprinklered fire test (Test 10). This assumption matches the KA analysis which assumed a smoke concentration for the unsprinklered fire scenario that was approximately 30 times the sprinklered scenario.

**Table 2: KA Analysis Results**
**Smoke Concentration on Non-Fire Floor**
(presented as % of smoke concentration on Fire Floor)

| | Smoke Dampers | Without Smoke Dampers |
|---|---|---|
| 5 Story Building @ 30 mins | 1.37% | 25.05% |
| 5 Story Building @ 1 hour | 2.51% | 40.33% |
| 5 Story Building @ 12 hours | 7.78% | 64.28% |
| 50 Story Building @ 30 mins | 0.11% | 2.88% |
| 50 Story Building @ 1 hour | 0.21% | 5.21% |
| 50 Story Building @ 12 hours | 0.69% | 15.15% |

The most severe conditions on the non-fire floor predicted by the KA analysis consider a 5 story building, no smoke dampers, and a constant smoke concentration on the fire floor over a 12-hour period. This scenario predicted that after 12 hours, the conditions on the non-fire floor, in terms of smoke concentrations, would be 64.28% of the conditions on the fire floor. After 30 minutes of constant conditions on the fire floor, the non-fire floor smoke concentration is 25.05% of that on the fire floor.

It should be noted that the assumption of constant peak smoke conditions for an extended period of time (as much as 12 hours) on the fire floor is extremely conservative. The Klote study data is based on a 30 minute test duration where the peak smoke concentrations (obscuration and CO concentrations) occur at one particular instance during the 30 minute test. Further, a fire burning at a constant rate over a 12 hour period of time would necessitate a fuel load to support such a fire. The most densely packed storage occupancies have fuel loads approaching only 3 or 4 hours.

The KA assumption is particularly conservative when considering the sprinkler controlled fire where Klote's study indicates that the fire in Test 10 was extinguished about 7 minutes after fire ignition. Klote's study also indicates that for the unsprinklered fires (Tests 1 and 5) the heat release rate of the fire decreased due to low oxygen levels after approximately 15 minutes as can be seen by the reduction in temperature shown in Figure 12 of the Klote study. So, maintaining a constant fire burning rate over a 30- minute duration is unlikely and is a very conservative assumption, especially in a building like hospitals that is occupied 24/7 by alert staff.

The following tables are intended to assess the degree of tenable conditions that may be present on the non-fire floor (for cases with and without smoke dampers) considering the referenced data from the Klote's study and the smoke concentration modeling performed in the KA analysis. The data in Table 3 is based on the CONTAM model results for the 5 story building only, which was the most challenging building configuration in terms of smoke concentrations on the non-fire floor.

**Table 3: Tenability Analysis- Sprinklered Fire Scenario**

| **Klote Test 10 (Sprinklered Fire)** | | |
|---|---|---|
| Peak Optical Density (D) on Fire Floor (Fig. 24, 25) | 0.1 $m^{-1}$ @ 3 mins | |
| Peak CO Concentration on Fire Floor (Fig. 21) | ~200 ppm | |
| Calculated Visibility Based on Optical Density[1] | 34.8 m (lighted sign) | |
| | | |
| | **With Smoke Dampers** | **Without Smoke Dampers** |
| Predicted CO Concentration on Non-Fire Floor at 30 mins | 200 ppm * 1.37% = **3 ppm** | 200 ppm * 25.05% =**50 ppm** |
| Predicted Visibility on Non-Fire Floor at 30 mins | 34.8 m / 1.37% = **2538 m** | 34.8 m / 25.05% = **138 m** |
| Predicted CO Concentration on Non-Fire Floor at 1 hour | 200 ppm * 2.51% = **5 ppm** | 200 ppm * 40.33% =**81 ppm** |
| Predicted Visibility on Non-Fire Floor at 1 hour | 34.8 m / 2.51% =**1385 m** | 34.8 m / 40.33% = **86 m** |
| Predicted CO Concentration on Non-Fire Floor at 12 hours | 200 ppm * 7.78% =**16 ppm** | 200 ppm * 64.28% =**129 ppm** |
| Predicted Visibility on Non-Fire Floor at 12 hours | 34.8 m / 7.78% =**447 m** | 34.8 m / 64.28% =**54 m** |

[1] The optical densities (D) reported in the Klote Study were converted to light extinction coefficients (K) by K=2.3D and visibilities (V) were calculated to light-emitting (exit) sign by V-8/K.

**Table 4: Tenability Analysis- Unsprinklered Fire Scenario**

| **Klote Tests 1 and 5 Data (Unsprinklered Fire )** | | |
|---|---|---|
| Peak Optical Density (D) on Fire Floor (Fig. 24, 25) | 3 $m^{-1}$ @ 4 min | |
| Peak CO Concentration on Fire Floor (Fig. 21) | ~6,000 ppm | |
| Calculated Visibility Based on Optical Density [1] | 1.2 m (lighted sign) | |
| | | |
| | **With Smoke Dampers** | **Without Smoke Dampers** |
| Predicted CO Concentration on Non-Fire Floor at 30 mins | 6,000 ppm * 1.37% =**83 ppm** | 6,000 ppm * 25.05% =**1503 ppm** |
| Predicted Visibility on Non-Fire Floor at 30 mins | 1.2 m / 1.37% = **84.7 m** | 1.2 m / 25.05% = **4.6 m** |
| Predicted CO Concentration on Non-Fire Floor at 1 hour | 6,000 ppm * 2.51% =**151 ppm** | 6,000 ppm * 40.33% =**2420 ppm** |
| Predicted Visibility on Non-Fire Floor at 1 hour | 1.2 m / 2.51% =**46.2 m** | 1.2 m / 40.33% = **2.9 m** |
| Predicted CO Concentration on Non-Fire Floor at 12 hour | 6,000 ppm * 7.78% =**467 ppm** | 6,000 ppm * 64.28% =**3857 ppm** |
| Predicted Visibility on Non-Fire Floor at 12 hour | 1.2 m / 7.78% =**14.9 m** | 1.2 m / 64.28% =**1.8 m** |

[1]The optical densities (D) reported in the Klote Study were converted to light extinction coefficients (K) by K=2.3D and visibilities (V) were calculated to light-emitting (exit) sign by V=8/K.

The KA analysis discusses tenability on the non-fire floor in terms of visibility through smoke. A tenability performance criterion of approximately 10 meters (30 feet) is cited by the KA analysis as a commonly used value. While this visibility criterion is within ranges of visibility criteria for general building applications presented by The SFPE Handbook, 4th edition (Section 2, Chapter 4) Table 2-4.3, a lower criterion of 4 meters is suggested for healthcare occupancies where patients and staff are familiar with their surroundings and egress paths are typically defined by small rooms and corridors as opposed to large open

spaces where greater visibility is necessary. Table 2-4.2 of the SFPE Handbook suggest a visibility threshold of 4 meters to allow safe escape when occupants are familiar with their surroundings.

Although not referenced in the KA analysis, tenability is also often measured in terms of carbon monoxide (CO) concentrations. CO is a measure of the toxicity of smoke that occupants are exposed to during evacuation. Carbon monoxide (CO) causes the formation of carboxyhemoglobin in the bloodstream when it is being breathed in the air during exposure. This relationship between exposure time and the concentration of carbon monoxide is dynamic, varying based upon the varying concentrations of CO within the surroundings and the physical condition of the individual. A more detailed discussion of the formation of carboxyhemoglobin can be found in the SFPE Handbook, 4th edition (Section 2, Chapter 6). Figure 2-6.14 of the SFPE Handbook indicates that occupant exposure with an at rest respiratory rate to a carbon monoxide concentration of 2,000 parts per million (ppm) can be experienced for 30 minutes before incapacitation occurs. Based on this relationship between exposure time and concentration, a conservative tenability criterion for carbon monoxide concentrations of 2000 ppm is suggested.

Based on the tenability criteria of 4 meters for visibility and 2000 ppm for CO concentrations, the data in the Klote study for the sprinklered fire indicates that conditions were tenable on the fire floor during the 30 minute fire test as the minimum visibility was measured to be 34.8 meters to a lighted exit sign and a maximum CO concentration of approximately 200 ppm. If the conditions on the fire floor are tenable, then any lower concentrations of smoke on non-fire floors, as predicted by the KA analysis, will also be tenable. This suggests that for sprinkler controlled fires, tenable conditions will be maintained on the non-fire floor, regardless of whether smoke dampers are installed, when considering the assumptions contained in the KA analysis. This is further supported by a study performed by Notarianni, "Measurement of Room Conditions and Response of Sprinklers and Smoke Detectors During a Simulated Two- Bed Hospital Patient Room Fire", NISTIR 5240, 1993 which assessed performance of sprinklers and smoke detectors in typical hospital room configurations. This study concluded that in all tests, with one exception, the sprinklers actuated in the room of fire origin before the patient's life would be threatened. The one exception was the shielded fire test where the sprinklers activated after untenable conditions were reached in the patient room. This study supports the assertion that in most cases sprinklers will activate and control further growth of the fire before untenable conditions are reached in the room of origin. Therefore, the sprinklers help to control the spread of untenable conditions throughout the building.

The results of for the unsprinklered fire scenario in Table 4 above show a minimum visibility on the non-fire floor of 4.6 meters to a lighted exit sign and a maximum CO concentration of 1503 ppm after 30 minutes of constant peak conditions on the fire floor. Based on the tenability criteria cited above of at least 4 meters of visibility and a maximum CO concentration of 2000 ppm, the conditions after 30 minutes for the unsprinklered fire scenario can also be considered tenable. It should be noted that the lowest visibility conditions in the Klote study occurred no earlier than 4 minutes after fire ignition and the maximum CO concentrations occurred no earlier than 15 minutes after fire ignition. The KA analysis for the 30 minute exposure assumes these most severe conditions on the fire floor from fire ignition (time zero) which indicates that tenable conditions should be maintained on the non-fire floor for more than 30 minutes after fire ignition when considering the delay in the Klote tests from ignition to when the most severe conditions occur in on the fire floor.

For the 1991 edition of NFPA 101, the Subcommittee on Health Care Occupancies performed studies that evaluated the benefits of healthcare occupancies when provided with a fully automatic sprinkler system and quick response sprinkler heads. All new Group I-2 buildings are required to be provided with a fully automatic sprinkler system and QRS. The studies discussed and mentioned above provide further scientific documentation that sprinklers are a more than effective means of mitigating the transfer of smoke beyond smoke compartment walls, as was discussed over twenty years ago.

Additionally, the requirements for interior finishes, decorative materials, mattresses, upholstered furniture, decorative vegetation and other decorative furnishings have become more restrictive in the past twenty years as well. Test standards have been developed to further quantify statistical information regarding the flame spread and smoke development of each of these above items. With these added restrictions within Group I-2 occupancies, the flame spread and smoke development ratings of these have assisted in the reduction of a greater potential event.

This review and analysis of previous fire tests, studies, and performance data provides a basis for justification to omit smoke dampers in new I-2 healthcare facilities. The performance of a building without automatic sprinkler protection has many variables to consider. The analysis above does look at typical non sprinklered scenarios and shows acceptable performance for at least the first 30 minutes. Emergency responders will be on site to assist the staff in a fire response. The recent fire records in healthcare facilities both sprinklered and non sprinklered show an ability to protect the person not intimate with a fire.

Bibliography


(1) *U.S. Experience with Sprinklers and Other Automatic Fire Extinguishing Equipment*, John R. Hall, Jr. P.E. PhD, National Fire Protection Association, 2010

(2) *Structure Fires in Medical, Mental Health, and Substance Abuse Facilities*; Jennifer D. Flynn; National Fire Protection Association; February 2009


**Cost Impact:** The code change proposal will reduce the cost of construction and will eliminate on-going maintenance costs.

## FS114-12

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| Public Hearing: | Committee: | AS | AM | D |
| | Assembly: | ASF | AMF | DF |

# REPORT OF HEARING FOR FS114-12

# FS114-12

**Committee Action:** **Disapproved**

**Committee Reason:** The committee disapproved this proposal based on the following reasons: Ambulatory care facilities should not be included as they have less restrictive parameters than an I-2, such as construction type; removing dampers from the complete HVAC system, even if it is fully ducted, is too broad and would rely too heavily on the sprinkler system performance; and the scope is too broad and should be limited to patient care areas.

**Assembly Action:** **None**

## SUGGESTED PUBLIC COMMENT

# FS114-12
**717.5.5 (IMC 607.5.4)**

*Individual Consideration Agenda*

**This item is on the agenda for individual consideration because a public comment was submitted.**

*Public Comment:*

**Name:** John Williams, CBO, Chair, ICC Ad Hoc Committee on Healthcare

**Modify the proposal as follows:**

**717.5.5 (IMC 607.5.4) Smoke barriers.** A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *smoke barrier*. *Smoke dampers* and *smoke damper* actuation methods shall comply with Section 717.3.3.2.

**Exceptions:**

1. *Smoke dampers* are not required where the openings in ducts are limited to a single smoke compartment and the ducts are constructed of steel.
2. Smoke dampers are not required in ~~ambulatory care facilities and~~ Group I-2 hospitals ~~occupancies~~ *smoke barriers* required by Section 407.5 where the HVAC system is fully ducted in accordance with Section 603 of the *International Mechanical Code* and where buildings are equipped throughout with an *automatic sprinkler system* in accordance with Sections 903.3.1.1 and equipped with quick response sprinklers in accordance with Section 903.3.2.

**Commenter's Reason:** This public comment responds to the committee's stated concerns and clarifies that the omission of smoke dampers is limited to smoke barriers that create smoke compartments as required by IBC Section 407.5. Smoke dampers will remain in vertical shaft walls, floor and ceiling penetrations and other spaces that serve as vertical shafts in both patient and non-patient care areas.

## C. Group B Code Change Draft for K-tag K20

International Code Council
Ad Hoc Committee for Healthcare
Fire Safety Work Group

Proposed Code Change
by Jeff O'Neill – June 6, 2012

**Purpose:** To clarify the allowable hazards in atria located in hospital and ambulatory care occupancies. This change addresses K-20.

**Relevant Code Section(s):** 2012 IFC: Chapter 11 – Section 1103 – FIRE SAFETY REQUIREMENTS FOR EXISTING BUILDINGS – Paragraph 1103.4.1 Vertical Openings, Group I Occupancies

Proposed Change Language (in underline):

**Revise as follows:**

**1103.4.1 Group I occupancies.** In Group I occupancies, interior vertical openings connecting two or more stories shall be protected with 1-hour fire-resistance-rated construction.

> **Exception:** In Group I-2 hospital occupancies that are equipped throughout with an automatic sprinkler system, atriums connecting two or more stories need not be protected with 1-hour fire-resistance-rated construction where all of the following conditions are met:
>
> 1. Opening protectives are not required between the atrium and the adjoining spaces provided such spaces are accounted for in the design of a smoke control system in accordance with Section 909.
>
> 2. Glass walls and non-operating windows are permitted where an automatic sprinkler system is installed in accordance with Section 404.6 of the *International Building Code*.
>
> 3. The atrium shall contain only low or ordinary fire hazard uses.

**Reason:** The intent of this code change is to clarify the allowable use and construction of atria in hospitals. This adds language to clarify the fire hazard class allowed in the existing atrium (no higher than ordinary), as opposed to only low hazard class in new. A smoke control system is also acknowledged as a factor when it comes to separation of the atrium, and clarifies that the smoke control system's engineering analysis must account for any spaces open to it.

Glass walls points back to the language in the IBC in an attempt to set that as a minimum, retroactive standard. It is far simpler to address a potential deficiency with addition of a smoke control system or properly installed sprinklers at glass, rather than reconstructing the walls themselves.

This proposal would make the IFC consistent with federal standards that are in place to maintain hospitals, and therefore would not represent an increase in cost.

This proposal is submitted by the ICC Ad Hoc Committee for Healthcare (AHC). The AHC was established by the ICC Board of Directors to evaluate and assess contemporary code issues relating to hospitals and ambulatory healthcare facilities. The AHC is composed of building code officials, fire code officials, hospital facility engineers, and state healthcare enforcement representatives. The goals of the committee are to ensure that the ICC family of codes appropriately addresses the fire and life safety concerns of a highly specialized and rapidly evolving healthcare delivery system. This process is part of a joint effort between ICC and the American Society for Healthcare Engineering (ASHE), a subsidiary of the American Hospital Association, to eliminate duplication and conflicts in healthcare regulation. Since its inception in April, 2011, the AHC has held 5 open meetings and over 80 workgroup calls which included members of the AHC as well as any interested party to discuss and debate the proposed changes. All meeting materials and reports are posted on the AHC website at: http://www.iccsafe.org/cs/AHC/Pages/default.aspx

## D. Group B Code Change Draft for K-tag K71

International Code Council
Ad Hoc Committee for Healthcare
Fire Safety Work Group

Proposed Code Change
by Jeff O'Neill – ~~June 6, 2012~~ Revised June 13, 2012

**Purpose:** To clarify the restrictions on chutes in hospital and ambulatory care occupancies. This change addresses K-71.

**Relevant Code Section(s):** 2012 IFC: Chapter 11 – Section 1103 – FIRE SAFETY REQUIREMENTS FOR EXISTING BUILDINGS – Paragraph 1103.4 Vertical Openings

Proposed Change Language (in underline):

### PROPOSED REVISED CODE CHANGE DRAFT FOR K-TAG K71

**1103.4.8 Trash and Linen Chutes** In Group I-2 hospital occupancies, ~~any~~ existing trash and linen chutes shall ~~have~~ comply with Sections 1103.4.8.1 through 1103.4.9.5.

**1103.4.8.1 Enclosure.** Chutes shall be protected by 1-hour fire-resistance-rated construction. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a fire protection rating of not less than1-hour.

**1103.4.8.2 Chute access.** Where access to chutes is direct from a corridor, the access openings shall be equipped with an opening protective in accordance with Section 716 of the *International Building Code* and have a fire protection rating of not less than1-hour.

**1103.4.8.3 Automatic sprinkler system.** Chutes shall be equipped with an *approved automatic sprinkler system* ~~per~~ in accordance with Section 903.2.11.2.

**1103.4.8.4 Termination rooms.** Chutes shall terminate in a dedicated trash or linen collection room used for no other purpose. Such rooms shall be separated

from the remainder of the building by 1-hour fire-resistance-rated. Opening protectives shall be in accordance with Section 716 of the *International Building Code*.

**1103.4.8.5 Chute bottom protection.** The bottom of chutes shall be equipped with a self-closing or automatic-closing 1-hour opening protective in accordance with Section 716 of the *International Building Code*.

**1103.4.9 Flue-fed incinerators.** The continued use of existing flue-fed incinerators is prohibited. Existing flue-fed incinerator rooms and associated flue shafts shall be protected with 1-hour fire-resistance-rated ~~fire rated~~ construction and have no other vertical openings connected with the space other than the associated flue. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a fire protection rating of not less than1-hour.

**Reason:**

(Insert Ad hoc Intro Statement)

The intent of this code change is to clarify the allowable use and construction of chutes and incinerators hospitals. These items are still used as an integral part of the operation of a hospital, especially the trash or linen chutes. Some incinerators are still in use, but this proposed requirement seeks to separate them from other vertical openings, especially a trash chute by requiring a separate discharge room from the incinerator. Most incinerators are not in use or otherwise abandoned in existing facilities, due to other regulation from entities such as the EPA, and this requirement seeks to separate and protect any potential hazard from the rest of the building.

This proposal would make the IFC consistent with federal standards that are in place to maintain hospitals, and therefore would not represent an increase in cost.

## Questions/Things to Ponder

1. Should ambulatory care be included?

2. Should it be sent to CTC-Care for their consideration to co-sponsor (i.e., make it applicable to all I-2's)?

3. Compare the termination room requirements to IBC Table 509 in both the 2012 and as it was revised in the current code change cycle by G130-12. IFC Chapter 11 requirements cannot be more stringent than IBC new building requirements in Section 713.13.

Some concern has been expressed by interested parties that Section 1103.4.8.5 may be too restrictive for existing buildings or that such doors may not be listed. Collaboration is on-going on this issue.