Alcohol-Based Hand Rub Solution Fire Modeling Analysis Report

Prepared For:

American Society for Healthcare Engineering of the American Hospital Association
One North Franklin
Chicago, Illinois 60606

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Prepared By:

Thomas W. Jaeger, P.E.

Christopher M. Leaver, P.E.

Rick Glenn, P.E.

Gage-Babcock & Associates, Inc.
600 Hunter Drive, Suite 225
Oak Brook, Illinois 60523

EXECUTIVE SUMMARY

Alcohol-based products are more effective for standard hand hygiene or hand antisepsis by health care personnel than soap or antimicrobial-containing soap products. For optimal effectiveness both the type and concentration of alcohol in the hand rub are important variables. Two of the more common formulations of alcohol-based hand rubs used in the U.S. are equal to or greater than 60% of ethyl alcohol or isopropyl alcohol by volume. Alcohol is a flammable liquid. Local building and fire codes regulate the storage and use of flammable liquids. The use of alcohol-based hand rubs therefore may present a fire hazard within health care facilities. This fire hazard, combined with the increasing prevalence in the use of alcohol-based hand rubs as part of overall hand hygiene programs in U.S. health care facilities, necessitates careful analysis to assure the spectrum of safe care of patients mitigates both healthcare associated infections (HAI) and facility-associated fires.

The American Society for Healthcare Engineering (ASHE) of the American Hospital Association (AHA) commissioned a study of how these hand rubs will react to a fire in a typical patient care environment. This report documents a computerized fire modeling study conducted for typical installations of dispensers containing alcohol-based hand rubs. This study includes modeling a reasonable range of potential fire scenarios to analyze the overall level of hazard presented by the hand hygiene solution. The scenarios chosen capture a reasonable range of scenarios by analyzing up to the largest container sizes expected and the most difficult locations (i.e. double loaded corridors).

The results of the study indicate that installing hand-rub dispensers is acceptable in both corridor and suite locations. The results also showed the spacing of dispensers at or near each patient room entrance not to be a significant risk for additional ignition and involvement of more than one dispenser. Based on these results, ASHE recommends the following for the use and storage of the alcohol-based hand rub solutions:

1. Single containers installed in an egress corridor should not exceed a maximum capacity of 1.2 liters for alcohol-based hand-rub solutions in gel/liquid form. Single containers installed in a suite should not exceed a maximum capacity of 2 liters for alcohol-based hand-rub solutions in gel/liquid form.
2. Dispensers should not be installed over electrical receptacles or near other potential sources of ignition.
3. Dispensers that project more than 3½ inches (4½ inches if the 2003 Edition of the Life Safety Code is adopted) into the corridors should be noted in the facility 's Fire Plan and Training Program.
4. All storage of replacement alcohol-based hand rub containers on patient floors, regardless of the quantity, should be within an approved flammable liquid storage cabinet.
5. The quantity of replacement alcohol-based hand rub containers stored and used on any floor, including bulk storage in Central Supply Rooms, should not exceed the maximum quantity permitted by the local prevailing building and fire codes.

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I. INTRODUCTION

The American public deserves and demands the highest level of protection from all risks associated with patient care. This includes the latest in medical technology, the training necessary to perform quality patient care, built environments that support every aspect of care, fire protection systems and fire safety programs, and the solution to an ever increasing problem of "hospital acquired" infections or the more broad term healthcare associated infections (HAIs). According to the Centers for Disease Control and Prevention (CDC)[1]:

- ***Hospital-acquired infections affect 2 million persons annually***
- ***5-10% of all people admitted to U.S. health care facilities contract infections each year***
- ***Nosocomial or hospital-acquired Infections contribute to >88,000 deaths per year estimated for 1997***
- ***2.5 billion dollars are spent annually on treating patients with HAIs***

In recognition of the ongoing morbidity, mortality, and cost of HAIs coupled with the primary role hand hygiene plays in reducing the transmission of pathogenic microorganisms in health care facilities, the CDC in collaboration with several professional organizations developed and published an updated *Guideline for Hand Hygiene in Health-Care Settings* in October 2002.[2] Of note, the following excerpt from the Guideline highlights the importance of incorporating new evidence to prevent HAIs:

> "…Alcohol-based products are more effective for standard handwashing or hand antisepsis by health care workers (HCWs) than soap or antimicrobial soaps.[3-23] In all but two of the trials that compared alcohol-based solutions with antimicrobial soaps or detergents, alcohol reduced bacterial counts on hands more than washing hands with soaps or detergents containing hexachlorophene, povidone-iodine, 4% chlorhexidine, or triclosan. In studies examining antimicrobial-resistant organisms, alcohol-based products reduced the number of multidrug-resistant pathogens recovered from the hands of HCWs more effectively than did handwashing with soap and water.[6-24]
>
> " …Alcohol solutions containing 60%-95% alcohol are most effective, and higher concentrations are less potent [9-27] because proteins are not denatured easily in the absence of water.[27]
>
> …Alcohols are flammable. Flash points of alcohol-based hand rubs range from 21ºC to 24ºC, depending on the type and concentration of alcohol present. [30] As a result, alcohol-based hand rubs should be stored away from high temperatures or flames in accordance with National Fire Protection Association (NFPA) recommendations. In Europe, where alcohol-based hand rubs have been used extensively for years, the incidence of fires associated with such products has been low. [30] One recent U.S. report described a flash fire that occurred as a result of an unusual series of events, which included an HCW applying an alcohol gel to her hands, immediately removing a polyester isolation gown, and then touching a metal door before the alcohol had evaporated.[31] Removing the polyester gown created a substantial amount of static electricity that generated an audible static spark when the HCW touched the metal door, igniting the unevaporated alcohol on her hands.[31] This incident emphasizes the need to rub hands together after application of alcohol-based products until all the alcohol has evaporated…"

NOTE: For this study an alcohol hand rub in gel formulation with 70% (by volume) Ethyl Alcohol or Isopropyl Alcohol delivered from a wall-mounted pump dispenser was one of the key assumptions for the design fires incorporated into the modeling scenarios.

As a result of an extensive literature search, research and expert testimony the following recommendations are offered in the Hand Hygiene Guidelines:

8. Administrative Measures:

C. As part of a multidisciplinary program to improve hand-hygiene adherence, provide HCWs with a readily accessible alcohol-based hand-rub product (Category IA - *see end of report for explanation of evidence ranking scheme*) [6-32]

D. To improve hand-hygiene adherence among personnel who work in areas in which high workloads and high intensity of patient care are anticipated, make an alcohol-based hand rub available at the entrance to the patient's room or at the bedside, in other convenient locations, and in individual pocket-sized containers to be carried by HCWs (Category IA). [37,32,33,34,38,36,39,40]

The CDC Hand Hygiene Guidelines note the use of alcohol-based hand rubs may present a fire hazard within health care facilities. In keeping with its longstanding strategic goal of providing fire safe facilities that also promote the highest quality of health care, the American Society for Healthcare Engineering (ASHE) of the American Hospital Association solicited unrestricted sponsorships from manufacturers of alcohol-based hand rubs to perform a study of how these solutions will react to a fire in a typical patient care environment. ASHE hired prominent national Fire Protection Engineering firm, Gage Babcock and Associates, with extensive experience in using the latest National Institute of Standards and Technology computerized fire modeling programs.

This report documents a computerized fire modeling study conducted for typical installations of dispensers containing alcohol-based hand rubs. As all possible installation scenarios could not cost-effectively be modeled, ASHE staff and the fire protection engineers at Gage-Babcock & Associates selected a series of the most challenging patient care area layouts and fire inception hazards. This study included modeling eleven separate fire scenarios to capture a reasonable range of potential fire scenarios to analyze the overall level of hazard presented by the hand hygiene solution. Recommendations are provided for decreasing the level of hazard presented by the alcohol-based hand rub solution.

A. Rationale for Convenient, Accessible Location of Dispensers for Alcohol-Based Hand Rubs:

In addition to the antimicrobial efficacy of waterless alcohol-based hand rubs, the CDC/HICPAC Guideline also noted the following that highlights the rationale for locating this class of hand hygiene product in convenient, accessible locations:

> "Studies indicate that the frequency of handwashing or antiseptic handwashing by personnel is affected by the accessibility of hand-hygiene facilities. [3-41] In certain health-care facilities, only one sink is available in rooms housing several patients, or sinks are located far away from the door of the room, which may discourage handwashing by personnel leaving the room. In intensive-care units, access to sinks may be blocked by bedside equipment (e.g., ventilators or

> intravenous infusion pumps). In contrast to sinks used for handwashing or antiseptic handwash, dispensers for alcohol-based hand rubs do not require plumbing and can be made available adjacent to each patient's bed and at many other locations in patient care areas. Pocket carriage of alcohol-based hand-rub solutions, combined with availability of bedside dispensers, has been associated with substantial improvement in adherence to hand hygiene protocols. [32,38] ...Perceived barriers to adherence with hand-hygiene practice recommendations include skin irritation caused by hand hygiene agents, inaccessible hand-hygiene supplies, interference with HCW-patient relationships, priority of care (i.e., the patients' needs are given priority over hand hygiene), wearing of gloves, forgetfulness, lack of knowledge of the guidelines, insufficient time for hand hygiene, high workload and understaffing, and the lack of scientific information indicating a definitive impact of improved hand hygiene on healthcare–associated infection rates…" [37,44-49]

Indirect evidence that highlights the importance of making products convenient and accessible has been shown by studies of occupational sharps injuries. A ground breaking investigation by McCormick found that provision of sharps disposal containers at every patient bedside resulted in a two-fold reduction in sharps injuries among healthcare personnel at the facility under study. [50] Others have confirmed findings by McCormick observing reductions in sharps injuries as high as 70% with improvements in disposal systems. [3-51] Conversely, when disposal containers are inadequate or in inconvenient locations, risk of injury to personnel is increased. [54,55] The National Institute for Occupational Safety & Health (NIOSH) has utilized this evidence to develop guidelines on selection and placement of sharps disposal containers. [56]

Use of alcohol-based hand rubs is quite prevalent in health care facilities across the US. An informal online survey assessing use of this class of hand antiseptics of the membership of the Society for Healthcare Epidemiology of America, Inc. (SHEA), the Association for Professionals in Infection Control & Epidemiology Inc. (APIC) and Emerging Infections Network (EIN) of the Infectious Diseases Society of America (IDSA) conducted between March 25-31, 2003 yielded a total of 840 responses. Of these 798 (95%) indicated that an alcohol-based hand rub was in use in their affiliated facilities and that for facilities where used, between 60-89% were providing this product in dispensers in patient rooms or hallways outside patient rooms. [57]

B. Analysis of Fires In Medical Facilities

While incomplete, analysis of data on fires in medical facilities provided to the U.S. Fire Administration (USFA) and National Fire Incident Reporting System (NFIRS) indicates there are an estimated 2,500 fires each year costing $8.7 million in property loss with 10% occurring in clinics.[58] Fires most often originate in the kitchen (20%); additionally, 11% begin in patient rooms and 9% in laundry rooms. Extrapolation from 3 years of reports in which the source of the fire was determined is illustrated in the following figure:

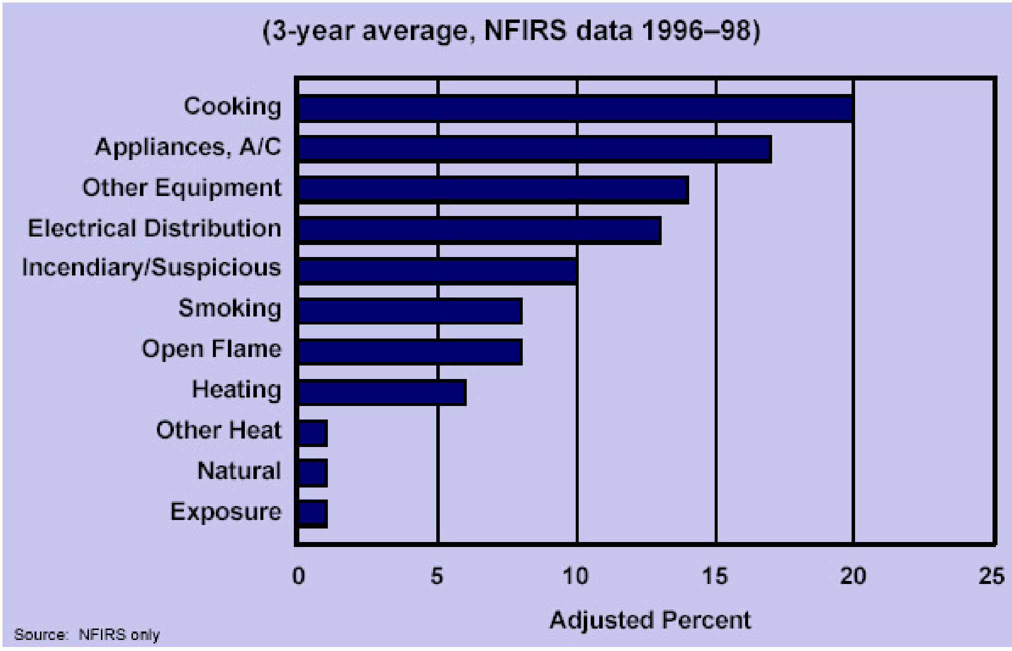

Figure 1: Leading Causes of Medical Facility Fires

Casualties do occur in medical facilities. Patients in hospitals are more likely than patients in other facilities to be incapacitated or otherwise unable to escape from a fire. Further, 48% of casualties in hospitals either are intimately involved with the fire's ignition (e.g., their clothing or bedding ignites) or are in the room where the fire ignites. Additional analysis of casualties in medical facilities conducted by the NFPA between 1994-1998 identified 5 civilian deaths and 107 injuries associated with fires in health care facilities.[59] Given that a substantial proportion of patients or residents of health care facilities are not capable of self-evacuation, fire protection design and systems are based on a defend-in-place principle, which necessitates redundancies to assure optimal fire prevention and mitigation. Details on such systems have been reviewed elsewhere.[60]

Types of materials that ignited in reported fires in medical facilities are listed in the figure below.

(3-year average, NFIRS data 1996–98, adjusted percentage)

TYPE OF MATERIAL IGNITED	PERCENT OF FIRES	FORM OF MATERIAL IGNITED	PERCENT OF FIRES
Plastic	27.9	Electrical Wire	23.5
Fabric	19.5	Cooking Materials	18.4
Paper	17.3	Rubbish	8.0
Volatile Solid (including food, grease)	10.7	Bedding	5.7

Source: NFIRS only

Figure 2: Materials Ignited in Medical Facility Fires

Given the high incidence of cooking and various electrical fires as major causes of such fires, the prominence of fabrics, plastics (including wire insulation), and cooking materials (including grease) is not surprising. A smoke alarm was present and activated in 63% of medical facility fires, a higher percentage than is found in other property types. Even though sprinkler systems operated in only 6% of medical facility fires, sprinklers were installed in 94% of the structures. The presence of built-in suppression and alarm systems in medical facilities is tightly regulated, so it is not surprising that a preponderance of such properties are equipped with alarms and sprinklers. (For further information, see NFPA 99 *Standard for Health Care Facilities*, and NFPA 101 *Life Safety Code*)

II. TECHNICAL ANAYLYSIS OF ALCOHOL-BASED HAND RUB PRODUCT

There are a wide variety of alcohol-based hand rub products on the market. The available products range from a liquid/gel form to foam, are available in a variety of quantities, and are available in a variety of dispensing apparatus. The most commonly installed products at this time are 1 to 2 Liter size liquid/gel solutions dispensed from wall mounted pump dispensers. Therefore, this analysis focuses on these types and sizes of alcohol-based hand rub solutions and applications.

Our analysis focused on products that met the criteria set by the CDC of a minimum of 60% ethanol or isopropanol. The MSDS sheets for multiple brands of liquid/gel products were reviewed and all were determined to be Class I-B flammable liquids. In addition, it was found the products did not exhibit any unusual decomposition products from combustion, such as Hydrogen Cyanide, and Hydrogen Chloride. Carbon monoxide was the most common product reported.

III. CODE ANALYSIS – STORAGE QUANITITY & LOCATION

A thorough code review and analysis was conducted of the requirements pertaining to the storage and use of flammable and combustible liquids in health care occupancies. The following codes and standards were reviewed as part of this analysis:

- The *International Building Code* (IBC) – 2003 Edition
- The *International Fire Code* (IFC) – 2003 Edition
- NFPA 5000, *Building Construction and Safety Code* – 2003 Edition
- NFPA 1, *Uniform Fire Code* – 2003 Edition
- NFPA 30, *Flammable and Combustible Liquids Code* – 2000 Edition
- NFPA 99, *Standard for Health Care Facilities* – 2003 Edition
- NFPA 101, *Life Safety Code* – 2003 Edition

The following terms used in this report have the following meanings as defined in the IBC and IFC as applicable to this analysis. The definitions for these terms is very similar, if not identical, to those in NFPA 5000 and NFPA 1.

Combustible Liquid. A liquid having a closed cup flash point at or above 100°F (38°C).

Flammable Liquid. A liquid having a closed cup flash point below 100°F (38°C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

> ***Class IA.*** Liquids having a flash point below 73°F (23°C) and having a boiling point below 100°F (38°C).
> ***Class IB.*** Liquids having a flash point below 73°F (23°C) and having a boiling point at or above 100°F (38°C).
> ***Class IC.*** Liquids having a flash point at or above 73°F (23°C) and below 100°F (38°C).

Control Area. Spaces within a building that are enclosed and bounded by exterior walls, fire walls, fire barriers, and roofs, or a combination thereof, where quantities of flammable liquids not exceeding the maximum allowable quantities per control area are stored, dispensed, used, or handled.

Fire Area. The aggregate floor area enclosed and bounded by fire walls, fire barriers, exterior walls, or fire resistance rated horizontal assemblies of a building.

Storage. The keeping, retention, or leaving of flammable liquids in closed containers, tanks, or similar vessels.

Use. Placing a flammable liquid into action.

A. International Building Code (IBC)

Table 307.7(1) of the IBC specifies the maximum quantity per control area of hazardous materials to be stored and used in order to be exempt from the High-Hazard Use Group requirements of the code. The maximum amounts allowed are dependent upon several factors including:

- Type of material (most of the hand hygiene solutions are classified as a Class IB liquid)
- Whether the facility is equipped throughout with an automatic sprinkler system
- Whether the material is stored in approved cabinets
- Whether the system in which the material is used is a "closed" or "open" system (the proposed use of the hand sanitizers is considered an "open" system by the code)
- The number of control areas in the building
- The floor level, above and below grade, that the material is stored and/or used.

Table 1 indicates the maximum allowable quantity of a Class IB liquid per control area on a grade level floor.

Table 1 - Maximum Allowable Quantity of Class IB Liquid Per Control Area on Grade Level Floor

CODE[1]	USE	SPRINKLERED FACILITY	NON-SPRINKLERED FACILITY
IBC, IFC, NFPA 5000, & NFPA 1	Storage & Use	240 gal (912 L) [2]	120 gal (456 L) [2]
	Use Only	60 gal (228 L)	30 gal (114 L)

[1]This table is consistent for the IBC, IFC, NFPA 5000 and NFPA 1.
[2]The maximum quantities for storage only can be increased 100% when stored in approved cabinets. Table 1 does not reflect this increase.

Note that sprinklered facilities are allowed to store and/or use twice as much material as non-sprinklered facilities.

Table 414.2.2 of the IBC specifies the maximum number of control areas per floor, the fire resistance ratings required for fire barriers enclosing control areas, and the maximum quantities of hazardous materials allowed per floor level. This table reduces the maximum quantities allowed based on the floor level of the building in which the material is being stored and/or used.

Table 2 indicates the maximum allowable quantities of a Class IB liquid per control area for the various floor levels for a sprinklered health care occupancy.

Table 3 indicates the maximum allowable quantities of a Class IB liquid per control area for the various floor levels for a non-sprinklered health care facility.

Table 2 - Maximum Quantities of Class IB Liquids Allowed and Number of Control Areas for Sprinklered Health Care Occupancies

		IBC, IFC, NFPA 5000 & NFPA1[1]		
FLOOR	LEVEL	MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA FOR STORAGE[2] & USE	NUMBER OF CONTROL AREAS PER FLOOR	FIRE RESISTANCE RATING FOR FIRE BARRIERS IN HOURS
Above grade	Higher than 9	12 gal (45.6 L)	1	2
	7-9	12 gal (45.6 L)	2	2
	6	30 gal (114 L)	2	2
	5	30 gal (114 L)	2	2
	4	30 gal (114 L)	2	2
	3	120 gal (456 L)	2	1
	2	180 gal (684 L)	3	1
	1	240 gal (912 L)	4	1
Below grade	1	Not Allowed[3]	3	1
	2	Not Allowed[3]	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

[1]This table is consistent for the IBC, IFC, NFPA 5000, & NFPA 1.
[2]The maximum quantities for storage only can be increased 100% when stored in approved cabinets. Table 2 does not reflect these increases.
[3]The IFC and NFPA 1 do not permit the storage of Class I liquids in basement areas.

Table 3 - Maximum Quantities of Class IB Liquids Allowed and Number of Control Areas for Non-Sprinklered Health Care Occupancies

		IBC, IFC, NFPA 5000 & NFPA1[1]		
FLOOR	**LEVEL**	**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA FOR STORAGE[1] & USE**	**NUMBER OF CONTROL AREAS PER FLOOR**	**FIRE RESISTANCE RATING FOR FIRE BARRIERS IN HOURS[2]**
Above grade	Higher than 9	6 gal (22.8 L)	1	2
	7-9	6 gal (22.8 L)	2	2
	6	15 gal (57 L)	2	2
	5	15 gal (57 L)	2	2
	4	15 gal (57 L)	2	2
	3	60 gal (228 L)	2	1
	2	90 gal (342 L)	3	1
	1	120 gal (456 L)	4	1
Below grade	1	Not Allowed[3]	3	1
	2	Not Allowed[3]	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

[1]This table is consistent for the IBC, IFC, NFPA 5000, & NFPA 1.
[2]The maximum quantities for storage only can be increased 100% when stored in approved cabinets. Table 3 does not reflect these increases.
[3]The IFC and NFPA 1 do not permit the storage of Class I liquids in basement areas.

B. International Fire Code (IFC)

The pertinent requirements in the IFC include all those contained in the IBC, and the following:

- The combined total quantity of liquids in a cabinet shall not exceed 120 gal (454 L).
- Not more than three storage cabinets shall be located in a single fire area.
- Storage of any liquid shall not be stored near the route of egress.
- Class I liquids shall not be permitted in the basement areas.

C. NFPA 5000 – Building Construction and Safety Code

Table 34.1.3.1 of NFPA 5000 specifies the maximum quantity per control area of hazardous materials to be stored and used in order to be exempt from the High Hazard Occupancy requirements of the code. Table 34.1.3.1 of NFPA 5000 is consistent with Table 307.7(1) of the IBC.

As with the IBC and IFC, NFPA 5000 allows sprinklered facilities to store and/or use twice as much material as non-sprinklered facilities.

Table 34.2.4.2 of NFPA 5000 specifies the maximum number of control areas per floor, the fire resistance ratings required for fire barriers enclosing control areas, and the maximum quantities of a hazardous material allowed per floor level. This table is identical to its counterpart in the IBC and IFC.

D. NFPA 1 – Uniform Fire Code

The pertinent requirements in NFPA 1 include all those contained in NFPA 5000, and the following:

- Not more than 120 gal (454 L) of Class I, Class II, and Class IIIA liquids shall be stored in a storage cabinet.
- Not more than three storage cabinets shall be located in any one fire area.
- Class I liquids shall not be permitted in basement areas.
- Containers of Class I liquids that are stored outside of an inside liquid storage area shall not exceed a capacity of 1 gal (3.8 L).
- Not more than 10 gal (37.8 L) of Class I and Class II liquids combined shall be stored in a single fire area outside of a storage cabinet or an inside liquid storage area.

E. NFPA 30 – Flammable and Combustible Liquids Code

NFPA 30 applies to the storage, handling, and use of flammable and combustible liquids. The pertinent sections of NFPA 30 are Chapter 4 and Section 5-5. Chapter 4 applies to storage of liquids in containers in storage areas. Section 5-5 applies to areas where the use, handling, and storage of liquids are only an incidental operation (e.g.: limited activity to the established occupancy classification). The following summarizes the pertinent requirements of Section 5-5:

- Means shall be provided to minimize generation of static electricity.
- The quantity of liquid outside of identified storage areas, such as storage cabinets, shall not exceed the aggregate sum of 120 gal (454 L) of Class IB, Class IC, Class II, or Class III liquids in containers in a single *fire area.* NFPA 30 defines a *"fire area"* as *"an area of a building separated from the remainder of the building by construction having a fire resistance rating of at least 1 hour with all communicating openings properly protected by an assembly having a fire resistance rating of at least 1 hour."*

The following summarizes the pertinent requirements of Chapter 4:

- Non-rigid plastic containers for Class IB liquids shall not exceed a capacity of 5 gal (18.9 L) and shall conform to Polyethylene DOT Specification 34, UN 1H1, or as authorized by DOT exemption.
- Class I liquids shall not be stored in basement areas.
- Containers of Class I liquids that are stored outside of an inside liquid storage area shall not exceed a capacity of 1 gal (3.8 L).
- Not more than 10 gal (37.8 L) of Class I and Class II liquids combined shall be stored in a single fire area outside of a storage cabinet or an inside liquid storage room.

F. NFPA 99 – Standard for Health Care Facilities

Section 11.7.2 of NFPA 99 contains requirements for the storage and use of flammable and combustible liquids in laboratories within health care facilities. The following summarizes the pertinent requirements:

- Flammable and combustible liquids shall be used from and stored in approved containers in accordance with NFPA 30, *Flammable and Combustible Liquids Code.*
- The total volume of Class I, II, and IIIA liquids outside of approved storage cabinets and safety cans shall not exceed 1 gal (3.78 L) per 100 sq. ft.
- The total volume of Class I, II, and IIIA liquids, including those contained in approved storage cabinets and safety cans, shall not exceed 2 gal (7.57 L) per 100 sq. ft.
- No flammable or combustible liquids shall be stored or transferred from one vessel to another in any exit access corridor or passageway leading to an exit.

G. NFPA 101 – Life Safety Code

Section 8.7.3.1 of NFPA 101 requires that the storage and handling of flammable liquids be in accordance with NFPA 30, *Flammable and Combustible Liquids Code.* No storage or handling of flammable liquids is permitted in a location where such storage would jeopardize egress from the structure, unless otherwise permitted by NFPA 30.

H. Code Comparisons

The following general observations were made when comparing the various codes:

1. The maximum quantities of Class IB liquids allowed and number of control areas is consistent between the IBC, IFC, NFPA 5000, & NFPA 1.
2. The codes allow facilities that are equipped with an automatic sprinkler system throughout the building to store and/or use twice as much liquid as non-sprinklered facilities.
3. The maximum allowable quantities per control area significantly decreased on floors that are 4 or more levels above grade.
4. The IBC and IFC require that floors of control areas have a minimum fire resistance rating of 2 hours, as opposed to NFPA 5000 and NFPA 1 which require only a 1 hour fire resistance rating.
5. NFPA 30, NFPA 1, and the IFC do not permit storage of Class I liquids in basement areas.
6. NFPA 99 does not permit storage or use of flammable or combustible liquids in exit access corridors of laboratories.
7. The IFC and NFPA 1 limit the total amount of flammable and combustible liquids that can be stored in a single storage cabinet to 120 gal (454 L).

I. Case Studies

The following are case studies indicating the maximum quantities of hand rub solution allowed under various scenarios. Note that the aggregate quantity of hand rub solution stored and used cannot exceed the maximum quantity allowed for storage.

1. Case No. 1: Sprinklered Health Care Facility;
   Storage and Use of Product Per Control Area, Grade Floor.

   Quantities: No more than 60 gallons (228 L) in use (in hand rub dispensers) and no more than 360 gallons (1360.8 L) stored in approved cabinets.

2. Case No. 2: Sprinklered Health Care Facility;
   Storage and Use of Product Per Control Area, 4th Floor.

   Quantities: No more than 30 gallons (114 L) in hand rub dispensers with no storage; or 15 gallons (57 L) in hand rub dispensers with 30 gallons (114 L) stored in an approved cabinet.

3. Case No. 3: Non-Sprinklered Health Care Facility;
   Storage and Use of Product Per Control Area, Floors 8 and Higher.

   Quantities: No more than 6 gallons (22.7 L) in hand rub dispensers with no storage; or 2 gallons (7.6 L) in hand rub dispensers with 8 gallons (30.2 L) stored in an approved cabinet.

4. Case No. 4: Sprinklered Health Care Facility;
   Storage and Use of Product Per Control Area, 7th Floor.

   Quantities: No more than 12 gallons (45.6 L) in hand rub dispensers with no storage; or 6 gallons (22.7 L) in hand rub dispensers with 12 gallons (45.6 L) stored in an approved cabinet.

J. Corridor Width and Projections of Hand Rub Dispensers

During the development of the 1991 Edition of the NFPA Life Safety Code, the Technical Committee on Health Care Occupancies removed the requirements that beds in healthcare facilities be easily movable under conditions of evacuation and that beds be equipped with casters (Refer to Appendix A). The Technical Committee's substantiation was that healthcare facilities were a "defend in place" occupancy and the common practice and the preferred technique is to move patients during an emergency on bedding such as blankets and not in beds.

The Committee discussions indicated that if the Code required beds to be readily movable and have casters, the user of the Code would conclude that the Committee wanted patients to be evacuated in beds during an emergency, just the opposite of the Committee's intent. The Committee clearly recognized that moving patients in beds during an emergency would quickly clog up the corridors and make movement in the corridors almost impossible for both building occupants and emergency responders.

The Committee further stated that without the necessity to move patients in beds during an emergency and based on the average occupant load of a healthcare facility in patient sleeping and treatment areas, there was no technical justification to require 8-foot wide corridors in the name of life/fire safety. The Committee wanted to reduce the minimum requirement for corridors in new facilities to 6 feet and leave the requirement of 4 feet for existing buildings. The healthcare providers strongly requested that the Committee not reduce the requirement for an 8-foot corridor with the substantiation that an 8-foot corridor was desirable for operational reasons. The providers clearly agreed that for fire/life safety reasons an 8-foot corridor was not required. The healthcare providers further argued that if the Code did not require an 8-foot corridor and only required a 6-foot corridor that management would require the building be designed to minimum requirements, this being 6 feet. The providers further argued that in many states reimbursement is based on the minimum requirements of the Code.

The Committee reluctantly maintained the requirement for an 8-foot corridor. The Committee was not comfortable including in the Life Safety Code a minimum requirement that exceeded the needs for fire/life safety and was solely based on operational needs. The requirement for an 8-foot corridor continues through the 2003 Edition of the Code, as well as the elimination of the requirement for movable beds.

With the recent adoption of the 2000 Edition of the Life Safety Code by the Joint Commission on Healthcare Organizations and the Federal Medicare/Medicaid Program, all existing healthcare facilities require a minimum 4-foot wide corridor. It is clear that the Technical Committee believes that for new buildings a minimum of a 6-foot wide corridor is adequate.

The 2000 Edition of the code currently allows for projections into the corridor of 3½ inches on each side at 38 inches and below. Annex Section A.18.2.3.3 of the 2000 Edition recognizes that the minimum clear width of the corridor will not be maintained clear and unobstructed at all times due to wheeled items in use at all times. The newest version of the Life Safety Code, 2003 Edition, has increased the allowable projections to 4½ inches on each side.

The containers for the alcohol-based hand hygiene solution are always installed at least 38 inches above the finished floor and have a maximum projection from the wall of up to 5 inches. It is our professional opinion, as a twenty year member of the Technical Committee on Health Care Occupancies, that if a clear width of 48 inches in an existing building and 72 inches in a new building can be maintained in the corridors above 38 inches while the containers are installed, this would meet the intent of the Code and/or the Technical Committee. It is further our professional opinion that an unobstructed width of 48 and 72 inches, regardless of the 5-inch projections provide an adequate width for the evacuation of patients during an emergency. Healthcare occupancies are staffed on a 24/7 basis with a trained professional staff. It is also our recommendation that any hand rub dispenser installed in the corridor that projects more than 3½ inches (4½ inches where 2003 Edition is adopted) into the corridors be noted in the facility's Fire Plan and Training Program.

Like any other occupancy, all the risks to the occupants of a building must be adequately addressed. In this particular case, we are addressing the risks of providing infection and control solutions and weighing them against existing fire codes and standards. We believe that from a fire/life safety standpoint, the 48 inches for existing buildings and 72 inches for new buildings adequately addresses the fire/life safety risks in healthcare occupancies.

IV. FIRE MODELING ANALYSIS

As part of this analysis a number of challenging fire scenarios were chosen to capture a reasonable range of potential conditions. Each scenario was modeled using computer fire modeling techniques to estimate the development of heat and hot gases from a potential fire involving the alcohol-based product. The objective of this modeling was to evaluate the overall level of hazard associated with alcohol hand hygiene solutions. For this project, the fire model Fire Dynamics Simulator (FDS) Version 3.1, a computational fluid dynamics model published by the National Institute of Standards and Technology (NIST) was chosen for the required computer modeling calculations.

Using the results of the FDS model the potential hazards were evaluated by reviewing the data in the following areas:

1. Tenability of the spaces chosen with particular attention to means of egress

2. Ignition of adjacent fuel loads/combustibles (i.e. adjacent hand hygiene dispensers)

3. Sprinkler activation

The sections that follow describe the fire scenarios and design fires chosen, performance and tenability criteria used to evaluate the results, the fire model and assumptions used, and an analysis of the results.

A. Fire Scenarios

Gage-Babcock developed several fire scenarios to assess the relative fire hazard of the placement of alcohol-based hand rubs in healthcare facilities. The scenarios selected focused on two typical areas of a healthcare facility: hall/corridor with patient rooms opening into the corridor (no additional open areas, such as nursing stations or waiting spaces, have been included so the modeling is reviewing only the effects on the corridor and patient rooms), and an open suite (i.e. surgical suite scrub areas, ICU, CCU, SICU, etc.) with more area open in the center of the suite with patient treatment areas along the exterior perimeter of the space.

See figures 1 & 2 for an illustration of the proposed geometries of the locations selected. Varying important parameters, such as corridor width, and fuel load in these two locations, the fire scenarios for this analysis were developed. For each scenario a single parameter was adjusted in order to better compare the results.

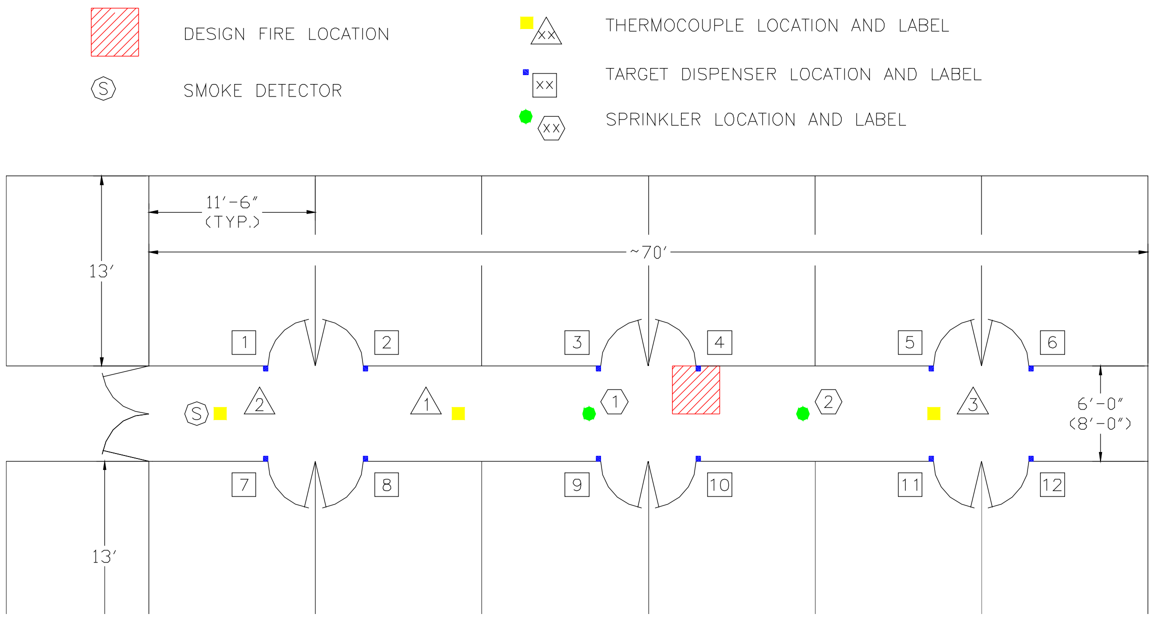

Figure 3 - Corridor/Hallway Geometry

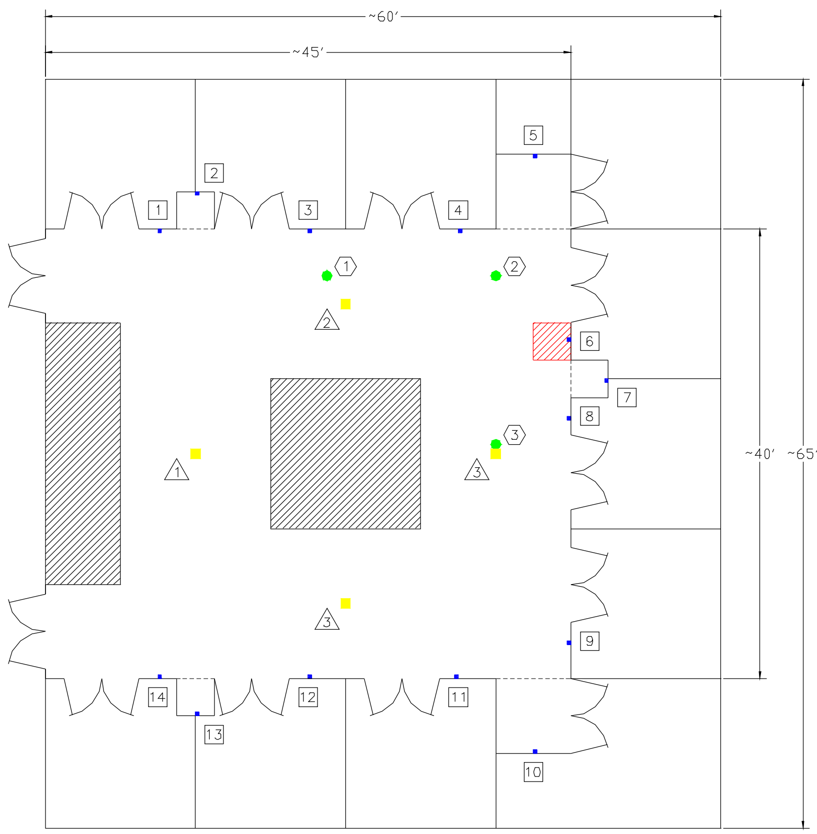

Figure 4 - Suite Geometry

The fire scenarios are described in a short narrative below and a table has been provided to summarize the important details. The scenarios are grouped by location.

Scenario #1 Hall/Corridor

The hall/corridor locations represent a situation where the alcohol-based hand rub has been installed in a typical healthcare corridor with the nurses station and other open areas located outside of the smoke control doors and several patient rooms opening into the corridor from both sides. Each room is approximately 150 ft^2 (13 ft. x 11.5 ft.) and has a single door opening into the corridor. The corridor has a set of smoke barrier doors at one end, and the scenarios assume that these doors are in the open position on magnetic holders and close upon smoke detection at the door. The containers are installed outside each room door at a height of approximately 48-inches above the floor with a separation of 6.5 feet on the same side of the corridor and 6 or 8 feet across the corridor (depending on the scenario). The corridor width was modeled at a 6 foot or 8 foot width (depending on the scenario), 70 feet long from the end to the smoke doors, and all the ceiling heights were assumed to be 8'-0" with ceilings that would stay in place during the modeling. No ventilation systems were taken into consideration in the models. Sprinkler protection via ordinary standard response sprinklers were modeled in all scenarios to see if activation would occur. It was determined that standard sprinklers over quick response sprinklers would be the most challenging condition for the activation of the system. Suppression of the fire or any other affects from sprinkler flow were not modeled unless specifically stated other wise.

Scenario 1-1: This scenario consists of a 1 liter (33.8 oz) container (approx. midway down the corridor). In order to completely challenge the modeling the full content of the container have completely leaked out and is pooled on the floor. The pool of alcohol based hand sanitizer on the floor is instantly fully ignited and burned until the amount of liquid present has been exhausted. The corridor was assumed to be 6 feet wide, once again to challenge the modeling, and 50% of the patient room doors were assumed open. The flooring material was a typical vinyl tile.

Scenario 1-2: This scenario consists of a 2 liter (67.6 oz) container (approx. midway down the corridor). In order to completely challenge the modeling the full content of the container have completely leaked out and is pooled on the floor. The pool of alcohol based hand sanitizer on the floor is instantly fully ignited and burned until the amount of liquid present has been exhausted. The corridor was assumed to be 6 feet wide, once again to challenge the modeling, and 50% of the patient room doors were assumed open. The flooring material was a typical vinyl tile.

Scenario 1-3: Same as 1-1 except all patient room doors were assumed closed.

Scenario 1-4: Same as 1-2 except all patient room doors were assumed closed.

Scenario 1-5: Same as 1-1 except the corridor was assumed to be 8 feet wide.

Scenario 1-6: Same as 1-1 except the flooring material was assumed to carpet.

Scenario 1-7: Same as 1-5 except the flooring material was assumed to carpet.

Scenario 1-8: Same as 1-1 except the container size was increased to 1.2 liters (40.6 oz.) and isopropyl alcohol was used as the fuel

Scenario #2: Suite

The Suite layout represents a typical patient care suite of rooms where the alcohol-based hand rub has been installed. The suite has patients who are incapable of self preservation in rooms protected with sliding glass doors and the layout is an oval around a common nurses' workstation. Each patient room is approximately 170 ft^2 (13 ft. x 13 ft.) and has a door opening into the suite. The entire suite is approximately 3,900 sq.ft. with some enclosed areas in the center. Two sets of double doors open into the suite from a common corridor but were assumed to be closed for the model. The containers are installed outside each room door at a height of approximately 48-inches above the floor with a separation of 6.5 feet on the same side. All the ceiling heights were assumed to be 8'-0" and the flooring material was standard vinyl tile. No ventilation systems were taken into consideration in the models. Sprinkler protection via ordinary standard response sprinklers were modeled in all scenarios to see if activation would occur. It was determined that standard sprinklers over quick response sprinklers would be the most challenging condition for the activation of the system. Suppression of the fire or any other affects from sprinkler flow were not modeled unless specifically stated other wise.

Scenario 2-1: This scenario consists of a 1 liter (33.8 oz) container. In order to completely challenge the modeling the full contents of the container have completely leaked out and is pooled on the floor. The pool of alcohol based hand sanitizer on the floor is instantly fully ignited and burned until the amount of liquid present has been exhausted.

Scenario 2-2: Same as 2-1 except all that the container size was assumed to be 2 litters (67.6 oz.).

Table 4 - Summary of Computer Fire Model Runs

Scenario	Description	FDS File
1-1	Corridor w/ 50% Open Doors, 1L spill, 100 kW - 104s (4mm x 0.25m^2)	ASHE710
	Corridor w/ 50% Open Doors, 1L spill, 40 kW - 259s (10mm x 0.10m^2)	ASHE711
1-2	Corridor w/ 50% Open Doors, 2L spill, 200 kW - 104s (4mm x 0.50m^2)	ASHE720
	Corridor w/ 50% Open Doors, 2L spill, 80 kW - 259s (10mm x 0.20m^2)	ASHE721
1-3	Corridor, 1L spill, 100 kW - 104s (4mm x 0.25m^2)	ASHE210
	Corridor, 1L spill, 40 kW - 259s (10mm x 0.10m^2)	ASHE211
1-4	Corridor, 2L spill, 200 kW - 104s (4mm x 0.50m^2)	ASHE220
	Corridor, 2L spill, 80 kW - 259s (10mm x 0.20m^2)	ASHE221
1-5	8-ft Corridor w/ 50% Open Doors, 1L spill, 100 kW - 104s (4mm x 0.25m^2)	ASHE810
	8-ft Corridor w/ 50% Open Doors, 1L spill, 40 kW - 259s (10mm x 0.10m^2)	ASHE811
1-6	Corridor w/ 50% Open Doors, Carpet Flooring, 1L spill, 40 kW - 259s (10mm x 0.10m^2)	ASHE112
1-7	8-ft Corridor w/ 50% Open Doors, Carpet Flooring, 1L spill, 40 kW - 259s (10mm x 0.10m^2)	ASHE813
1-8	Corridor w/ 50% Open Doors, 1.2L spill (IPA), 200 kW - 70s (4mm x 0.30m^2)	ASHE910
	Corridor w/ 50% Open Doors, 1.2L spill (IPA), 55 kW - 256s (10mm x 0.12m^2)	ASHE911
2-1	Suite, 1L spill, 100 kW - 104s (4mm x 0.25m^2)	ASHE610
	Suite, 1L spill, 40 kW - 259s (10mm x 0.10m^2)	ASHE611
2-2	Suite, 2L spill, 200 kW - 104s (4mm x 0.50m^2)	ASHE620
	Suite, 2L spill, 80 kW - 259s (10mm x 0.20m^2)	ASHE621

B. Design Fires

The modeling for this project focused on fire from the ignition of an alcohol based hand hygiene solution. The solution contains more than 60% alcohol and has a gel like consistency. Based on this information a liquid pool fire was determined to be the most likely worst-case design fire. Using techniques found in the SFPE Handbook (3^{rd} Edition) the growth, fire size, and duration of the design fires for each scenario were estimated.

Pool fires are governed by the following equation:

$$\dot{Q} = A \cdot \dot{m}'' \cdot \Delta h_c$$

where:

$\dot{Q}$	=	heat release rate (kW)
A	=	spill fire area (m^2)
$\dot{m}''$	=	mass burning rate (kg/m^2s)
Δh_c	=	heat of combustion (MJ/kg)

Based on this equation we calculated a range of design fires for both 1 litter and 2 litter containers. The design fires were calculated using the following assumptions:

1. The entire container was available to burn.

2. The solution was 70% (by volume) Alcohol.

3. The solution had fire dynamic properties of either pure Ethyl Alcohol or Isopropyl Alcohol (i.e. burning rate, species yield, etc.).

A range of design fires was developed due to the lack of reliable information on the anticipated pool diameter for the alcohol solution (fuel) in an unconfined spill. Since the design fire characteristics are heavily dependent on the spill area for both burn time and fire size it was determined that a range of possible fire sizes could be created for use in the modeling scenarios. The SFPE Handbook provides data on several liquids as to predicted spill depths. The challenge is that many factors affect the final spill depth and pool size such as surface tension of the liquid, surface material, height spilled from, spill quantity, and other unknown factors. The modeling used a reasonably conservative range of spill depths by comparing the actual product to know materials such as water. The alcohol based hand rub solutions are significantly more viscous than water and from some informal spill comparisons the product produced spill depths at least twice (1/2 the pool size) that of water. Therefore, the spill depths used ranged from slightly higher than the data reported for water (3.4 mm) up to three times this depth. The calculations for 1 liter and 2 liter containers of Ethyl Alcohol and 1.2 liter container of Isopropyl Alcohol are shown below.

Ethyl Alcohol - Pool Fire Calculations

$\dot{m}''_{\infty} =$ 0.015 $kg/m^2 s$ (D < 0.6m); 0.022 $kg/m^2 s$ (D > 0.6m) $\Delta h_c =$ 26.8 *MJ/kg*

Container volume	Container volume	Ethanol	Ethanol Vol per container	Ethanol Mass per container	Energy per container
ml	m^3	%	m^3	kg	MJ
1000	0.001	70	0.0007	0.389	10.4

Spill Depth		Pool Area		Equivalent Diameter		Peak HRR	Solution pyrolosis rate	Approximate burn time	Surface Density
m	in	m^2	in^2	m	in	kW	kg/s	s	kg/m^2
0.0040	0.16	0.250	388	0.564	22.190	100.5	0.004	104	1.556
0.0045	0.18	0.222	344	0.532	20.921	89.3	0.003	117	1.751
0.0050	0.20	0.200	310	0.505	19.847	80.4	0.003	130	1.945
0.0055	0.22	0.182	282	0.481	18.923	73.1	0.003	143	2.140
0.0060	0.24	0.167	258	0.461	18.118	67.0	0.003	156	2.334
0.0065	0.26	0.154	238	0.443	17.407	61.8	0.002	169	2.529
0.0070	0.28	0.143	221	0.427	16.774	57.4	0.002	182	2.723
0.0075	0.30	0.133	207	0.412	16.205	53.6	0.002	195	2.918
0.0080	0.31	0.125	194	0.399	15.690	50.3	0.002	207	3.112
0.0085	0.33	0.118	182	0.387	15.222	47.3	0.002	220	3.307
0.0090	0.35	0.111	172	0.376	14.793	44.7	0.002	233	3.502
0.0095	0.37	0.105	163	0.366	14.398	42.3	0.002	246	3.696
0.0100	0.39	0.100	155	0.357	14.034	40.2	0.002	259	3.891

Container volume	Container volume	Ethanol	Ethanol Vol per container	Ethanol Mass per container	Energy per container
ml	m^3	%	m^3	kg	MJ
2000	0.002	70	0.0014	0.778	20.9

Spill Depth		Pool Area		Equivalent Diameter		Peak HRR	Solution pyrolosis rate	Approximate burn time	Surface Density
m	in	m^2	in^2	m	in	kW	kg/s	s	kg/m^2
0.0040	0.16	0.500	775	0.798	31.381	294.8	0.011	71	1.556
0.0045	0.18	0.444	689	0.752	29.586	262.0	0.010	80	1.751
0.0050	0.20	0.400	620	0.714	28.068	235.8	0.009	88	1.945
0.0055	0.22	0.364	564	0.681	26.762	214.4	0.008	97	2.140
0.0060	0.24	0.333	517	0.652	25.622	196.5	0.007	106	2.334
0.0065	0.26	0.308	477	0.626	24.617	181.4	0.007	115	2.529
0.0070	0.28	0.286	443	0.603	23.722	168.5	0.006	124	2.723
0.0075	0.30	0.267	413	0.583	22.917	107.2	0.004	195	2.918
0.0080	0.31	0.250	388	0.564	22.190	100.5	0.004	207	3.112
0.0085	0.33	0.235	365	0.547	21.527	94.6	0.004	220	3.307
0.0090	0.35	0.222	344	0.532	20.921	89.3	0.003	233	3.502
0.0095	0.37	0.211	326	0.518	20.363	84.6	0.003	246	3.696
0.0100	0.39	0.200	310	0.505	19.847	80.4	0.003	259	3.891

ASHE Hand Sanitizer Fire Modeling

Isopropyl Alcohol (IPA)- Pool Fire Calculations

$\dot{m}''_{\infty}$ = 0.015 kg/m^2s (D < 0.6m)
0.022 kg/m^2s (D > 0.6m)

Δh_c = 30.45 MJ/kg

Container volume	Container volume	IPA	IPA Vol per container	IPA Mass per container	Energy per container
ml	m^3	%	m^3	kg	MJ
1200	0.0012	70	0.00084	0.462	14.1

Spill Depth		Pool Area		Equivalent Diameter		Peak HRR	Solution pyrolosis rate	Approximate burn time	Surface Density
m	in	m^2	in^2	m	in	kW	kg/s	s	kg/m^2
0.0040	0.16	0.300	465	0.618	24.307	201.0	0.007	70	1.539
0.0045	0.18	0.267	413	0.583	22.917	121.8	0.004	115	1.731
0.0050	0.20	0.240	372	0.553	21.741	109.6	0.004	128	1.923
0.0055	0.22	0.218	338	0.527	20.729	99.7	0.003	141	2.116
0.0060	0.24	0.200	310	0.505	19.847	91.4	0.003	154	2.308
0.0065	0.26	0.185	286	0.485	19.068	84.3	0.003	167	2.500
0.0070	0.28	0.171	266	0.467	18.375	78.3	0.003	180	2.693
0.0075	0.30	0.160	248	0.451	17.752	73.1	0.002	192	2.885
0.0080	0.31	0.150	233	0.437	17.188	68.5	0.002	205	3.077
0.0085	0.33	0.141	219	0.424	16.675	64.5	0.002	218	3.270
0.0090	0.35	0.133	207	0.412	16.205	60.9	0.002	231	3.462
0.0095	0.37	0.126	196	0.401	15.773	57.7	0.002	244	3.654
0.0100	0.39	0.120	186	0.391	15.373	54.8	0.002	256	3.847

From the calculations above the heat release rates and burn times are now known. The next aspect that needs to be determined is the growth rate of the fire. For this project, due to the fuels involved and the relatively small size of the spill pool it was appropriate to assume that the fire would grow to full magnitude almost immediately after ignition. In addition, the model used (FDS) has the ability to predict the growth of the fire based on chemical properties of the fuel. For all fire scenarios we chose to allow the FDS model to predict the growth and then compared the results with our professional assumptions, in all cases they compare very well the fire grew very rapidly (almost immediately) to the maximum fire size and held at a steady state until the fuel was depleted. The chemical properties used in the FDS modeling are found below:

```
&SURF ID='ETHANOL'
    PHASE='LIQUID'
    RGB = 0.40,0.40,0.40
    HEAT_OF_VAPORIZATION=837.
    HEAT_OF_COMBUSTION=26800.
    BURNING_RATE_MAX=0.015
    DELTA=0.05
    KS=0.16
    ALPHA=6.9E-8
    TMPIGN=78.
    SURFACE_DENSITY= (varies) /
```

```
&SURF ID='ISOPROPANOL'
    PHASE='LIQUID'
    RGB = 0.40,0.40,0.40
    HEAT_OF_VAPORIZATION=663.
    HEAT_OF_COMBUSTION=30450.
    BURNING_RATE_MAX=0.022
    DELTA=0.004
    KS=0.16
    ALPHA=6.9E-8
    TMPIGN=82.
    SURFACE_DENSITY=(varies) /
```

The final piece of defining the design fires was to determine the combustion products yields (i.e. CO, soot) in order to properly evaluate tenability and the relative hazard of the alcohol-based hand rub solutions. Species yields for a variety of common fuels are reported in a variety of sources including the SFPE Handbook. The yields for a fuel source are used to determine the amount of a combustion product produced for a given amount of fuel and is typically reported in grams of species produced per gram of fuel burned. For this report analysis the yields for pure Ethyl Alcohol or Isopropyl Alcohol (IPA) were used. After careful review this seemed appropriate since the majority of flammable ingredients for the alcohol-based hand rub products reviewed were Ethanol or IPA and the MSDS data sheets did not give any just cause for adjusting the yields for the other non-flammable ingredients. The yields for Ethanol are already part of the database of reactions provided with the FDS model used. Therefore, the numbers provided were confirmed to be valid and the default information was used for our model runs with Ethyl Alcohol based products. IPA was not included in the default database and needed to be created. Using the data available in the SFPE Handbook a reaction line was added to the database for use in the model runs with Isopropyl Alcohol based products. One exception to these yields was for the scenarios that assumed a carpeted floor in the corridor. For these scenarios the yields were adjusted to include more soot and CO than ethanol to simulate the additional burning or charring of the carpet (nylon) directly in contact with the fire. The yields were adjusted upward by assuming a certain amount of nylon material was also burning at the same time as the alcohol. The yields used in the model are shown below compared to the data for the pure substances:

	Ethanol	**IPA**	**Ethanol/ Carpet**	**Ethanol**	**IPA**	**Nylon**
	(Used in FDS Model)			*(From SFPE Handbook*)*		
Soot Yield	0.008	0.015	0.021	0.008	0.015	0.075
CO Yield	0.004	0.006	0.009	0.001	0.003	0.038

C. Fire Model

Fire Dynamics Simulator (FDS) Version 3.1 from the National Institute of Standards and Technology was used on this project to simulate conditions in the occupied space for the proposed fire scenarios. The modeler has key elements of input such as the geometry of the space, location of the fire, ventilation (when applicable), fire size and growth (HRR), species yields (CO, O_2, CO_2, soot), and location of thermocouples to monitor output information.

The geometry of the spaces was inputted to correspond with Figures 1 & 2 in this report and the descriptions provided in Part IV, Subsection A of this report. The model was configured to monitor output mainly via thermocouples placed at 6 feet above the floor at several locations also noted in Figures 1 & 2 of this report. The thermocouples recorded values for temperature, visibility, and carbon monoxide for review and analysis.

Fire Dynamics Simulator (FDS) is a computational fluid dynamics (CFD) model of fire-driven fluid flow. The software solves numerically a form of the Navier-Stokes equations appropriate for low-speed, thermally-driven flow with an emphasis on smoke and heat transport from fires. Smokeview is a visualization program that is used to display the results of an FDS simulation

* SFPE Handbook, 3rd Edition, Table 3-4.14

FDS was originally designed primarily as a tool to predict the transport of heat and smoke from a fire, and for this purpose the code has undergone a considerable amount of validation work. Papers and reports of this work can be found on the NIST Website[†]. The most common uses for the model to date have been for smoke control designs/analysis, such as atrium occupancies, and for fire recreations used in court cases.

D. Performance/Tenability Criteria

To assess the relative hazard of the alcohol-based hand rub solutions a variety of key elements areas were reviewed. The first was to examine the tenability of the spaces selected in the scenarios. This was accomplished in this analysis by monitoring temperature, carbon monoxide and visibility. The second area was to monitor the ignition of adjacent fuel load/combustibles, in particular hand hygiene dispensers. The FDS model has the ability to directly predict the ignition of materials. The final way that the hazard was assessed in this project was by the activation of sprinklers. Again, the FDS model is able to provide reasonable predictions of heat-actuated devices such as sprinklers. Below is a discussion on how these areas were quantified in this analysis.

Thermal Exposure:

There are three ways that exposure to heat may lead to incapacitation or death for an occupant exposed to a fire. They are heat stroke, body surface burns, and respiratory tract burns. Tenability limits for skin pain and burns are typically lower than for respiratory burns. Therefore, our analysis will focus on burns and heat stroke. For exposure to heat, the SFPE Handbook (3rd Edition - Section 2, Chapter 6) provides equations for calculating the time to incapacitation (minutes) for exposure to radiant and convective heat. For radiant heat there is a clear threshold of 1.7 to 2.5 kW/m^2 where exposure above this limit causes pain and skin burns in a few seconds and below can be tolerated almost indefinitely. For situations where occupants must pass under a hot smoke layer this radiant heat flux corresponds to a hot smoke layer of 390°F (200°C). Above this threshold, the time (minutes) to incapacitation due to radiant heat can be calculated using Equation 26 from the SFPE Handbook (see below).

$$t_{Irad} = \frac{133}{q^{1.33}}$$

where :

t_{Irad} = time in minutes to incapacitation from radiant heat

q = radiant flux exposed (kW/m^2)

† Information obtained from the NIST website - http://fire.nist.gov/fds/

For convective heat, Equation 27 from the SFPE Handbook (see below) can be used to determine the time to incapacitation for an occupant exposed to a constant temperature.

$$t_{Iconv} = 5 \times 10^{7} T^{-3.4}$$

$$where:$$

$$t_{Iconv} = \text{time in minutes to incapacitation from convective heat}$$

$$T = \text{Temperature exposed in degrees Celsius}$$

$$\text{Rearraging to solve for temperature assuming a 10 minute exposure:}$$

$$T = \left(\frac{5 \times 10^{7}}{10} \right)^{0.294}$$

$$T = 93^{\circ}\text{C}$$

Due to the short exposure times expected in the analysis, we used the above equation to determine the temperature at which an occupant can be exposed to for up to 10 minutes (see above). The result shows that a person may be exposed to 200°F (93°C) for up to 10 minutes. This temperature is less than determined for radiant exposure so for our analysis, we will assume that exposure to temperatures above 200°F is unacceptable.

Since we are not exposed to a constant temperature and the occupancy being evaluated (healthcare) has what can be considered a susceptible population, additional analysis is required for temperatures below the above threshold to determine whether they are acceptable. The body of a fire victim may be regarded as acquiring a "dose" of heat over a period of time during exposure. There is a method for determining the accumulated "dose" acquired by an exposed occupant. The method determines for each time step (typically per minute) the fraction of the incapacitating exposure, which then summed together (accumulated) over time. The equation for this is shown below and is for one minute time steps (Equation 28, SFPE Handbook, 3rd Edition):

$$\text{FED} = \sum_{t_1}^{t_2} \left(\frac{1}{t_{Irad}} + \frac{1}{t_{Iconv}} \right) \Delta t$$

$$where:$$

$$\text{FED} = \text{Fraction Effective Dose}$$

****Note that for smoke layer temperatures below 390°F (200°C) radiation term is zero.*

When the FED reaches unity (1.0) an occupant is assumed to have been exposed to an incapacitating dose of heat. To protect susceptible occupants, it is suggested that a FED of 0.1 not be exceeded (safety factor of 10). This factor should allow for safe escape for nearly all exposed individuals‡. Therefore, when the temperatures are below the threshold stated above further analysis using the FED method described will be done. If the FED analysis yields a value of 0.1 or lower the scenario will be assumed acceptable.

‡ SFPE Handbook (3rd Edition), p2-110

Carbon Monoxide:

Carbon Monoxide (CO) represents the most common fire toxicant, to the extent that over half of all fire fatalities are due to CO inhalation. Concentrations as low as 4000 parts per million (ppm), or 0.4 % by volume, can be fatal exposures in durations less than an hour. For this analysis, a CO threshold value of 1400 ppm was used, which is taken from The SFPE Handbook (3rd Edition), Table 2-6B(a) for a 30-minute exposure. Values obtained from the results of the model above this threshold will be considered anacceptable.

Visibility:

Beside the toxicological significance of smoke, it is important to consider the psychological impact of smoke with respect to visual obscuration. Depending on whether occupants are familiar with the space, the complexity of the egress system, and the spacing of exit signs, different visibility criteria can be established. The SFPE Hand Book (3rd Edition) Table 3-6.10 provides suggested tenability limits for smoke densities and visibility that permit safe egress. For small enclosures and travel distances the table suggests a smoke obscuration limit of 0.2 m^{-1} (OD/m), which corresponds to about 21 feet of visibility. For large enclosures and travel distances the table suggests a smoke obscuration limit of 0.08 m^{-1} (OD/m), which corresponds to about 53.5 feet of visibility. The corresponding visibility distances are assuming a reflective sign or surface (C-factor of 3.0), which is used in the FDS model.

The scenarios that are being modeled are all small enclosures and travel distances. Therefore, a visibility of 21 feet will be used as the tenability threshold and visibility values below this will be considered unacceptable.

Ignition of Adjacent Materials:

In evaluating the relative hazard of the proposed alcohol-based hand rub dispensers; a major consideration is the spacing of multiple dispensers and the likelihood of a fire spreading by igniting more than one dispenser. Using the FDS model we were able to monitor targets to see if they would become involved from the exposure of our design fires. Using FDS an ignition temperature was set for the targets and if the ignition temperature were reached for the surfaces of the target the material would become involved in the fire. The ignition temperature used was 697°F (370°C), which is comparable to PVC (357-374°C)[§] but is lower than most other plastic materials (443°C or greater). For this analysis, if adjacent targets ignite the scenario would be considered unacceptable. This failure would indicate that additional consideration would need to be given to the spacing of the dispensers but would not necessarily show that the presence of dispensers in the space to be too hazardous.

Sprinkler Activation:

Ordinary temperature, standard response sprinklers were incorporated into the model by defining detectors. This was done in lieu of actual sprinklers so that suppression of the fire would not occur if the sprinklers activated. By monitoring sprinkler activation we were able to determine a number of things about the hazard, such as whether the design fires were significant enough to actuate sprinklers, whether a sprinkler protection would be a significant factor in the results, etc. Sprinkler activation alone in this analysis was not a pass fail type performance criteria but rather a qualitative method for further assessing the hazard of each scenario.

[§] SFPE Handbook (3rd Edition), Table 3-4.3

E. Results

Using the FDS model, the scenarios described above were run and the results obtained via a combination of visual observation of output files and data obtained through a number of data collecting thermocouples put into the model. The results of the models are summarized below and further information from the results can be found in Appendix B.

The table below shows the maximum values during each scenario, reports sprinkler activation and time, and states whether ignition of any target fuels occurred. Temperature, CO and visibility values are taken as an average value at head level (6 feet above the floor).

Table 5 - Summary of Fire Model Results

	Fire Size	**Temp.**	**$\sum FED_{heat}$**	**Visibility**	**Carbon Monoxide**	**Sprinkler Activation**	**Ignition of Targets**
	kW	ºF		feet	ppm		
Tenability Thresholds	-	*200°F*	*0.10*	*21*	*1400*	-	-
Scenario 1-1	100	158	0.06	47	13	N	N
	40	135	0.07	49	12	N	N
Scenario 1-2	200	**247**	N/A	27	25	Y 64 sec	N
	80	190	**0.27**	**19**	31	N	N
Scenario 1-3	100	195	**0.15**	30	21	N	N
	40	142	0.08	35	16	N	N
Scenario 1-4	200	**397**	N/A	**12**	56	Y 49 sec	N
	80	190	**0.27**	**19**	31	Y 195 sec	N
Scenario 1-5	100	150	0.05	49	12	N	N
	40	131	0.06	68	10	N	N
Scenario 1-6	40	134	0.07	**18**	28	N	N
Scenario 1-7	40	150	0.05	**18**	28	N	N
Scenario 1-8	200	199	0.10	**19****	31	N	N
	55	149	0.10	25	23	N	N

	Fire Size	Temp.	$\sum FED_{heat}$	Visibility	Carbon Monoxide	Sprinkler Activation	Ignition of Targets
	kW	ºF		feet	ppm		
Tenability Thresholds	*-*	*200°F*	*0.10*	*21*	*1400*	*-*	*-*
Scenario 2-1	100	102	0.001	90	6	N	N
	40	108	0.001	79	7	N	N
Scenario 2-2	200	138	0.006	61	10	Y 77 sec	N
	80	117	0.002	60	9	Y 251 sec	N

Note: Values stated are maximum values for each scenario.

*** Value dropped below visibility limit at end of fire burn for a maximum of 15 seconds and continued to improve to a visibility of 45 feet by the end of the model run*

V. CONCLUSIONS

The results clearly indicate that the 2-Liter container size to be unacceptable in a corridor location. In addition, the results also indicate the scenario with a carpeted floor is a concern due to visibility problems. The scenario showed that the visibility in the corridor dropped slightly below our assigned threshold. The carpet scenario is based on assumptions (soot & CO yields) that are not validated via any test data or other available data sources. The yields used are based on engineering judgment and needs further study to make a firm recommendation. Visibility, unlike other tenability areas (i.e. temperature, toxicity), is based on a number of factors, has limited real life test data, and is very subjective. The resources available have a wide range of values that could be considered acceptable based on various factors, such as type of smoke (irritating vs. non-irritating), travel distances, familiarity with escape routes, etc. The tenability value for this report was chosen to be conservative but Gage-Babcock feels that the value is appropriate for the generic scenarios chosen.

The fire modeling does clearly show that up to 1.2-Liter container size in both a corridor and suite location to be acceptable for either Ethyl or Isopropyl Alcohol based products. Except for Scenario 1-8 that was modeled with the 1.2-Liter Isopropyl Alcohol container all of the results with realistic conditions showed no issues. For Scenario 1-8, the visibility did drop below the stated threshold but since visibility is not an immediate health concern and it did not occur until the very end of the fire's burn time (final 15 seconds) only to improve dramatically to twice the allowable value, we feel that this is still an acceptable result. The scenario with 6-ft corridors and all doors closed, which is a very extreme case compared to actual conditions, does show some concerns compared to our tenability criteria. The results showed that the corridor remained below the visibility and CO thresholds established. The temperature in this scenario did drop below the tenability threshold (which has a factor of safety of 10) but not significantly. This scenario helps to prove that the hazard is acceptable by performing relatively well under extreme condition.

The results showed that none of the fuel targets put into the models would ignite based on the design fires chosen. This indicates that the proposed spacing to be reasonable to prevent additional involvement of more than one dispenser.

Sprinkler activation was not predicted for most of the scenarios modeled. When the sprinklers actuated it was most often after the conditions had exceeded the tenability thresholds and typically with the larger 2-liter spills. Due to the lack of sprinkler activation, it is important to address the hazard from products of combustion such as smoke or CO more than the hazards from heat or the actual fire.

VI. RECOMMENDATIONS

As a result of this analysis, the American Society for Health Care Engineering in consultation with Gage-Babcock & Associates has the following recommendations for the use and storage of the alcohol-based hand rub solutions in the liquid/gel form:

1. Single containers installed in an egress corridor should not exceed a maximum capacity of 1.2 liter (40.6 ounces). Single containers installed in a suite should not exceed a maximum capacity of 2 liter.

2. Alcohol-based hand rub dispensers should not be installed over electrical receptacles or near other potential sources of ignition.

3. Alcohol based hand rub dispensers that project more than 3½ inches (4½ inches where 2003 Life Safety Code is adopted) into the corridors should be noted in the facility's Fire Plan and Training Program.

4. All storage of replacement alcohol-based hand rub containers on patient floors, regardless of the quantity, should be within an approved flammable liquid storage cabinet.

5. The quantity of replacement alcohol-based hand rub containers stored and used on any floor, including bulk storage in Central Supply Rooms, should not exceed the maximum quantity permitted by the local prevailing building and fire codes.

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CDC/HICPAC CATEGORIES:

As in previous CDC/HICPAC guidelines, each recommendation is categorized on the basis of existing scientific data, theoretical rationale, applicability, and economic impact. The CDC/HICPAC system for categorizing recommendations is as follows:

Category IA	Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.
Category IB	Strongly recommended for implementation and supported by certain experimental, clinical, or epidemiologic studies and a strong theoretical rationale.
Category IC	Required for implementation, as mandated by federal or state regulation or standard.
Category II	Suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale.
No recommendation Unresolved issue.	Practices for which insufficient evidence or no consensus regarding efficacy exist.

SPONSORSHIP CONTACT INFORMATION

Coloplast Corporation
Skin Care Division
Darcy Helder
Assistant Product Manager
Commercial Development
1940 Commerce Drive,
North Mankato, MN 56003
507-386-4345
USDLH@coloplast.com

Johnson & Johnson
Division of ETHICON, Inc.
Joseph Boyle
Product Director
Advanced Wound Care
U.S. Highway 22 West
P.O. Box 151
Somerville, NJ 08876
817-423-1132
Jboyle@ethus.jnj.com

3M Health Care Markets
Melanie J. Zahler
Market Development Manager
Medical Division
3M Center, Building 275-04-W-02
St. Paul, MN 55144
651-733-9638
mjzahler@mmm.com

GOJO Industries, Inc.
Patty Taylor
Marketing Director
Acute Care
One GOJO Plaza
Suite 500
Akron, OH 44311
330-255-6381
taylorp@GOJO.com

Ecolab, Inc.
John Bucholz
Market Manager
Professional Products Division
370 North Wabash Street
St. Paul, MN 55102
651-293-2607
john.bucholz@ecolab.com

Steris Corporation
Healthcare Group
Will Shane
Vice President, Sales
5960 Heisley Road
Mentor, OH 44060
440-354-2600
will_shain@steris.com

APPENDIX A

EXCERPTS FROM REPORTS ON
PROPOSALS TO NFPA 101

(Log # 741)
101- 784 - (31-2.10 (New)): Accept
SUBMITTER: Committee on Safety to Life - Subcommittee on Assembly and Educational Occupancies
RECOMMENDATION: Add a new 31-2.10 to read:
"Proscenium Curtain. All procenium curtains shall be in the closed position except during performances, rehersals or similar activity."
SUBSTANTIATION: Proscenium (fire) curtains are usually large crude operating assemblies custom built for each installation. By committee members observation and by admission of many fire curtain installers a substantial number of fire curtains, fifty percent of the installations by many accounts, are inoperable or not fully operable. Requiring fire curtains to be closed on a regular basis will provide some assurance that the movement of the curtain has not been obstructed, either temporarily by scenery or props or permanently by alterations to the building or as quick fixes for fire curtains in need of maintenance. This normally closed routine is common practice on European stages where the record indicates fire curtains have certainly limited property loss and may have provided life safety. Finally, in the 1903 Iroquois Theater Fire in Chicago, the apparent basis for most of the codes in this country regulating theaters and stages, the fire curtain apparently failed to close fully.
COMMITTEE ACTION: Accept.

(Log #710)
101- 785 - (31-4.1.2): Accept
SUBMITTER: Committee on Safety to Life - Subcommittee on Health Care Occupancies
RECOMMENDATION: Delete 31-4.1.2.
SUBSTANTIATION: Health care is a defend in place occupancy and it is common practice and the preferred technique to move patients and residents on bedding, not beds. This eliminates the need for this paragraph.
COMMITTEE ACTION: Accept.

(Log #301)
101- 786 - (31-4.1.5 (New)): Reject
SUBMITTER: Eugene A. Cable, U.S. Veterans Administration
RECOMMENDATION: Add new Section 31-4.1.5 as follows:
31-4.1.5 For non-sprinklered fire/smoke zones special fire drill procedures are required. All drills in such zones shall include the evacuation of ambulatory patients (who would not be adversely affected) to a safe area of refuge, normally beyond a smoke barrier.
Exception: Where all rooms in the fire/smoke zone are separated by smoke tight partitions with at least a 20 minute fire resistive rating.
SUBSTANTIATION: As allowed by the 1988 Life Safety Code, modern construction can provide no fire/smoke resistance between rooms located on the same side of corridor wall (i.e., non-rated false ceilings or connecting bathrooms with louvered doors). Placing patients in their room with door closed will provide no protection from a fire in the neighboring room(s). Smoke produced could quickly spread into all rooms on the same side of corridor.
Section 31-4.1.3 implies the intent to move patients during drills. This proposed added section would clearly require such movement.
The Life Safety Code must provide for fire resistance between patient rooms or provide for well trained immediate evacuation out of the fire area and into an area of refuge. Most health care fire drills have regressed to R.A.C.E. with no preparation for evacuation from the zone. A requirement to move those patients which would not be adversely affected during drills would cause no risk to the patient and force the health care staff to be prepared to move patients during an actual fire.
Health care staff cannot depend on the fire service to move patients as the situation would likely deteriorate fast on the fire side of corridor before their arrival and for health care the fire service generally places initial arriving resources into fire suppression, not rescue.
A 150 ft long smoke zone, 12 feet deep rooms, with a 14 ft high floor slab above, has 25,200 cu ft of space on one side of the corridor. A one room fully developed fire produces around 30,000 cu ft of smoke per minute. This would fill the affected side of the corridor with smoke within one minute of flashover. Hence, the need to truly protect in place or move patients out fast.
COMMITTEE ACTION: Reject.
COMMITTEE STATEMENT: The Committee does not intend that patient movement be a part of fire drills. The potential for harm to patients does not justify the benefit.

(Log #711)
101- 787 - (31-4.5.1): Accept in Principle
SUBMITTER: Committee on Safety to Life - Subcommittee on Health Care Occupancies
RECOMMENDATION: Revise 31-4.5.1 as follows:
31-4.5.1 Draperies, cubicle curtains and other loosely hanging fabrics and films serving as furnishings or decorations in health care occupancies shall be in accordance with the provisions of 31-1.4.1.
SUBSTANTIATION: Paragraph 31-4.5.1 is concerned with hanging fabrics, specifically draperies and cubicle curtains, but has been worded in an effort to be sufficiently generic to cover the use of any "fabrics or films" as furnishings or decorations. The emphasis on "fabrics or films" is to indicate wording similar to that used in NFPA 701, Standard Methods of Fire Tests for Flame-Resistant Textiles and Films. NFPA 701 appears to use the words "textiles" and "fabrics" interchangeably. NFPA 701 also makes the point that it applies to the use of textiles, fabrics or films which are loosely hanging. When textiles, fabrics or films are applied to surfaces of a building or backing materials as interior finishes, they are to be tested in accordance with NFPA 255 (the tunnel test). Additionally, the reference to 31-1.4 should be specific to the paragraph which deals with hanging fabrics and NFPA 701.
COMMITTEE ACTION: Accept in Principle.
See Committee Action on Proposal 101-789 (Log #554) on 31-4.5.
COMMITTEE STATEMENT: The Committee Action on the above referenced proposal accomplishes the Subcommittee's intent.

(Log #712)
101- 788 - (31-4.5.2): Accept in Principle
SUBMITTER: Committee on Safety to Life - Subcommittee on Health Care Occupancies
RECOMMENDATION: Revise 31-4.5.2 to read:
31-4.5.2* Bedding, furnishings, and decorations in health care occupancies shall be in accordance with the provisions of 31-1.4.2.
SUBSTANTIATION: Paragraph 31-4.5.2 suffers from the same problems as 31-4.5.1 in that the reference to 31-1.4 is too broad and has created some questions among enforcement personnel that bedding can be construed as being subject to NFPA 701 causing all bed spreads, blankets and sheets to be potentially subject to testing. There is parallel structure to 31-4.5 and 31-1.4 indicating that it has been the Committee intent to have hanging fabrics in 31-4.5.1 covered by 31-1.4.1 and to have other furniture and bedding in 31-4.5.2 covered by 31-1.4.2. By making reference to specific parts of 31-1.4, the Committee intent would be met.
COMMITTEE ACTION: Accept in Principle.
Renumber and revise current 31-4.5.2 to read:
31-4.5.6 Bedding, furnishings, and decorations in health care occupancies shall be in accordance with the provisions of 31-1.4.5.
COMMITTEE STATEMENT: Section 31-1.4 is being revised by Proposal Log #553. Existing paragraph 31-1.4.2 is being retained but renumbered as 31-1.4.5. Per the Committee Action on Proposal Log #554 on 31-4.5, the next available paragraph number that can be used to retain the concept of current 31-4.5.2 is 31-4.5.6. the Committee Action achieves the intent of the Subcommittee on Health Care Occupancies which drafted this proposal.

(Log #CP775)
Committee: SAF-AXM
101- 915 - (A-8-2.5.6.3 and A-9-2.5.6.3 (New)): Accept
SUBMITTER: Technical Committee on Assembly Occupancies and Membrane Structures
RECOMMENDATION: Create new Appendix notes to read:
A-8-2.5.6.3 It is the intent to permit handrails to project a maximum of 3-1/2 in. (8.9 cm) into the clear width of aisles required by 8-2.5.6.3.
A-9-2.5.6.3 It is the intent to permit handrails to project a maximum of 3-1/2 in. (8.9 cm) into the clear width of aisles required by 9-2.5.6.3.
SUBSTANTIATION: The subject of the appendix notes arose through the processing of a formal interpretation. The wording clarifies the committee's intent.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 21
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 19
NEGATIVE: 1
NOT RETURNED: 1 Cich
EXPLANATION OF NEGATIVE:
PAULS: This ballot is consistent with my ballot of "No" for the Formal Interpretation. See the comment which accompanies the Formal Interpretation ballot. It notes that 8-2.5.6.3(c) and (f) specifically refer to measurement to a handrail. Thus the widths are meant to be clear to the handrail. Note that 5-3.2 should not be applied to aisles. Otherwise the 48-in. aisles would end up being only 41 in. between seats. Therefore the committee action on Committee Proposal 101-915 (Log #CP775) should be reversed in my opinion.

(Log #243)
Committee: SAF-END
101- 916 - (A-10-3.6 Exception No. 2 (New) and A-11-3.6 Exception No. 2 (New)): Accept in Principle
SUBMITTER: James Knox Lathrop, Koffel Associates, Inc.
RECOMMENDATION: Add a new A-10-3.6 Exception No. 2 and add a new A-11-3.6 Exception No. 2 to read:
It is the intent of the Code to allow corridor walls that are only required to be smoke resistant to terminate at a smoke resistant ceiling. Drop-tile ceilings that are properly installed and maintained and do not contain air transfer grilles (i.e., the space above the ceiling is not used as an air handling plenum) may usually be considered smoke resistant.
SUBSTANTIATION: When this exception was added to the Code it was intended to allow corridor walls in sprinklered facilities to terminate at ceilings as long as the wall and ceiling are smoke resistant, not smoke tight. I specifically remember SAF-HEA being provided research from NIST (then NBS-CFR) that showed that drop-tile ceilings resisted the passage of smoke, especially in a sprinklered building. However, there are many people that are saying that drop-tile ceilings are not smoke resistant. There is no code text or appendix notes to support what has previously been the intent of the Committee.
COMMITTEE ACTION: Accept in Principle.
See Committee Proposal 101-393 (Log #CP756) on Exception No. 2 to 10-3.6.
COMMITTEE STATEMENT: The revision to Exception No. 2 to 10-3.6, via the referenced proposal, adds a mandatory reference to new 6-2.4 on smoke partitions. A new appendix note, A-6-2.4.2 Exception, explains much of the same concept that the submitter addressed. This should meet the submitter's intent.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 15
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 15

(Log #CP136)
Committee: SAF-END
101- 917 - (A-11-3.6 Exception No. 2 (New)): Accept
SUBMITTER: Technical Committee on Educational and Day-Care Occupancies
RECOMMENDATION: In 11-3.6 Exception No. 2, add an asterisk and create an appendix note to read:
A-11-3.6 Exception No. 2. The exception permits valve supervision in accordance with Section 7-7 rather than requiring that the entire automatic sprinkler system be electrically supervised. It is intended that the valve supervision be performed electrically, not by chaining and locking the valves in the open position.
SUBSTANTIATION: Exception No. 2 to 11-3.6 requires that the automatic sprinkler system be provided with valve supervision in accordance with Section 7-7. The appendix note clarifies that it is not the intent to rely solely on valves that have been chained and locked in the open position. Rather, the reference to Section 7-7 was meant to implement the requirement that such valve supervision be performed electrically.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 15
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 13
NEGATIVE: 1
ABSTENTION: 1
EXPLANATION OF NEGATIVE:
WEAVER: The appendix is considered to not be part of NFPA 101 and therefore stating it is the intent of the committee that "such valve supervision be performed electronically" would be construed as a suggestion and not a requirement.
This view is held because 7-7.2.1 states, "Where supervised, automatic sprinkler systems are required" and therefore unless it is specifically required by the appropriate occupancy chapter, Section 7-7 could not be inferred as meaning valve supervision would be performed electronically.
EXPLANATION OF ABSTENTION:
DUFFIN: The first sentence to the proposed new Appendix A-11-3.6 Exception No. 2 is confusing as written. The second sentence is clear. This paragraph needs to be clarified.

[redacted]
Committee: SAF-HEA
101- 918 - (A-12-2.3.3 (New)): Accept in Principle
SUBMITTER: James Knox Lathrop, Koffel Associates, Inc.
RECOMMENDATION: Add a new A-12-2.3.3 to read:
A-12-2.3.3 It is not the intent that the 8 ft (2.4 m) width be maintained clear and unobstructed at all times. First, items can project 3 1/2 in. into the required width at and below handrail height per 5-3.2. It is not the intent of this paragraph to supersede 5-3.2. Also, it is recognized that items will be parked in health care corridors, such as food service carts, housekeeping carts, gurneys, beds, and similar items. If it was not for this expectation, the minimum corridor widths could be reduced. It is simpler to design and enforce an 8 ft corridor with the expectation of parking, than to require a 4 ft or similar measurement to be free and clear at all times. It should be noted that "parking" is not the same as storage. Storage is not allowed to be open to corridors unless it meets one of the exceptions provided in 12-3.6 and is not a hazardous area.
SUBSTANTIATION: I have submitted this appendix note for consideration by the Committee due to rumors I have heard that the Committee is considering dropping the 8 ft corridor requirement. I think this would be a major mistake. I understand the Committee's concerns and have run into some interesting interpretations of this requirement lately. I have no "pride of authorship" in the appendix note. The Committee can, of course, massage it. However, I do feel that maintaining the 8 ft requirement but adding material that will clarify the purpose will be better than changing to a smaller number with a strict maintenance requirement. I have been in several facilities that have 4 or 6 ft corridors, and it only takes one gurney in the corridor to create significant egress issues. I recognize that "parked" vs. "stored" is very judgmental, but it doesn't take inspecting too many facilities before it becomes obvious when something is being stored in a corridor vs. being parked there.
COMMITTEE ACTION: Accept in Principle.
Add a new A-12-2.3.3 to read:
A-12-2.3.3 It is not the intent that the required corridor width be maintained clear and unobstructed at all times. Projections into the required width are permitted per the exceptions to 5-3.2. It is not the intent that 12-2.3.3 supersede 5-3.2. Also, it is recognized that wheeled items "in use" (such as food service carts, housekeeping carts, gurneys, beds, and similar items) and wheeled crash carts not "in use" (because of the need to have them immediately accessible during a clinical emergency) will occur in health care occupancy corridors. The health care occupancy's fire plan and training program should address the relocation of these items during a fire. Note that "in use" is not the same as "in storage." Storage is not allowed to be open to the corridor unless it meets one of the exceptions to 12-3.6.1 and is not a hazardous area.

Add a new A-13-2.3.3 to read:

A-13-2.3.3 It is not the intent that the required corridor width be maintained clear and unobstructed at all times. Projections into the required width are permitted per the exceptions to 5-3.2. It is not the intent that 13-2.3.3 supersede 5-3.2. Also, it is recognized that wheeled items "in use" (such as food service carts, housekeeping carts, gurneys, beds, and similar items) and wheeled crash carts not "in use" (because of the need to have them immediately accessible during a clinical emergency) will occur in health care occupancy corridors. The health care occupancy's fire plan and training program should address the relocation of these items during a fire. Note that "in use" is not the same as "in storage." Storage is not allowed to be open to the corridor unless it meets one of the exceptions to 13-3.6.1 and is not a hazardous area.

COMMITTEE STATEMENT: The action should meet the submitter's intent. The appendix note provides useful guidance for existing facilities as well as new facilities. Thus, the appendix note will appear both in the A-12's and the A-13's.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 18

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 17

NOT RETURNED: 1 Petresky

(Log #287)
Committee: SAF-HEA

101- 919 - (A-12-3.4.3.1 (New)): Reject

SUBMITTER: Eugene A. Cable, U.S. Department of Veterans Affairs

RECOMMENDATION: Add new appendix note as follows:

A-12-3.4.3.1 The general evacuation alarm signal, as stated in 7-6.3.5, in itself is not adequate or appropriate for health care occupancies. Unless the health care facility fire plan is total evacuation upon fire alarm activation, it is intended that the fire alarm system notify staff (and possibly occupants) automatically and immediately of the zone or area where fire is detected. Staff must respond to that area to prepare patients for evacuation, and possibly evacuate patients to an area of refuge. Staff must know, without delay, where the fire emergency is located in order to remove patients and visitors from harms way.

SUBSTANTIATION: Recent health care fire incidents have shown that staff response, without delay, to the fire zone is critical to patient safety. Petersburg, VA; Brooklyn, NY; Norfolk, VA; Ocean Springs, MS, are examples. This appendix note would help the code user understand the new sentence concerning fire alarm notification.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: The general evacuation alarm required by 7-6.3.5 is adequate.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 18

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 17

NOT RETURNED: 1 Petresky

(Log #CP728)
Committee: SAF-HEA

101- 920 - (A-12-3.6.2 and A-13-3.6.2.1 Exception No. 1): Accept

SUBMITTER: Technical Committee on Health Care Occupancies

RECOMMENDATION: Add the following to existing appendix note A-12-3.6.2 as a second paragraph:

"An architectural, exposed suspended grid acoustical tile ceiling with penetrating items such as sprinkler piping and sprinklers, ducted HVAC supply and return air diffusers, speakers, and recessed lighting fixtures is capable of limiting the transfer of smoke."

Add the following as a new appendix note to Exception No. 1 to 13-3.6.2.1:

A-13-3.6.2.1 Exception No. 1 An architectural, exposed suspended grid acoustical tile ceiling with penetrating items such as sprinkler piping and sprinklers, ducted HVAC supply and return air diffusers, speakers, and recessed lighting fixtures is capable of limiting the transfer of smoke.

SUBSTANTIATION: The proposed appendix note draws from the wording of proposed A-6-2.4.2 Exception from Proposal 101-260 (Log #CP607). It is helpful information for the user that should be included in the health care occupancies' appendix given that proposed new Section 6-2.4 will not be referenced by Chapters 12 and 13.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 18

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 17

NOT RETURNED: 1 Petresky

(Log #247)
Committee: SAF-HEA

101- 921 - (A-12-3.6.2 and A-13-3.6.2.1 Exception No. 1 (New)): Accept in Principle

SUBMITTER: James Knox Lathrop, Koffel Associates, Inc.

RECOMMENDATION: Add the following to A-12-3.6.2 and add a new A-13-3.6.2.1 Exception No. 1 to read:

It is the intent of the Code to allow corridor walls that are only required to be smoke resistant to terminate at a smoke resistant ceiling. Drop-tile ceilings that are properly installed and maintained and do not contain air transfer grilles (i.e., the space above the ceiling is not used as an air handling plenum) may usually be considered smoke resistant.

SUBSTANTIATION: Over the years all the discussions by SAF-HEA and several other committees have been based on allowing corridor walls in sprinklered facilities to terminate at ceilings as long as the wall and ceiling are smoke resistant, not smoke tight. I specifically remember SAF-HEA being provided research from NIST (then NBS-CFR) that showed that drop-tile ceilings resisted the passage of smoke, especially in a sprinklered building. However, there are many people that are saying that drop-tile ceilings are not smoke resistant. There is no code text or appendix notes to support what has previously been the intent of the Committee.

COMMITTEE ACTION: Accept in Principle.

See Committee Proposal 101-920 (Log #CP728).

COMMITTEE STATEMENT: The action on the referenced proposal should meet the submitter's intent.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 18

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 17

NOT RETURNED: 1 Petresky

(Log #CP704)
Committee: SAF-HEA

101- 922 - (A-12-7.2.1(a) and (b); A-13-7.2.1(a) and (b)): Accept

SUBMITTER: Technical Committee on Building Service and Fire Protection Equipment

RECOMMENDATION: In A-12-7.2.1(a) and A-13-7.2.1(a) change "manual alarm station" to "manual fire alarm box."

In A-12-7.2.1(b) and A-13-7.2.1(b) change "manual alarm station" to "manual fire alarm box."

SUBSTANTIATION: Correction of terminology.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 18

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 17

NOT RETURNED: 1 Petresky

(Log #301)
Committee: SAF-HEA

101- 923 - (A-13-3.6.2.1): Accept

SUBMITTER: Philip R. Jose, Guilderland, NY

RECOMMENDATION: Change 20 minutes to 30 minutes in this Appendix note.

SUBSTANTIATION: To be consistent with the 20 to 30 minute changes made last cycle and the paragraph in the body of the code to which it refers.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 18

VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 17

NOT RETURNED: 1 Petresky

(Log #CP737)
Committee: SAF-HEA

101- 924 - (A-13-3.6.3.2): Accept

SUBMITTER: Technical Committee on Health Care Occupancies

RECOMMENDATION: Revise the third paragraph, subitem (b) of A-13-3.6.3.2 to read:

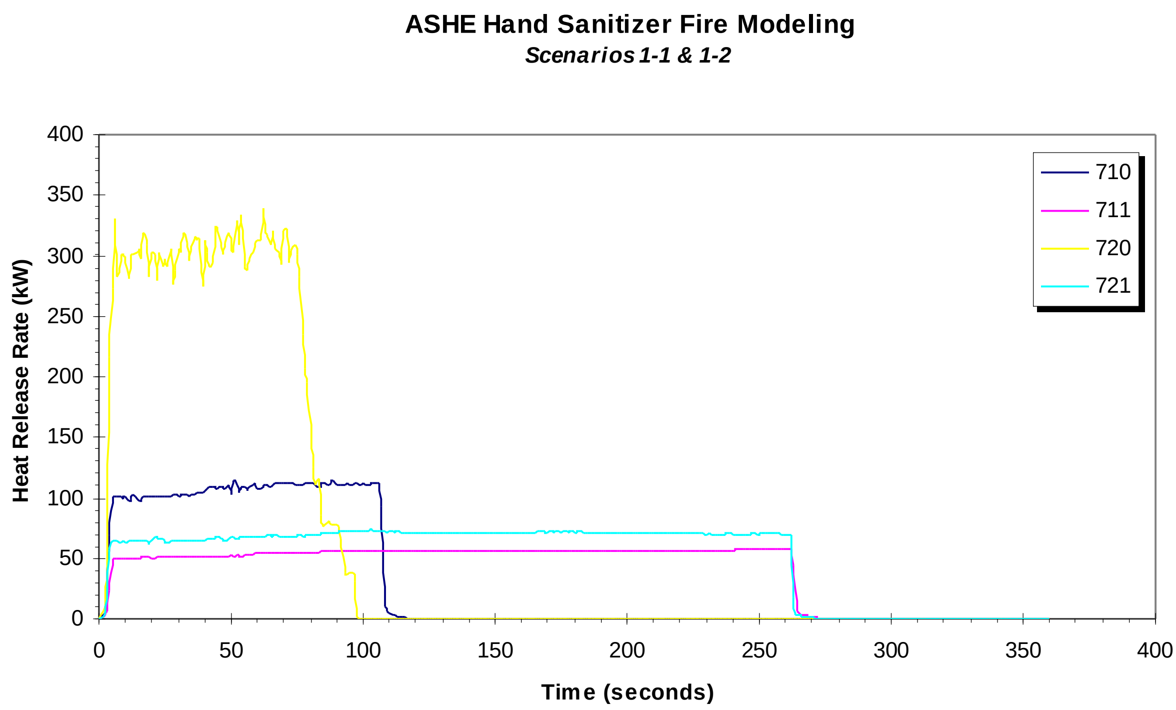
(b) It is the intent of the Code that no new installations of roller latches be allowed. The repair or replacement of existing roller latches is not considered a new installation. ~~However, existing installations of roller latches that keep the door closed against a force of 5 lbf (22 N) and are acceptable to the authority having jurisdiction, coupled with adequate maintenance and staff training, may be continued to be used.~~

SUBSTANTIATION: The added verbiage explains committee intent; the deleted verbiage is already addressed in the body of the Code.

COMMITTEE ACTION: Accept.

APPENDIX B

ADDITIONAL FIRE MODEL RESULTS
CHARTS AND SMOKEVIEW SCREEN SHOTS



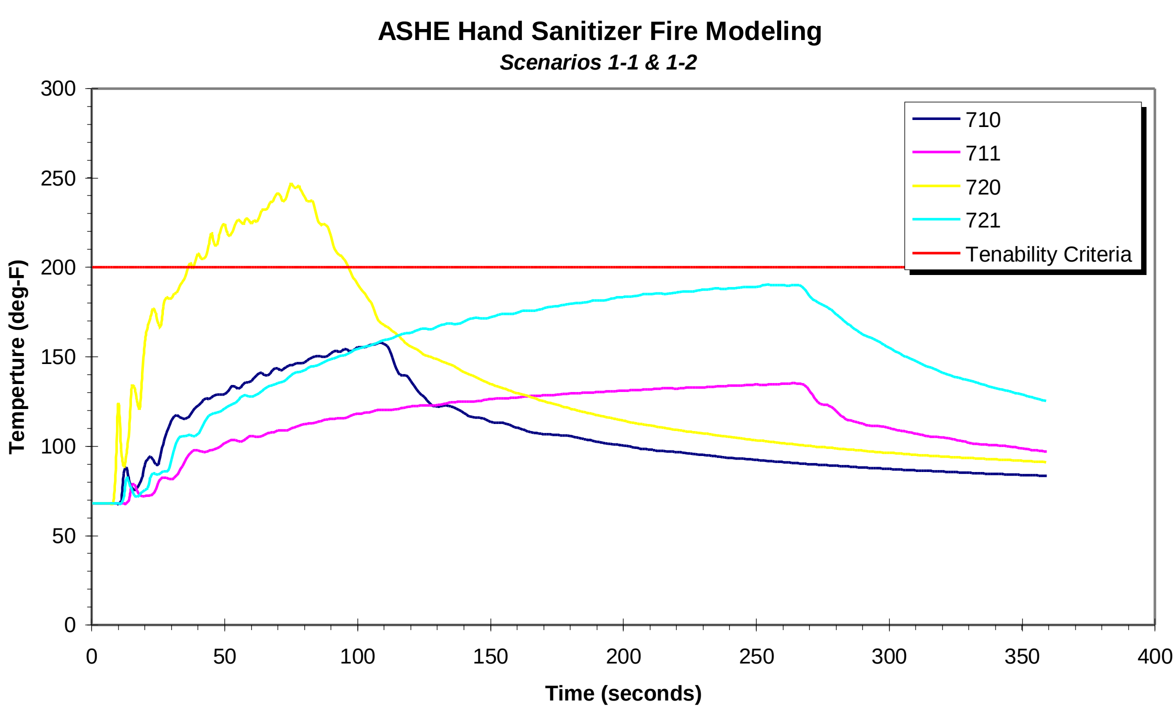
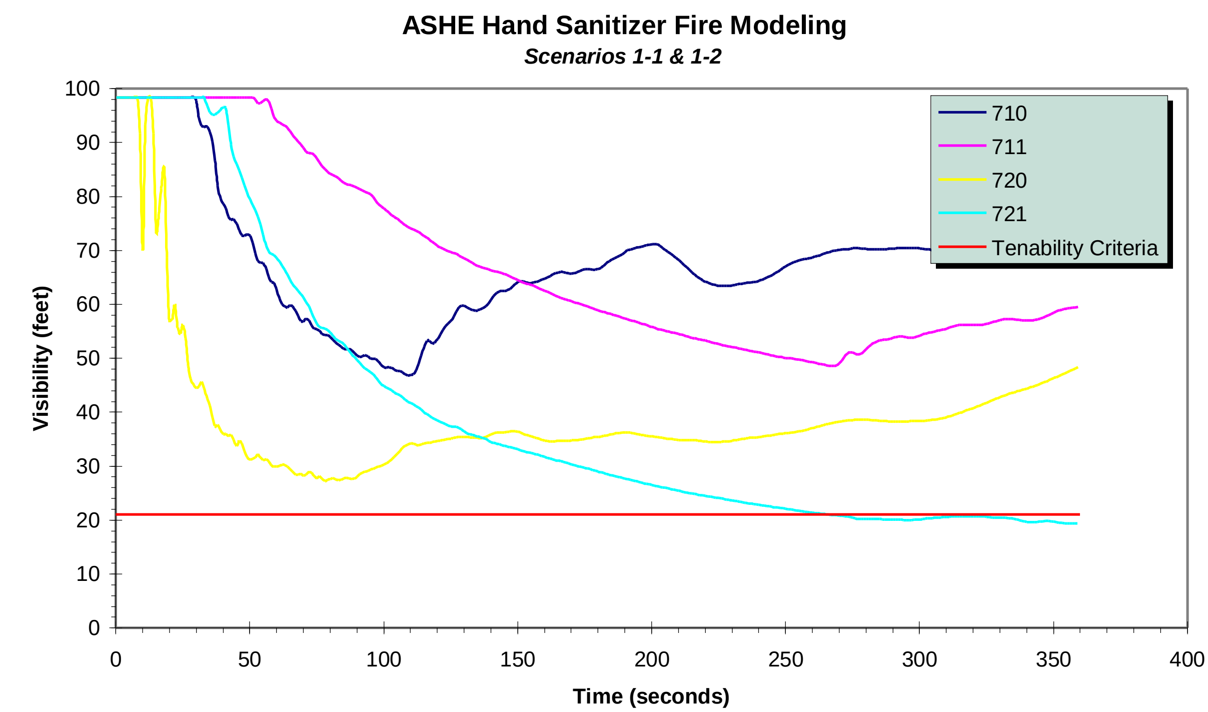


Figure 5 - Scenarios 1-1 & 1-2 (Heat Release Rate and Temperature Graphs)



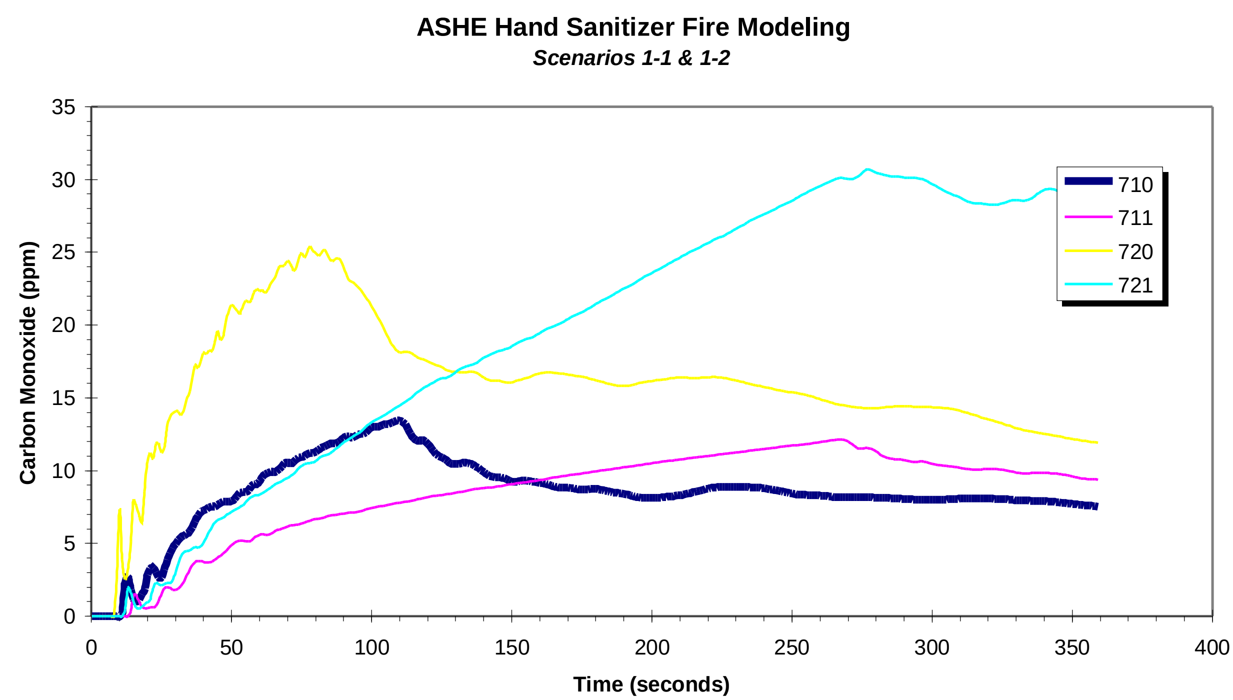


Figure 6 - Scenarios 1-1 & 1-2 (Visibility and Carbon Monoxide Graphs)

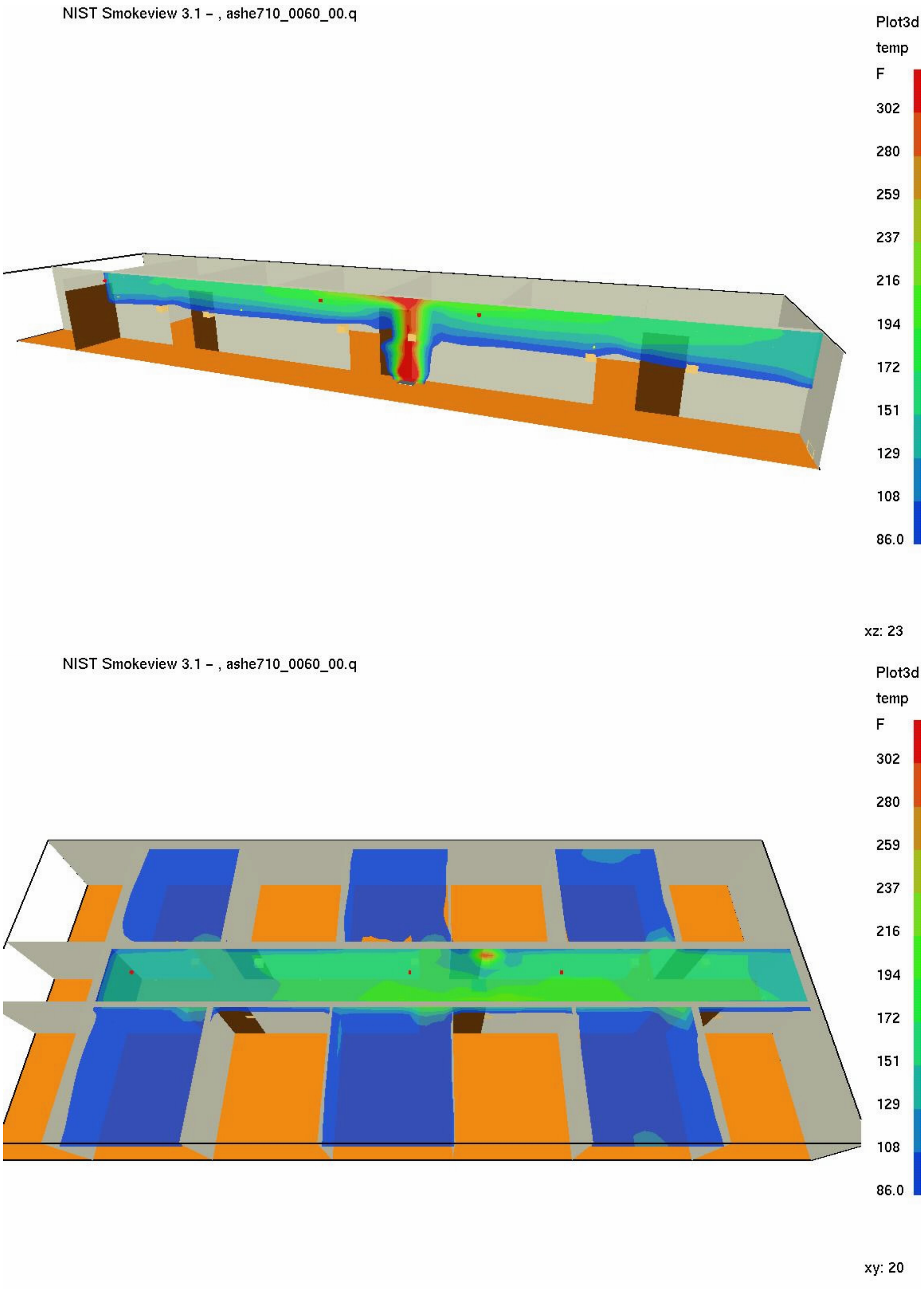
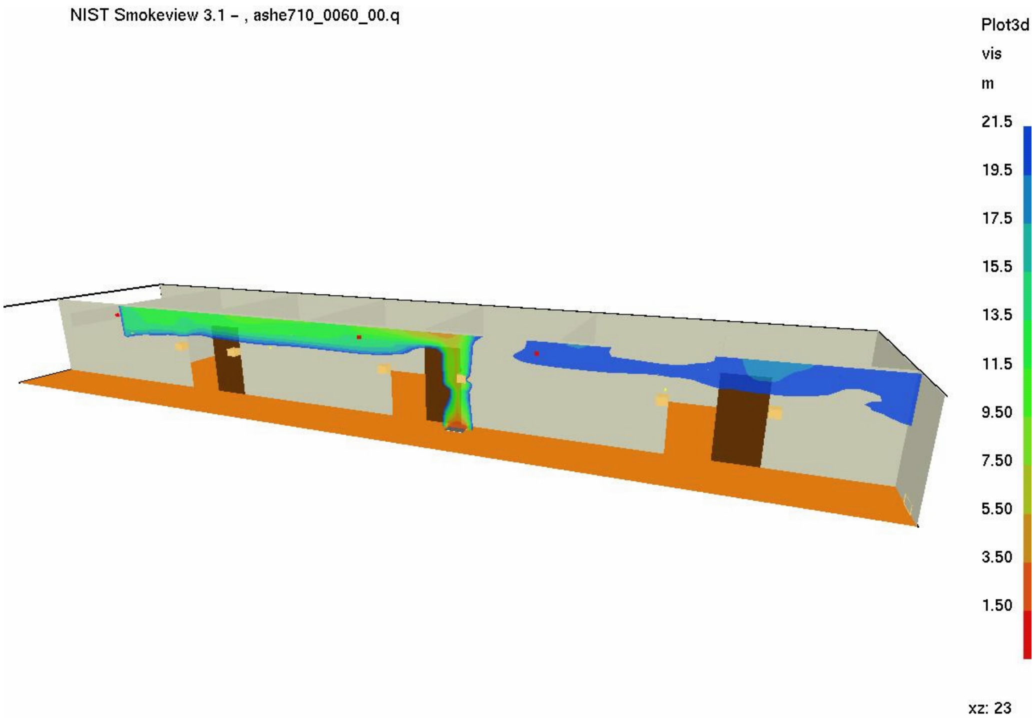


Figure 7 - Scenario 1-1 (ASHE 710) Temperature @ 60 sec



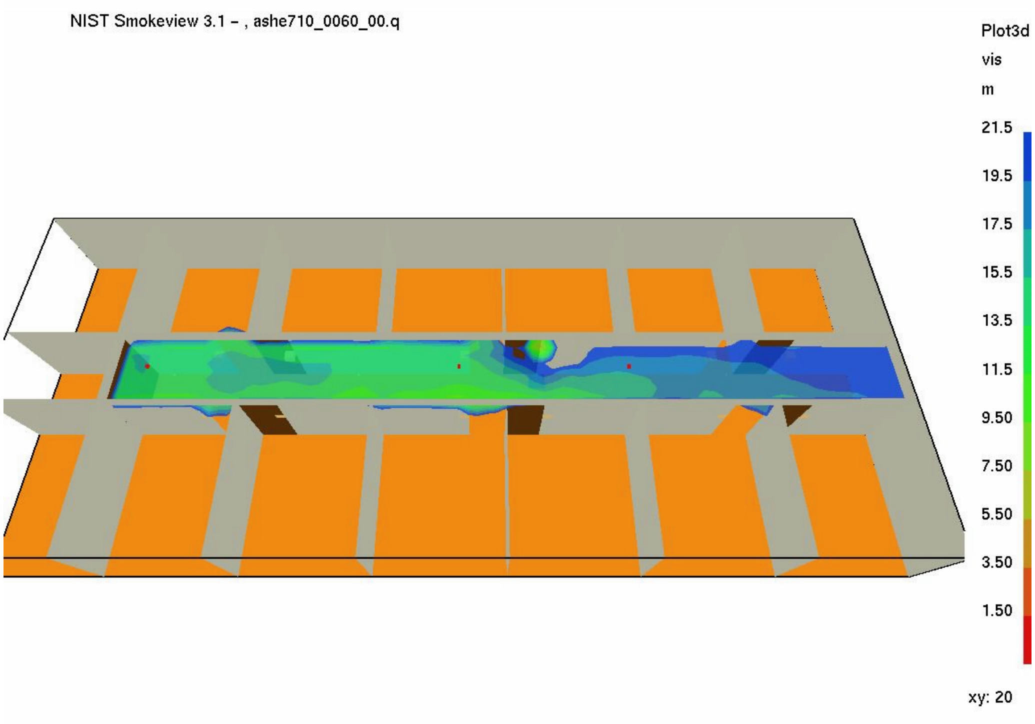


Figure 8 - Scenario 1-1 (ASHE 710) Visibility @ 60 sec

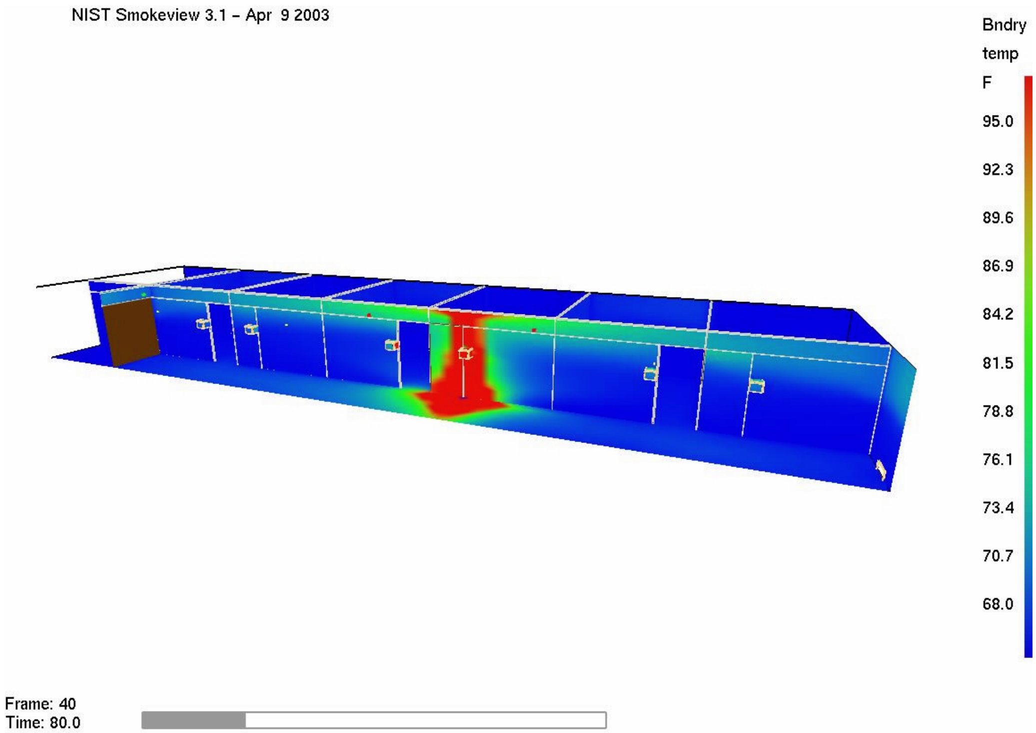


Figure 9 - Scenario 1-1 (ASHE 710) Wall Temperature @ 80 sec

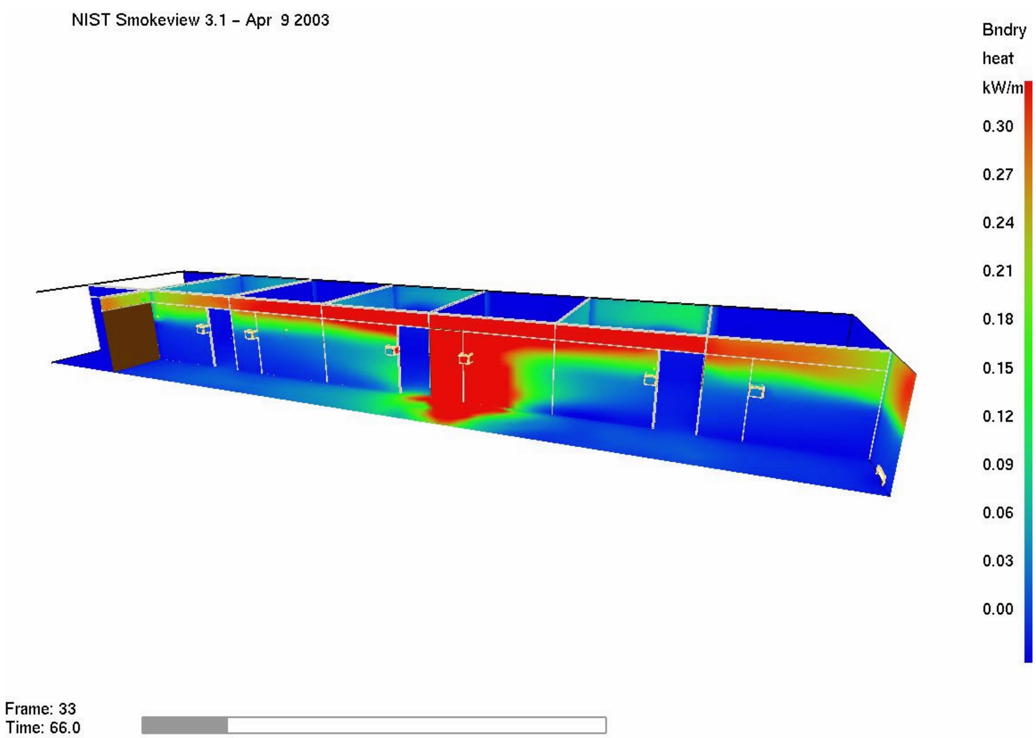


Figure 10 - Scenario 1-1 (ASHE 710) Heat Flux @ 66 sec