LIVE FIRE TRIANING: LIQUID VERSUS SOLID FUEL?

Strategic Management of Change

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ABSTRACT

Gaston College faces a dilemma in fire training exercises involving live fires of complying with fuel requirements of the National Fire Protection Association's standard, "NFPA 1403 Standard for Conducting Live Fire Training Evolutions" which prohibits use of liquid fuels or following the North Carolina Fire and Rescue Commission's practice which permits use of combustible liquids in such evolutions. In Gaston County and throughout North Carolina, Fire Service Instructors have expressed overwhelming support for use of liquid fuels even though such actions are in direct opposition to the national standard. This research was to evaluate differences in the training methods and propose a rationale for selecting a method. Research questions were 1) what are the advantages and disadvantages of using liquid and solid fuels for live fire training? 2) Do training objectives and methods differ in live burn training using liquid fuels compared with solid fuels? 3) What empirical data is available which may affect selection of fuels for live fire training exercises? Research included conducting three surveys of live fire training from differing perspectives; reference to another survey, sampling of fabrics exposed to live fire conditions; and theoretical calculations of fire growth based on fuel used. Results indicated that: 1) The potential liability associated with divergence from the national standard is Recommendations were: 1) Gaston College should maintain the policy of utilizing only Class A fuels in live fire training exercises; 2) The North Carolina Fire and Rescue Commission should revise their position on fuel use during live fire training to exclude use of combustible liquids; 3) North Carolina should seek changes in NFPA 1403 to permit use of limited quantities of combustible liquids for ignition of class A fuels; 4) Additional analyses of fabric flammability of turnout gear materials in fires fueled by both Class A and Class B fuels is needed to develop empirical data concerning the issue; 5) The North Carolina Fire and Rescue commission should utilize the SMOC Change Management Model to facilitate change in fuel usage and training objectives for live fire evolutions for North Carolina.

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INTRODUCTION

Historically, fire service leaders have deemed that effective training of fire suppression personnel requires physically extinguishing flaming fires, a process generally called Live Fire Training. In the mid 1980s, the National Fire Protection Association (NFPA) developed and promulgated a standard that outlines procedures to conduct Live Fire Training evolutions entitled NFPA 1403, *the Standard Practice for Conducting Live Fire Training Evolutions in Structures* (NFPA 1403). The standard was developed after several training incidents that resulted in deaths of fire fighters. NFPA 1403's expressed intention is to reduce the chances of injury and death during Live Fire Training Exercises.

NFPA 1403 received a mixed reception within the fire service, yet has remained in effect and has been revised twice since the initial printing. The North Carolina Fire and Rescue Commission adopted the standard in 1988 as the accepted practice for conducting live fire training evolutions with fire fighters, with the assumption that section 4-1.3.1 permitted using approximately one gallon of diesel fuel or kerosene to propagate fires in acquired structures. When NFPA 1403 was revised in 1992, North Carolina took exception with Section 4-1.3, fuels to be used for developing the fires. NFPA 1403 (1992) prohibits use of liquid fuels to ignite or fuel fires for structural fire fighter training. With that exception, the North Carolina Fire and Rescue Commission adopted a policy that permits and encourages use of combustible liquids with flash points over 100^{o} f to ignite and fuel fires for training exercises. Divergence from the nationally recognized standard raises legal and ethical concerns in local fire training agencies, such as Gaston College. Gaston College's Regional Emergency Services Training Center Director, Phil Welch, presented members of the Center's Advisory Committee, of which this researcher is a member, a dilemma of providing advice in deciding to accept or reject North Carolina's exception to NFPA 1403 (personal communication, October 20, 1997). In November

1997, Gaston College, despite opposition from many of its fire instructors, adopted a policy in compliance with NFPA 1403 (1992), prohibiting use of liquid fuels for live fire training. The North Carolina Fire Commission is reviewing their policy of fuel use in live fire training and whether their exception with NFPA 1403 (1992) should continue.

This research paper examines the positive and negative effects of diverging from the national standard. The research also explores issues related to the quality of training provided by each process.

Research questions are:

1) What are the advantages and disadvantages of using liquid and solid fuels for live fire training?
2) Do training objectives and methods differ in live burn training using liquid fuels compared with solid fuels?
3) What empirical data is available affecting selection of fuels for live fire training exercises?

BACKGROUND AND SIGNIFICANCE

North Carolina has made great strides in ensuring fire fighter training and certification since 1987. Changes in the training system include promulgation of live fire qualification for certified instructors. Training received and procedures promoted by the North Carolina Fire and Rescue Commission generally comply with NFPA 1403 (1992), with the exception of fuels for igniting and supporting fire for attack in acquired structures. Some instructors still expressed concern for practices not complying with nationally accepted standards. Still the Fire and Rescue Commission maintains that use of combustible liquids provides safe scenarios, possibly safer than use of Class A materials.

Gaston College has chosen to mandate compliance with NFPA 1403 (1992), including restrictions against combustible liquids. Dissention occurred between instructors, with some choosing to undertake training assignments outside the College system to burn structures using liquids as permitted by the North Carolina Fire Rescue Commission.

This research evaluated benefits of methods for igniting and fueling fires for live fire-training evolutions. Areas of exploration included training objectives, safety issues, flame generation, flame propagation, and personal protective clothing contamination.

The research is related the *Strategic Management of Change* course in that information was needed to determine if Gaston College should follow North Carolina's lead in maintaining older methods of fueling live fires or adhere to the national standards.

LITERATURE REVIEW

THE VOICE, September 1996, contained an article written by Donald C. Cox entitled "Live Fire Training: Let's Burn That Old Farmhouse." Cox discussed the reasons for compliance with NFPA 1403 and outlined methods of ensuring that smaller fire departments comply with the standard. Use of "Only Class A fuels controlled and managed by one person" is among the suggestions Cox offered for safe training exercises.

The January 1994 of Firehouse carried an article written by Harry R. Carter entitled Live Burn Exercises, Avoiding the Mistakes of the Past. Carter compared fatal training exercises in Boulder, Colorado (1982) and Milford, Michigan (1987) with an ill-fated exercise in Parisippany-Troy Hills, New Jersey (1992). Carter identified improper fuels as problematic factors in the Bolder and Milford incidents. He reiterated that only Class A fuels permitted by NFPA 1403 should be permitted in live fire training exercises.

"Preventing Live Burn Accidents," an article written by John A. Reardon, was included in the May 1985 issue of Fire Engineering. In this article, written before adoption of NFPA 1403, Reardon addressed safety issues in live fire training exercises. A sequence of small smoky fires fueled by wet straw for breathing apparatus training, followed by vertical ventilation of the structure prior to actual ignition was suggested. Reardon described placing trainees in the room adjacent to the space to be ignited, then setting a fire to the "entire room." When the instructor believed the fire was sufficient, extinguishment was initiated, followed by cross ventilation, overhaul, salvage, and origin determination training evolutions.

Timothy L. Bradley authored the article entitled "How to reduce the risks of live fire training in acquired structures" published in Fire Chief's March 1992 issue. In the article, Bradley described North Carolina's efforts to train instructors to safely conduct live fire training evolutions.

Mr. Bradley also authored an Applied Research Project for the Executive Fire Officer Program entitled National Standards Versus Local Practice: A Case Study (Bradley, ARP, 1992) In this research Bradley discussed the statewide forums wherein North Carolina's fire service instructors were provided the opportunity to discuss fuels to be used for lighting and fueling fires in live fire situations. He also conducted a survey of state fire training directors to determine local practices in relation to NFPA 1403. Mr. Bradley concluded that:

1) Data does not support the need to restrict liquid fuel use in live fire situations.
2) Amendments to standards place undue burdens on agencies that develop and promote their programs based in existing standards.
3) Re-qualification would have to occur with over 120 live fire qualified instructors, which places an unnecessary burden on the state of North Carolina.
4) Local practice of using combustible fuels was felt to be safer than the national standard, due to more managable fires.
5) Proper research and justification of standard changes would lessen the impact on local entities.
6) "There are occasions when generic national codes do not properly fit the mold necessary of a successful program locally" (Bradley ARP, 1992).

The National Fire Protection Association (NFPA) Standard 1403, "Live Fire Training Evolutions In Structures," was first adopted in 1986. Chapter 4, which specifies fuel materials acceptable for live fire training evolutions, permits "small amounts of uncontaminated diesel fuel or kerosene" for the ignition of fires. In the 1992 and 1997 revisions, fuel materials were again specified in Chapter 4, however the use of flammable or combustible liquids were expressly prohibited (NFPA, 1986, 1992 & 1997).

The NFPA Standard 1971, "*Standard on Protective Ensemble for Structural Fire Fighting*", 1997 edition, identified minimum fire resistance qualities required for approved fire fighter personal protective clothing for use in structural fire fighting. Section 6-2.5 specified the test method required as Method 5903.1 "Flame Resistance of Cloth; Vertical." Of Federal Test Method 191A, *Textile Test Methods* for testing of fabrics used in fire fighter protective clothing. This method, with noted exceptions, was used to develop comparison between fabric subjected to Class A and Class B fueled live fire training situations.

Web Site HTTP//WWW.skyenet.net/~firefighter/devil.htm (January 21, 1998) contained an article "Dance With The Devil," authored by Captain John D. Einhorn, conveying information about members of Polk Township Volunteer Fire Department participating in a live fire exercise in New Albany, IN. The stated purpose was to learn conditions that lead to flashover.

Settlement of a lawsuit initiated against the state of New Jersey for liability resulting from a training accident in Parisippany, NJ which injured three fire fighters in 1992 was described in Volunteer Firefighter Awarded $7.5 million on Web Site www. private/chiefs_aftr.htm. The fire fighter was injured during a live fire training exercise involving a school bus used in place of a legitimate burn building. The fire fighter received disabling burn injuries when the compartment experienced flashover while he and others were inside. All were injured and received compensation.

The Parisippany, NJ incident was detailed in The VOICE's January 1993 issue. Facts concerning the fire and training exercise were described in this article along with comments from Ed McCormick, Chief Executive Officer of the International Society of Fire Service Instructors.

Web Site http://flame.cfr.nist.gov/fire/fires/fires.html is maintained by the National Institute of Standards and Testing (NIST) in Rockville, Maryland. NIST conducts test on various materials and arrangements to determine the heat and smoke generation. These analyses provide information from which flashover determinations were initiated. Information was gleaned in January 1998.

The National Fire Academy's text, Fire Dynamics (May 1995) contained information on calculating fuel loads and flame development within structures. Information included formulas on fuel consumption of liquid fuels, heat release rates, and flashover development.

PPE Care and Use Guidelines, a recommendation by Robert Tutterow, et. Al. indicates recommended cleaning and decontamination practices for fire fighter protective equipment, including turnout gear. Contained in the document are statements that indicate soiled and contaminated personal protective clothing loses both thermal protective and flame resistive qualities.

The text from the National Fire Academy's course, Strategic Management of Change provided a model for managing change. This information was utilized in formulating a plan for changing the Live Fire Training program's objectives.

The City of Redmond, Washington's Fire Department has produced a package for live fire structural burns including a listing of objectives to be accomplished. This document, Objectives for House Burn, identifies safety, ventilation, search and rescue, basic fire investigation, hoseline advancement / operation and incident command structure / accountability

objectives to be accomplished in each scenario conducted. Procedures require completion of this form prior to each burn scenario.

Portland Oregon's Bureau of Fire, Rescue and Emergency Services published and distributed a guide entitled "Materials, Inspection, Maintenance Guide to Protective Clothing" (Portland, 1994). The document contained tables indicating flammability comparison between uncontaminated and contaminated protective clothing.

William Clark, writing in the Fire Chief's Handbook separated fire fighting tasks into those involving water, Wet Tactics and those support functions that utilize no water, Dry Tactics. Clark stated that these functions must be effectively coordinated to ensure efficient fire fighting operations.

PROCEDURES

Procedures include a literature review of materials in the Learning Resource Center at the National Fire Academy, Gaston County Fire Marshal's Office, and Gaston College. A search was conducted over the Internet for information relating to Live Fire Training of Fire Fighters. Also the Internet was used to identify heat release rates for various Class A fuels.

Three surveys were conducted; the first polled state training directors to expand on information received in a similar survey conducted in 1992. The second was to compare live fire training experiences of departments in North Carolina with similar departments out of state. Lastly, a survey was conducted of participants in live fire training exercises to compare and contrast the ignition methods and training objectives. Research also included a review of data collected by the North Carolina Fire and Rescue Commission in a December 1997 survey of Live Fire Qualified Instructors.

Limitations of this research are: 1) Information found during literature review is restricted to less than 10 years of experience and is relatively limited in technical data. 2) Surveys of those involved in live fire training exercises was predominately opinion data. 3) Empirical data was collected from analysis of personal protective clothing fabric exposed to live fire training exercise conditions, however this represented only a single training exercise. 4) Theoretical fire development models were calculated for common fuel methods, but are theory based on assumption of a particular fuel's heat output within a specific compartment. 5) Attempts were made to review the standard operating guide, lesson plan or course outline for the instruction course for the North Carolina Fire and Rescue Commission's training Live Fire Qualified instructors, a 24-30 hour class. Requests for this documentation were unfulfilled.

This was evaluative research to identify logical approaches for Gaston College to follow in defining procedures for live fire training exercises and to determine if sufficient data existed to suggest reexamination of North Carolina's stance on the live fire training fuel issue.

RESULTS

In an article penned prior to the adoption of NFPA 1403, John Reardon described methods of reducing the incident of accidents in live fire training exercises. He suggested starting training in acquired structures with smoke drills fueled by wet straw. When students became familiar with the process, he suggests positioning the crew into a room adjacent to the burn room, then igniting the fire. No fuel usage was mentioned, however he suggested that students would be able to observe flame development then practice "cross ventilation, overhaul, salvage and origin determination" (Reardon, 1985).

Writing for the International Society of Fire Service Instructors (ISFSI), Donald Cox addresses the applicability of NFPA 1403 to all fire departments, especially smaller departments.

> Sometime in the mid 80's, we realized the extent of our carelessness and NFPA 1403, Live Fire Training Evolutions in Acquired Structures was developed. Many smaller rural departments either continue to ignore the standard or simply have stopped burning acquired structures for training. Neither action is appropriate or necessary.
>
> To believe that all house burns are being conducted in accordance with all aspects of NFPA 1403 would be naïve. Yet, to allow a burn to be managed with anything less than 100 percent compliance would be malicious. (Cox, 1996).

When addressing fuels for live fire training exercises, training officers are warned, "Fuel (Class A only) must be tightly controlled and managed by one person" (Cox, 1996).

Comparison between tragic fire training exercises in Boulder, Colorado in 1982 and Milford, Michigan in 1987 led to the conclusion that improper fuels were contributing factors in fatalities and injuries in these incidents (Carter, 1994). Improper training techniques and lack of adherence to nationally recognized standards were cited as significant contributing factors in the injury of three fire fighters in Parisippany NJ in 1992. "Fire training officials have put training codes and procedures in place for this very reason. Had those NFPA codes been followed, those three kids would not be in the hospital today," stated Ed McCormick, Chief Executive Officer of the International Society of Fire Service Instructors in describing the reasons for the injuries (McCormick, January 1993).

The North Carolina Fire and Rescue Commission recommends "… that any agency conducting fire service training in North Carolina use NFPA 1403 as a guide" (Bradley, Fire Engineering, 1992). Qualification training for instructors prior to engaging in live fire exercises was also outlined. In addressing the subject of fuel usage, Bradley stated that "areas such as fuel, fuel loads, … are explained in detail" and "Each student instructor is required to prepare and light a fire using appropriate amounts of combustible liquids and Class A materials"

(Bradley, Fire Engineering, 1992). Mike Calhoun, the NCFRC instructor assigned to oversee the Live Fire Training Instructor Qualification Program, teaches potential live fire training instructors to start a small fire, then spread approximately one gallon of diesel fuel or kerosene onto the ceiling, in a sweeping motion, to generate the fire (Calhoun, personal communication, February 5, 1998). During a later interview, Mr. Calhoun reported that the Live Fire Qualification course now teaches spreading liquid fuels onto class A fuels (pallets and straw) then igniting the materials together. Throwing of fuel into the ceiling area is still permitted when a compartment is saturated with water and difficult to ignite. Calhoun states that the recommended quantity is approximately one half of a one peck bucket full of Class B fuel (Calhoun, Personal Communication, March 9, 1998).

Language in the original edition of NFPA 1403 permitted small amounts of combustible liquids for ignition of live burn fires (NFPA, 1986). Subsequent editions expressly prohibit the use of flammable or combustible liquids in any amounts for live fire training evolutions in acquired structures (NFPA, 1992 & 1997). The North Carolina Fire and Rescue Commission has held that safety can be assured when live burns are fueled by combustible liquids, if competent, trained instructors oversee the exercise.

Research question 1: What are the advantages and disadvantages of using liquid and solid fuels for live fire training?

Expert Opinions

The first step in this research was to discuss the advantages and disadvantages of each ignition scenario with live fire training specialists having vast experience in training evolutions using flame.

Liquid fuels offer ease of access and rapid repetition of scenarios. Fires are quickly generated and rapidly develop into flashover conditions. This allows more hose-stream attacks

by personnel during a training session. A collateral benefit is reduced destruction on the burn building by thermal degradation including charring and barrier penetration (paraphrased, Mike Calhoun, personal communication, February 5, 1998). When addressing concerns about North Carolina violating NFPA 1403, Mr. Timothy Bradley writes:

> NFPA standards are minimum standards that require verification by the local jurisdiction. We put a tremendous amount of effort into assuring that live fire instructors in our classes are taught to burn to the safest extent possible, so much so, that we have received repeated complaints about being too strict. I have concerns about the use of Class A materials only, due to the fact that the build-up time is so long, and flashover is unpredictable and may occur after initial entry by a nozzle crew. Use of foam rubber, plastics, and other materials that create polymers also create an unpredictable fire scenario. Although the practice of throwing fuels may seem archaic, it is performed by an instructor trained to do so, and creates a more predictable fire for students to attack. Your statement of creating a "hollow room" fire that is easily extinguished is true. Please keep in mind that the purpose is to train new firefighters on attack procedures and not spend time overhauling a structure (Tim Bradley, personal communication, May 17, 1991).

Advantages of solid fueled fires include scenarios where fire fighters must attack fire situations similar to those encountered in furnished structures according to Gaston College Instructor and Charlotte Fire Fighter Scott Hardin. When forced by changes in Gaston College policy to dispel his normal practice of using combustible liquids in live fires, Hardin states he was unsure of the quality of training Class A fuels could provide. After coordinating and participating in several fire-training scenarios that involve only Class A fuels, Hardin concluded the experience gained by trainees more realistically resembles actual emergency situations. With liquid fuels, many scenarios are repeated; however, participants only have the opportunity to extinguish a flaming fire. According to Hardin, this may cerate a false sense that those tasks preformed by hose crews are the only, or most important, ones conducted at emergencies. Utilizing Class A fuels, Hardin incorporated vertical ventilation crews and search crews with the attack crew to create a more realistic situation. He reports fewer scenarios, but more intense training (Scott Hardin, personal communication, February 9, 1998).

Flame / Flashover Development

Data relating to flame development and time to flashover occurrence was sought, evaluated and compared. For comparison purposes, a room (compartment) measuring 12' X 14' X 8' was selected. One opening, a 36 inch wide by 80-inch high door was included in the calculations.

Heat release rates data from various common Class A fuels (solid fuels) used in live fire training exercises was obtained from the National Institute of Standards and Testing (NIST) Building and Fire Research Laboratory (BFRL). Included were mattress fires at a corner and from the center; sofa; love seat, bunk bed, small dresser and wooden pallets more commonly encountered in live fire training.

TABLE 1

Item	Max Heat Release Rate (kW)	Time of max heat output (Seconds after Ignition)
Pallets (4 pallets on floor)	1800	640
Small Dresser	1750	425
Mattress – center burn	740	200
Mattress – corner burn	1025	300
Sofa	3500	425
Love seat	3000	400
Bunk Bed	4500	300

(NIST, 1998)

To calculate time until flashover development is likely using Class A fuels, the correlation formula contained in Fire Dynamics, pages 7-17 (NFA, 1995) was utilized. Four wooden pallets lying horizontally on the floor generated peak heat release rates of 1800 kW at about 640 seconds. Incremental increases were noted in heat development. Factoring that flashover occurs when compartments approximate 500^{o} C, this compartment should flash when the heat release rate reaches approximately 1400kW; in the case of burning pallets, at approximately 480 seconds (8 minutes). The bunk bed would generate flashover in

approximately 3.5 minutes. Other Class A fuels, such as the mattress, would never develop a flashover condition.

Hardin reports some reservations about some fire situations where he was unsure of when flashover would occur. At one point during his first Class A only burn, he noted impending flashover, withdrew his crew to a safe location, applied water to the threatening situation, then moved in to extinguish the fire. He reports this was a valuable training lesson to all participants in that they observed first-hand indicators of flashover (Hardin, personal communication, February 9, 1998).

Liquid fuel comparison was made on the assumption that fuel is applied as taught in the live fire training specialist class instructed by the North Carolina Department of Insurance. Fuel applied by throwing approximately one gallon of diesel or kerosene into the ceiling area of a room in a sweeping motion is estimated to yield coverage of approximately 80 square feet.

Kerosene, having a specific gravity of 0.8, density of 820 kg/m^3, burning rate of 0.039kg/m^2, and heat of combustion of 43.2 MJ/kg (Megajoules per kilogram) (NFA, 1995) was selected as the liquid fuel. Area of fuel distribution was calculated at 7.5 square meters (approximately 80 square feet) in this 168 square foot compartment. Adaptation for inverted fuel surface was not provided within the text; however, data does indicate that fuel on vertical and inverted surfaces is subject to more rapid flame spread than those surfaces, which are horizontal with the upper surface burning. Based on these data criterions, one gallon would be consumed in less than 11 seconds after flame development in an open burning area with unrestricted air influx. Restriction of the vent likely limits the quantity of available air, therefore prevents fuel oxidation within the calculated timeframe. Surface burning of the inverted and vertical fuel thrown into a room as specified by the Department Of Insurance creates conditions substantially equal to flashover almost immediately.

To answer **Research Question 2:** *Do training objectives and methods differ in live burn training using liquid fuels compared with solid fuels,* the first step was to contact Michel Calhoun, a senior instructor with the North Carolina Department of Insurance. Mr. Calhoun is assigned to manage the Live Fire Specialists Qualification Program. Mr. Calhoun stated that specific objectives for live fire evolutions are not generally provided to student instructors, however he perceives that the purpose is to teach student firefighters to properly maneuver hoses lines into a position for attack, select the proper nozzle setting, and then satisfactorily extinguish a fire. Fires set for this purpose should have reached the flashover stage to ensure the students are sufficiently challenged (Calhoun, personal communication, February 5, 1998). Attacking a fire that has reached full room flame involvement is necessary for fire fighters to experience a realistic fire according to Claude Shew (personal communication, March 23, 1998). George Altice, a Live Fire Instructor under the Fire and Rescue Commission, supported Shew's assessment of training objectives. Altice stated that during his training, requirements to pass the Live Fire Qualification class taught by the Department of Insurance included lighting a fire that reaches full room involvement.

Objectives for live fire training were described differently for Polk Township Volunteer Fire Department's August 1997 live fire training exercise. Here the primary objective was to develop understanding and recognition of flashover conditions. Crews were rotated between four coordinated duties: 1) Fire Attack, 2) Back-up attack line, 3) Truck ventilation crew, and 4) Rehabilitation and vital sign check (Dance with The Devil, 1997). Similar training objectives were reported by Scott Hardin in his Class A fueled exercises (Scott Hardin, telephone interview, February 9, 1998). Redmond Washington Fire Department produced and requires use of a document that outlines objectives and assignments for each live fire-training scenario. This document, Objectives for House Burn, identifies Safety, Ventilation, Search and Rescue, Basic

Fire Investigation, Hoseline Advancement / Operation and Incident Command Structure / Accountability objectives to be accomplished in each scenario conducted. Procedures require completion of this form prior to each burn scenario (Redmond FD, 1997).

Research question 3: *What empirical data is available affecting selection of fuels for live fire training exercises?*

The first source from which to glean data was found in Timothy Bradley's January 1992 Applied Research Project, "National Standards Versus Local Practice: A Case Study," which included a survey of all State Fire Training Program Directors in the United States regarding their live fire training practices. Questions within this survey directly related to fuel selection. Questions and responses were indicated in Table 2.

Question	Yes	No	N/A
Does your state fire-training agency follow the guidelines of NFPA 1403 for Live Fire Training?	30	3	1
Do you allow the use of small amounts of combustible liquids for starting the fire?	17	14	3
If you do allow combustible liquids, do you place limitations on the quantity?	16	3	15
Do you allow the use of acquired structures in Live Fire Training?	17	14	2
If acquired structure are not allowed, are there adequate burn buildings available statewide?	6	16	12
Does NFPA 1403 conflict with open burning or environmental protection laws in your state?	7	23	0
Does your state require any special qualification, designation, or training for Instructors who conduct Live Fire Training?	22	9	3
Does your state require any special release forms be signed by students taking Live Burn Classes?	15	14	5
Contrary to National Data, do you feel training injuries in your state warrant stronger requirements than NFPA 1403 now contain (1986 ed.)?	1	30	3

Table 2 (Bradley, 1992)

Because data from the original survey was developed more than five years earlier, the survey was replicated. Slight editorial license was taken with the questions, and additional scenarios were posed to identify professional opinions on fuel methods and training objectives.

The scenarios were used to elicit more direct information regarding professional opinion as to fuel use, amounts, ignition sequences, and training objectives. Survey results from the 35 respondents are indicated below. Numbers shown are indicate recorded responses, therefore may not result equal sums for all questions.

	State Training Director's Survey	Yes	No	Not Applicable
1	Does your state fire-training agency follow the guidelines of NFPA 1403 for Live Fire Training?	32	1	
2	Do you allow the use of small amounts of combustible liquids for starting the fire?	12	21	
3	If you do allow combustible liquids, do you place limitations on the quantity?	8	5	19
4	Do you allow the use of acquired structures in Live Fire Training?	21	10	2
5	If acquired structures are not allowed are adequate and convenient burn buildings available statewide?	13	10	10
6	Does NFPA 1403 conflict with open burning or environmental protection laws in your state?	12	20	
7	Does your state require any special qualification, designation, or training for Instructors who conduct Live Fire Training?	27	4	2
8	Does your state require any special release forms be signed by students taking Live Burn Classes?	23	8	2
9	Do you believe that NFPA 1403 compliant burns offer adequate safety levels for students and instructors?	29	3	1
	SCENARIO OPINIONS	Acceptable	Limited Acceptability	Unacceptable
10	Ignition of Class A fuels using a small flame and solid fuel kindling material such as straw.	26	3	1
11	Ignition of Class A fuels using a propane or similar fuel type torch.	22	5	3
12	Ignition of Class A fuels by placing a small quantity of combustible fuel (less than one liter) onto the fuel for kindling then igniting the liquid with a small flame.	7	6	17
13	Igniting a small Class A fire with straw or kindling then fueling the main fire by dashing combustible liquids onto the fire and ceiling areas limiting liquid fuel to a maximum of one gallon.	1	1	28
14	Use of combustible / flammable liquids, extinguished by experienced fire fighters during training for fire investigators.	10	14	6
15	Attacking fires with the primary objective of hose and nozzle manipulation.	22	5	3
16	Requiring fires to reach flashover prior to attack to ensure large flame volume.	6	16	8
17	Crew entry to the fire building during fire build-up to facilitate student observation of flashover indicators.	16	11	3
18	Multiple crews operating simultaneously under proper supervision and with adequate coordination.	22	7	1

Table 3

North Carolina Fire Commission Survey

In November and December 1997, the North Carolina Fire and Rescue Commission surveyed Live Fire Qualified Instructors for opinions regarding use of Class B fuels in live fire training. This was done to identify acceptable fuels in a revision of the live fire instructor

qualification program. Instructors were asked to select between two questions posed in the survey:

1) Support the continued use of Class "B" fuels during live fire evolutions in acquired structures.
2) Support current NFPA standard 1403 as written.

Claude Shew sates 434 surveys were distributed and 164 were returned. Survey results received indicate153 instructors prefer liquid use while only 11 support adherence to NFPA 1403 (Claude Shew, personal communication, March 23, 1998). Written comments included in the survey tend to indicate the primary reason many instructors prefer combustible liquid use policies is shorter time between burns and increased attacks on fires within structures.

Live Fire Training Survey

Another survey was conducted of fire department personnel to determine local applicability of fueling restrictions imposed by NFPA 1403 (1992). This survey was not conducted to obtain statistical data but to reflect comparison of live fire training methods of North Carolina with other states and jurisdictions. Participants of the North Carolina Breathing Equipment School, all were members of North Carolina fire departments, completed surveys in March of 1998. Surveys were distributed to two National Fire Academy classes by Dr. Calvin Posner, to various participants of the Fire Department Instructor's Conference in March by Robert Tutterow and at a meeting of the Fire Industry Equipment Research Organization (FIERO) in Virginia Beach, Va. by Mr. Tutterow. A total of 67 participants responded, 33 from North Carolina and 34 from outside the state. Survey results, as shown on the instrument, are indicated in the following table. Totals for categories may not justify depending on actual responses recorded.

Does your department conduct or participate in live fire training exercises?		
	NC	Others
YES	33	30
NO		4
If yes, how many live fires did your department participate in during 1997?		
1-5	14	18
6-10	13	6
11-15	3	1
16-25		2
26 or more	2	4
Where are live fire exercises held?		
Training center burn building		
<5	17	18
6-10	1	3
11-15		
16-25		3
26 or more		3
Acquired Structures		
<5	20	15
6-10	7	12
11-15	3	3
16-25		
26 or more	2	
Other – describe: Burn pit	1	
Flashover Simulator	1	
Texas A & M	1	
What fuel(s) was used to generate the fire?		
Wood / Straw (pallets)	33	27
Furniture	6	5
Combustible / Flammable Liquid	29	7
Other		3
If combustible and/or flammable liquids were used, in what capacity?		
On Class A fuel to initiate the fire.	32	10
As the primary fuel.	4	2
For investigator training.	2	3
Please describe the ignition sequence/method for fires.		
Liquid to ignite Class A fuel	21	3
Class A fuel ignited and allowed to develop	13	19
Class A fuel ignited then Combustible liquid thrown in to achieve flashover.	11	
What was the primary training objective?		
Training in hose stream application.	13	6
Hose stream application coordinated with other tactics	28	26
Other: Confidence Building 1		1
SCBA training		1
Train S & R under fire conditions		1
Investigator Training		1

Table 4

Personal Protective Equipment (PPE) Contamination

Statements contained in recommended PPE maintenance guides tend to indicate contamination reduces the thermal protection offered to fire fighters. "After materials are saturated with hydrocarbons, they will tend to absorb rather than reflect radiant heat from the surrounding fire" (Tutterow, et al, 1994). This leads one to conclude that heat from hostile fires would penetrate the thermal protective barrier designed into PPE, though empirical data is not provided to support this conclusion. Flammability of fabric was also addressed. "Clothing materials impregnated with oil, grease, and hydrocarbon deposits from soot and smoke can ignite and cause severe burns and injuries, even if the materials are normally flame resistant" (Tutterow, et al, 1994). Empirical data was found to support this conclusion in data provided by a study from the Portland Oregon Fire Department (Martin, 1994). Analysis conducted on protective gear after exposure to fires was compared to samples prior to and after laundering procedures. Table 5 indicates the results of these analyses:

DATE	Material	Total Petroleum Hydrocarbons	Vertical After Flame	Glow Time	Char Length
June 15, 1993	Shell Before Cleaning	28.5 PPM	0 sec	7 sec	2.25"
	Shell after cleaning		0 sec	0.1 sec	2.25"
	Thermal Before		0 sec	14 sec	0.75"
	Thermal After		0 sec	0 sec	0.6"
	Moisture before		0 sec	15 sec	1.75"
	Moisture After		0 sec	0 sec	.5"
September 22, 1992	Shell Before	238 PPM	8 sec	8 sec	3.2"
	Shell After	9.47 PPM	0 sec	0.1 sec	3.0"
	Thermal Before	238 PPM	0 sec	8 sec	0.5"
	Thermal After	9.47 PPM	0 sec	0 sec	0.6"
	Moisture Before	238 PPM	0 sec	8 sec	0.5"
	Moisture After	9.47 PPM	0 sec	0 sec	0.5"
March 1992	Before Cleaning	365 PPM	15 seconds		
	After Cleaning		0 seconds		
(Martin, 1994)					

Table 5

Test Burns

On March 28, 1998, Belmont Fire Department, Gaston County, NC, conducted live fire training exercises in two, identical, structures on Kale Street, Belmont. Live Fire Qualified instructors included George Altice, Steve Hubbard, Barry Wilson and Craig Austin, all members of Belmont Fire Department. With cooperation of these instructors, one house was burned using combustible liquids with emphasis on hose stream application. The other was ignited with only Class A fuels and focused on coordinated operations. A survey of participants was made to identify opinions of training quality between the structures and training methods.

Fires in the house at 319 Kale Street were fueled with Class A materials only. Sufficient amounts of Class A fuels including wooden pallets, fabric-covered furniture, and straw, were added to achieve flame development desired for each scenario. Fuel quantities and fueling sequences were record. Fuel used totaled approximately two chairs, two sofas, and approximately 30 pounds of clothing, forty wooden pallets and five bales of straw. Class B fuel was used during the fires in 321 Kale Street. Approximately 40 wooden pallets and five bales of straw were used to kindle the initial fires, then Class B fuel was added in quantities of ½gallon to 1 gallon per fire with approximately 12 gallons of diesel fuel utilized during the training prior to test apparatus removal.

During each burn, ten samples of PBI ® fabric were strategically placed to facilitate exposure to smoke and water from the fires and suppression operations. These samples were exposed, then collected for analysis to determine if changes in flammability characteristics occurred. Samples measuring 18 inches by 4 inches were attached to plywood apparatuses that suspended one sample horizontally approximately six inches above the floor level and placed another sample at the floor level, sloped upward one-inch across the fabric width. Samples were collected at the indicated times and placed in nylon bags, sealed and preserved until analysis

occurred. During the Class A structural burn, a prolonged scenario destroyed one apparatus, therefore no analysis was conducted on those fabric remains.

Samples were subjected to flame testing on May 27, 1998 at the North Carolina Center for Applied Textile Technology in Belmont, NC. Under the supervision of one of the center's instructors of testing, Mr. Wayne Moore, the testing was conducted substantially in accordance with the methods prescribed in NFPA 1971, Standard on Protective Ensemble for Structural Fire Fighting (NFPA 1971, 1997). Deviation was taken in the following areas of testing: 1) Samples were not conditioned as specified, so the samples would more realistically reflect conditions encountered by fire fighter protective clothing. 2) Complications with the commercial gas system precluded use of natural gas therefore propane was substituted. Char length remained relatively constant, within ½inch in all samples. No samples exhibited vertical flaming. A comparison of glow time in seconds is indicated in the following table. A diagram indicating the location of sample placement during fire exposure is included in Appendix B.

PPE Fabric Analyses (T indicates top fabric in apparatus, B indicates bottom fabric) Time is indicated in seconds.				
319 Kale Street – Class A fuels			**321 Kale Street – Class B Fuels**	
Sample	**After Burn Time**		**Sample**	**After Burn Time**
Control	0.2		Control	0.2
1B	0.4		1B	2.4
1T	0.4		1T	6.9
2B	0.4		2B	7.0
2T	0.2		2T	7.6
3B	0.2		3B	13
3T	0.2		3T	8.6
4B	0.2		4B	8.4
4T	0.2		4T	9.8
Apparatus 5 was destroyed during fires.			5B	5.4
			5T	4.2

Table 6

Live Fire Scenario Comparison

A survey of participants in these live fires was conducted to identify their opinion of training method effectiveness and record their comparison of ignition methods / training objectives. Survey questions and results are listed in Table 7.

Number of years in the Fire Service:

<1	**1**
1-5	**3**
6-10	**1**
11-15	**1**
16-20	**1**
21-25	**3**
26-30	**1**
>30	**2**

Certification Level:

Firefighter 1	**4**	
Firefighter 2	**3**	
Driver/Operator		**1**
Instructor	**4**	
Live Fire Qualification		**4**

In how many emergency situations have you participated in fire suppression?

<10	**3**
11-25	**1**
26-50	
51-75	
76-100	**3**
101-150	
>150	**6**

Number of live fire training exercise you have participated in before.

<5	
6-10	**1**
11-20	**2**
21-30	
31-40	**1**
41-50	
51-75	
76-100	**1**
101-150	**2**
>150	**6**

	Class A Structure	Class B Structure	Equal
Which structure provided the most realistic fires?	10	3	
Which structure offered the greatest challenge in suppressing the fire?	2	9	**2**
Which structure provided the best training in hose stream application practices?	4	4	**5**
Which structure provided the best training in ventilation practices?	7	3	**3**
Which structure provided the best training in overhaul practices?	5	7	**1**
Which structure provided the best training in coordinating fire attacks?	4	4	**5**
Which structure provided the best training in SCBA practices?	3	4	**6**
Overall, which structure offered the better training opportunity to increase your skill as a fire fighter?	4	5	**3**

Table 7 – Live Fire Training Participants Survey

During one scenario involving Class B fuels, an instructor was standing outside the fire room, throwing fuel onto an ignited fire through a window opening. Fuel was inadvertently splashed on the wall assembly and instructor. The fire rapidly spread from the fire room to the, forcing standby crews to suppress flames on the instructor's protective clothing.

A group discussion was held with participants, particularly those certified as instructors, after they completed the survey. Generalized discussion indicated that primary concern of change from use of liquid fuels to Class A fuels is the energy required to maintain fuel level sufficient to generate adequate fires and the time delay encountered between evolutions. Instructors indicate the number of instructors needed to maintain fires will double if only Class A

fuel is used. Most agreed that coordinated tactical evolutions provide superior training to a single primarily objective of hose stream application in attacking fires.

DISCUSSION

As with many new standards, controversy occurred when NFPA 1403, *Standard for Live Fire Training Evolutions in Structures,* was adopted in 1986. Near time much of the controversy which resulted from the original adoption of NFPA 1403 subsided, changes in the fueling methods permitted created a new controversy, especially in North Carolina. Much has been written about adherence to NFPA 1403, which tends to indicate no deviance from the standard is acceptable. Yet North Carolina permits, even encourages the use of combustible liquids to fuel fires in live fire training scenarios in direct contradiction of NFPA 1403. NFPA 1403 is an accepted standard for fire service training throughout the nation and North Carolina is the only location identified in the research where direct opposition to adherence to the fuel requirements of NFPA 1403 exists.

All factors identified in the research indicate North Carolina's divergence from NFPA 1403 stems directly or indirectly from the training objectives. As Mike Calhoun stated and Scott Hardin confirmed, the primary training objective in scenarios where liquid fuel is used is to attack as many fires as possible with hose streams. Less emphasis is placed on coordinating hose stream operations with other tactics such as ventilation, forcible entry, search, salvage and overhaul. Fire dynamics calculations indicate Class A fuels ignite and predictably fuel fires which provide more realistic environments, albeit slower flame development. Class A fuels such as pallets, flashover can be achieve if desired for an evolution. Understanding of fuel characteristics, fuel geometry, and compartment fire development are requisite in predicting fire behavior.

Mr. Calhoun and Mr. Shew were emphatic that fires fueled by Class B materials provide more realistic scenarios with a greater degree of predictability. Realism, however, is a term that is directly related to one's experience and knowledge of a given subject area. The assertion caused much thought by this researcher, because of the position and reputation these individuals hold. One possible explanation of their assertion of realism is that of their experience at emergency fire situations. Much of the training North Carolina's departments received in the 1950's and 1960 came through instructors with the North Carolina Department of Insurance. Live fire training was initiated and fueled by throwing fuel to achieve flashover, then attacked by fire fighters without truck company support in the form of ventilation. If this became a norm, focusing on suppression and not support activities would become institutionalized as acceptable fireground practice. Such a scenario could promote a paradigm that training fires fueled with Class B fuels are more realistic. Using Class A fuels, then supporting the interior crew with ventilation and other activities commonly known as truck work, may alter the perception of realism. Mr. Shew's and Mr. Calhoun's assumption of realism seems based on a paradigm that is taught to current the generation of fire firefighters through training practices, i.e., when one fails to ventilate, they experience conditions very similar to liquid fueled fires flashing over. Ventilation reduces heat and decreases chances of flashover, yet must be completed prior to attack in order to achieve maximum effectiveness. Interestingly, in the comparison survey between Class A and Class B fueled fires, 10 of 13 participants indicated the Class A fires were more realistic.

Empirical data, including flame tests conducted in Portland Oregon indicate contamination with hydrocarbons reduces the protective qualities of turnout gear. Analyses of fabric from the live burn comparison in Belmont tends to indicate the practice of using combustible liquids, particularly of 'throwing fuels,' greatly increases the chance of

contaminating protective clothing, thus burning fire fighters. No data was found that indicates use of liquid fuels provides a safer environment for fire fighter training. Therefore, it seems extremely risky to engage in such practice against nationally recognized standards. Adoption of standards with minor exceptions may be acceptable, however exclusion of such a subject area so significant and specifically addressed in the standard causes pause for consideration. Reflecting on the recent settlement for the Parisippany, New Jersey incident leads one to conclude that should an accident occur when liquid fuels are used, the probability of successful litigation is high. Many comments received from the 1997 Department of Insurance survey regarding fuel use related to instructor liability for injuries received during fires ignited outside the nationally recognized standard. Unless North Carolina ceases use of liquid fuels, a lawsuit will likely determine the acceptability of local practice preempting national standards in this arena.

Another more immediate question is whether those instructors following the state prescribed fueling methods are exempt from Occupational Safety and Health Administration (OSHA) oversight. Presuming North Carolina is required to comply with federal OSHA standards, one could assume that NFPA 1403 applies to all covered employees. Though North Carolina has generally held that volunteer fire fighters are exempt from the OSHA regulations, these laws govern state or local government and community college employees. Failure to comply with the dictates could result in fines levied against the employer.

One possible solution to difficulties encountered in igniting compartments where flames have previously been extinguished is to seek change in NFPA 1403 to permit a specific amount of combustible liquid to be applied to solid fuels for an ignition sequence. The original version of NFPA 1403 provided for this procedure, but was not included in later versions. Specific amounts and defined application procedures have never been identified however; the survey of State Fire Training Directors indicates some acceptance of this practice.

Writing in the Fire Chief's Handbook, William Clark concludes that fire fighting is not an art nor is it a science, it is a craft. "Firefighting is a craft because its principles can be learned and the necessary skills can be developed through training. Success in fire fighting requires the application of that knowledge and those skills" (Clark, 1995). Mr. Clark identifies fire ground activities as Wet Tactics (stream application) and Dry Tactics (truck company support) that must be coordinated to safely effectively combat fires. Following Mr. Clark's reasoning, it is essential that live fire training include activities such as search, ventilation and forcible entry, otherwise they are viewed as less important and not required functions at fire emergencies. Training objectives that incorporate these activities negate the need for rapid repetition of flame, thus eliminate or, at least, reduce the need for liquid fuel use.

RECOMMENDATIONS

North Carolina's December 1997 survey of instructor's qualified by the North Carolina Fire and Rescue Commission to conduct live fire training evolutions clearly demonstrated support for continued use of combustible liquids to fuel fires in structures. Comments received from the 164 respondents suggests that safe fires can be conducted utilizing liquid fuels, however national standards and a majority of industry experts identified in this research diametrically oppose this contention. Incidents where instructors and students are inadvertently contaminated with fuel as occurred during the Belmont training, are sufficient impetus for change.

Recommendation 1:

Conduct additional analyses on live fire training situations to develop additional empirical data relating to affects of fuel methods on fire fighter protective clothing. In the

interim, Gaston College should maintain the policy of utilizing only Class A fuels in live fire training exercises in compliance with NFPA 1403 (1992).

Recommendation 2:

Revise the state's position on fuel use during live fire training to exclude use of combustible liquids. Should a determination reveal that use of liquid fuel is necessary, identify maximum quantities per burn, and then enforce that limitation through administrative sanctions of instructors that violate the procedure. For reasons of safety and realistic training, prohibit application of liquid fuels to ignited fires, especially by tossing or throwing fuel from containers to intensify flames.

Recommendation 3:

Seek changes in NFPA 1403 to permit use of limited quantities of combustible liquids for ignition of class a fuels, yet specifically limit the amount and method of application, i.e. to a maximum of one liter applied to un-ignited fuels.

Recommendation 4:

Conduct additional analysis to compare fabric flammability and protective qualities of turnout gear materials in fires fueled by both Class A and Class B fuels. Data from these analyses can then be factored into recommendations for fuel selections in the next revision of NFPA 1403.

Recommendation 5:

Utilize the SMOC Change Management Model to facilitate change in fuel usage and training objectives for live fire evolutions. An application of the model is offered below, however, it was developed with limited input and should be reviewed and edited to increase efficiency.

ANALYSIS

1.1 – North Carolina's Fire and Rescue Commission and fire service instructors have historically used combustible liquids to fuel live fire training evolutions without significant injury or loss. Through these efforts, firefighters are provided an opportunity to attack multiple fires, however a paradigm of conducting fire attack without support activities is institutionalized through this training. Few, if any, internal conditions indicate the need for change in this practice.

1.2 – Legal constraints are the greatest impetus for change. Adherence to current nationally recognized standards is a significant step in reducing liability for individual instructors, training delivery agencies and state government agencies.

Additionally, permitting state or local government employees to participate in evolutions outside of compliance with national standards is likely to subject the agencies to legal sanctions initiated from the North Carolina or United States Departments of Labor (Occupational Safety and Health Administration).

Destabilizing forces are most likely to come from persons within the existing system resisting change. The research indicated live fire scenarios involving Class B fuels require less effort on the part of instructors and are not as physically challenging to participants.

1.3 - Changes in training methods will result in an increase of integrated operational activities during emergency responses. Increases will not occur immediately, however long term improvement will result.

1.4 - This change is transitional in nature. Current organizational culture recognizes the need for live fire training and professes to understand the need for integrated activities at fire emergencies, therefore incorporation of the training activities proposed is not paramount.

Simply changing training objectives and fuels used to achieve these objectives is limited in impact. Change in attitude is the primary objet of change in this matter.

PLANNING

2.1 - The primary force against this change is that of instructor preception that large flame volume is paramount to effective fire fighter training. Breaking the paradigm that liquid fuel fires are the most realistic, because support activities are often not accomplished, is necessary to facilitate this change. The force that should overcome this paradigm is threat of legal sanctions. As was observed in the Parrippsany, New Jersey incident, legal actions against the state government cost more than $7.5 million and settlement has not yet been reached with instructors and others involved.

Promotion of the altered live fire program with information of reasons for change and training materials directed at reducing fear of the change are essential factors in success.

2.2 - This change must be directed by a senior team / executive officer team approach. This team should identify methods of reducing resistance and ensuring compliance with the change methods. Members should include one representative from each of the following: North Carolina Fire and Rescue Commission, Department of Insurance Fire and Rescue Services Division, Department of Community Colleges, a metropolitan fire department training executive, volunteer fire department officer, live fire qualified instructor and representative of the North Carolina Department of Labor.

2.3 - This change will result in improved coordination of fire ground activities, especially earlier implementation of dry activities (truck company activities).

2.4 - Goals for this change are:

1 - Within one month of adoption, mail copies of standard operational guides to all live fire qualified instructors and delivery agencies on record with the North Carolina Fire and Rescue Commission.

2 – Within six months of implementation, offer upgrade training to all live fire qualified instructors to ensure understanding of standard operational guides. Provide an opportunity to engage in a live fire training or simulation.

3 – Have staff review sanctioned live fire training exercises to ensure compliance with guides.

IMPLEMENTATION

3.1 - Shared direction should result from the understanding that failure to comply may result in legal actions from students or the Department of Labor.

3.2 - Reduce resistance by instruction and training of instructors to ensure they understand effective, even improved, live fire training can occur under the new guides.

3.3 - Urgency should result when instructors understand potential sanctions against themselves.

3.4 - A standard operational guide should be developed to provide a process for change.

EVALUATION

Have area coordinators, auditors and fire training specialists with the Department of Insurance review training exercises by site visits and by documentation reviews to ensure compliance with the standard.

At intervals of one year and two years following the change, survey instructors, delivery institutions, fire department officers and participants on the effectiveness of the training delivery process.

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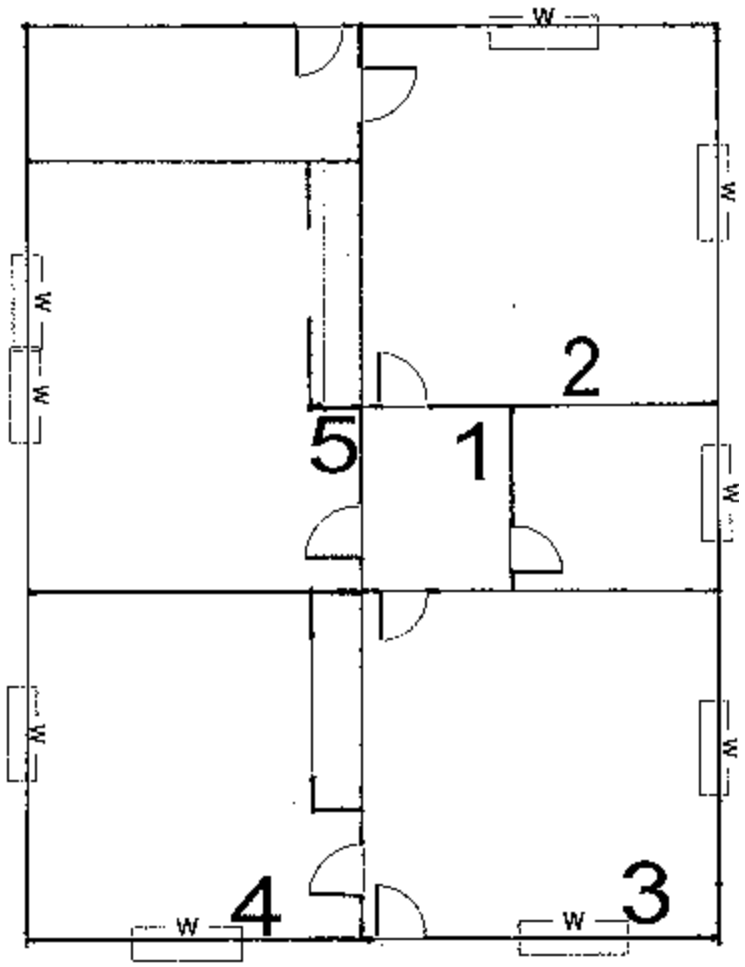
APPENDIX A

STATE FIRE TRAINING DIRECTOR'S SURVEY
Comments
Alabama- no comments
Alaska - No comments
Arizona -No comments
California - Question 1 - We have developed a course guide for instructors that covers similar concerns. (Assumed no for survey response.)
California - Question 14 - Only in flammable liquids fire fighting courses. Live structural firefighting: no flam/comb. Liquids allowed. Ideal is to build crib w/hollow core and straw. (Note: question 10 was answered unacceptable which seems inconsistent with this comment.)
California - Question 8 - Some courses accredited through state fire training and conducted by a local training offices association may require hold-harmless agreements.
Connecticut - Question 7 - All academy instructors are a minimum of FSI-I and we require a safety officer for each burn.
Delaware - Question 16 - Maybe a better word is rollover.
Delaware - Question 17 - Under strictly controlled conditions
Florida - no comments
GA – We will allow fires to reach flashover prior to attack, but not for the purpose of ensuring large flame volume.
Indiana - Answers based on schools run by Indiana Fire Instructors Association.
Iowa- no comments
Kansas - Question 5 - We have a modified 40' trailer used for live interior fire training.
Kentucky - no comments
Louisiana – No comments
Maine - Note: Maine puts 1,000+ firefighters through live fire training yearly with few injuries. I believe the standards/policy/law are adequate. Oversight is a major problem. "Freelancing" by accounts and individual organizations live fire training is the biggest threat to health and safety, I think.
Maine - Question 16 - Only if course performance objectives require it and students are qualified to operate in that environment, proper supervision, command, off, etc.
Maine - Question 17 - If facility (showing flashover conditions, for instructors) and course objectives warrant.
Maine - Question 6 - Maybe, but state D.E.P. supports firefighter live fire training.
Maryland - Question 15 - don't really understand the question - answer is yes, but no/unacceptable if applies to previous question(s) relating to combustible/flammable liquids. (Assumed Yes for survey).
Maryland - Question 17 - We do a session where students are placed in a room with Hoseline & several instructors and the fire is ignited with them present - fire behavior lab.
Maryland - Question 18 - Generally, only FF II level.
Maryland - Question 4 - Only for "advanced" classes, labs- not for FF I or FFII classes.
Maryland - Question 7 - "State" of MD requires "licensed instructors."
Maryland - Question 8 - "State being state fire training agency - No such state law- such as 2 (question 2).
Massachusetts - Question 7 - Not a state requirement. All state academy inst. And support staff must complete a training program prior to working live fire training for MA Fire Academy.
Massachusetts - Question 8 - Chief of Dept. attests that individual has been trained to level of FF1 and that turnout gear meet standards when purchased.
Massachusetts - Questions 16 & 17 - We burn in pre-constructed burn buildings. Fires do not reach flashover stage since there are no room contents other than fuel for fire and building on non-combustible.
Minnesota - If it comes in a can, you can't use it here. Period!
Minnesota - Our office deals with technical colleges through which the majority of training is delivered. While we have standards technical college instructors, there is nothing to prevent a local jurisdiction from conducting a burn on their own. They must get a Department of Natural Resources permit and have an asbestos inspection. As an OSHA state, our instructors must have training at a level above that which is being taught.
Minnesota - Question 11 - We once had an instructor set the torch on the floor… and then forget it. Luckily the BLEVE occurred while the students were outside.

Minnesota - Questions 10,11,15, 16 & 17 - OK (acceptable); Question 14 OK (limited Acceptability); Question 18 - Maybe in limited acceptability; Questions 12 & 13 - No Way.
Mississippi - Question 14 - Only on structure designated for fire investigation.
Mississippi - Question 5 - response appears to indicate one structure is available.
Mississippi - Question 6 - Burn should be approved by state DEQ agency.
Mississippi - Question 7 and 8 - Response indicates the state makes such requirements however local fire departments have no such requirements.
Mississippi - Questions 15-18 - Only within chapter 3 of 1403.
Montana – We have an outreach-training program and no central facility. We do not regulate the fire service, only our staff.
North Carolina – Question 1 - Commission took exception with non-use of combustible liquids, otherwise yes.
North Carolina – Question 11 - We have one experience in NC where a propane lighting torch was left during a burn down and bleve'd. No injuries. This was a non-qualified live burn instructor.
North Carolina – Question 13 - The reason 1403 was pushed so hard was an arson training fire using flammable liquids with trainers that killed two volunteers. (Michigan).
North Carolina – Question 9 - I haven't see any data suggesting justification for changes other than to promote sales of LPG burn buildings.
Nebraska – Question 1 - Reply was "mostly" in the Yes category. Assumed Yes.
Nebraska – Question 8 - We do require the students to belong to a political subdivision ERO so they are covered by Workers Comp. If they belong to a private fire department, they must have organization approval to attend and have insurance coverage.
Nevada - In burn buildings I feel the control is better that with acquired structures. For burns conducted by he state all rules of 1403 apply.
Nevada – Questions 16-18 - With the last three situations the students must be protected by full P.P.E. and a knowledgeable instructor with good judgement. Student safety is the first priority with the lesson being second. There is no excuse for student injury.
New Hampshire - Question 16 - In our flashover simulator we use propane torches.
New Hampshire - Question 17 - We have a Swede Survival Flashover Simulator for this type training.
New Hampshire - Question 4 - They are used in the state, but not in courses we sponsor. (Assumed answer was No)
New Hampshire - Question 5 - Trailer on order (assumed answer - yes)
New Jersey - Question 4 - Must obtain a permit for live fire training in acquired structure.
New Jersey - Questions 10 - 18 - no responses indicated.
New York – No comments
New Mexico – Acquired structures are allowed by certified adjunct instructors per NFPA 1403. To date no adjunct instructors have requested approval for use of an acquired building. All have arranged to bring students to our facility. Others arrange to use burn buildings located in their areas, of which there are some available.
New Mexico – Acquired structures are allowed by certified adjunct instructors per NFPA 1403. To date no adjunct instructors have requested approval for use of an acquired building. All have arranged to bring students to our facility. Others arrange to use burn
New Mexico – Question 9 - NFPA 1403 is a good place to start for safety issues, but we add other requirements to strengthen its ability.
Oklahoma - no comments
Oregon - no comments
Pennsylvania – Question 3 - 1 pint
Pennsylvania – Question 6 - Before a live fire training can occur the fire department must make application for a permit to our State Environmental Agency. The Agency conducts a site inspection, requires any remediation as need and issues a permit. Once a permit is issued, the burn there must receive a permit from the State Fire Academy to ensure 1403 compliance.
Pennsylvania – Question 8 - When a student registers for a live burn class their registration serves as a release. No special release is required.
Rhode Island - No comments

South Dakota – Currently the South Dakota Fire Training Program does not endorse live fire training in acquired structures. Those fire departments that do conduct live fire training follow guidelines of NFPA 1403. SDFST is lacking in adequate and convenient burn buildings, so training has begun for a select group of instructors to burn acquired structures according to 1403. (no data was shown in survey)
South Carolina - Question 1 - We only train/burn in approved burn buildings. We use no acquired structures.
South Carolina - Question 7 - We certify all live fire instructors through testing and apprenticeship programs.
South Carolina - These are personal opinions and not the policy of the South Carolina Fire Academy (relating to questions 10-18).
Tennessee - Tennessee discontinued ALL live firefighting in structures in 1995, including the burn building at the academy. The present burn building does not meet today's codes so as a safety precaution we only use it for smoke and SCBA training. A new academy is on the drawing boards. Hopefully we'll be able to resume live structural firefighting in 3-4 years. (No survey questions were marked).
Utah – Question 7 - Academy instructors are required to take special courses to use our mobile burn props. (questions 10-18 were not answered)
Utah –Question 6 - State law limits all departments to 2 acquired structure burns a year.
Washington - Question 3 - We are The issue is now under study there are some conflicts between state firefighter organizations and the Washington State Police.
Washington - Question 4 - We are not a controlling agency.
Washington - Question 6 - In some area EPS protection standards limit or prevent the use of burning for training.
Wisconsin – Question 5 - We currently have 8 live burn training centers throughout the state, with 2 more under construction. Our ultimate goal is to have at least 17 such sites by 2005.
Wisconsin – Question 6 - Structures to be burned for training purposes must first be inspected for asbestos. If asbestos (in the form of insulation, shingles or tile) is found, it must be removed before burning. This is monitored by the state Department of Natural Resources (DNR) per EPA guidelines.
Wyoming – Question 18 - We do simulated fire attack / ventilation / s& t for FF practical scenario training. We also fire behavior class with hose and nozzle to learn indicators.
Wyoming – Question 4 - Only for outside fire attack and positive pressure vent.

APPENDIX B
Sample Placement during Live Burn Comparison



Kale Street Houses
Sample locations

APPENDIX C

APPLIED RESEARCH PROJECT SURVEY

James L. Pharr
PO Box 1578
Gastonia, NC 28053

Completed by _____
Fire Department _____
Telephone _____
State or Country _____

PLEASE CIRCLE YOUR RESPONSE.

Does your department conduct or participate in live fire training exercises? YES NO

If yes, approximately how many live fire exercises have been conducted in the past year?

<5 6-10 11-15 16-25 26 or more

Where are live fire exercises held? Please indicate the approximate number in each location.

Training Center Burn Building <5 6-10 11-15 16-25 26 or more

Acquired Structures <5 6-10 11-15 16-25 26 or more

Other (Please describe) _____

What fuel(s) was used to generate the fire? (***Check all appropriate boxes)***

Wood / Straw (Pallets)	Furniture	Combustible Liquids	Other _____

If combustible and/or flammable liquids were used, in what capacity?

On Class A fuel to start fire	As the primary fuel	Investigator Training

Please describe the ignition sequence/method for fires.

Liquid to ignite Class A fuel	Class A fuel ignited and allowed to develop.	Fire ignited, then combustible fuel thrown into compartment to achieve flashover

Other _____

What were the objectives of the training exercise(s)?

To train personnel in hose stream application only	To train personnel in hose stream application coordinated with other tactics.	Other:

On the back, please describe any injuries related to heat / burns incurred during the 1997.

LIVE FIRE TRAINING SURVEY

State: _____

Please return to: James L. Pharr, 1480 Armstrong Ford Road, Gastonia, NC 28053

Question	Yes	No	N/A
Does your state fire-training agency follow the guidelines of NFPA 1403 for Live Fire Training?			
Do you allow the use of small amounts of combustible liquids for starting the fire?			
If you do allow combustible liquids, do you place limitations on the quantity?			
Do you allow the use of acquired structures in Live Fire Training?			
If acquired structures are not allowed are adequate and convenient burn buildings available statewide?			
Does NFPA 1403 conflict with open burning or environmental protection laws in your state?			
Does your state require any special qualification, designation, or training for Instructors who conduct Live Fire Training?			
Does your state require any special release forms be signed by students taking Live Burn Classes?			
Do you believe that NFPA 1403 compliant burns offer adequate safety levels for students and instructors?			
COMMENTS			

OVER

Please indicate your professional opinion on the following ignition methods/sequences in relation to Live Fire Training Exercises			
Sequence	**Acceptable**	**Limited Acceptability**	**Unacceptable**
Ignition of Class A fuels using a small flame and solid fuel kindling material such as straw.			
Ignition of Class A fuels using a propane or similar fuel type torch.			
Ignition of Class A fuels by placing a small quantity of combustible fuel (less than one liter) onto the fuel for kindling then igniting the liquid with a small flame.			
Igniting a small Class A fire with straw or kindling then fueling the main fire by dashing combustible liquids onto the fire and ceiling areas limiting liquid fuel to a maximum of one gallon.			
Use of combustible / flammable liquids, extinguished by experienced fire fighters during training for fire investigators.			
Attacking fires with the primary objective of hose and nozzle manipulation.			
Requiring fires to reach flashover prior to attack to ensure large flame volume.			
Crew entry to the fire building during fire build-up to facilitate student observation of flashover indicators.			
Multiple crews operating simultaneously under proper supervision and with adequate coordination.			

COMMENTS:

LIVE FIRE PARTICIPANT SURVEY

***Number of years in the Fire Service*– please circle your response:**

<1 1-5 6-10 11-15 15-20 21-25 26-30 >30

***Certification Level*:**

Firefighter 1 Firefighter 2 Driver/Operator Instructor Live Fire Qualification

***In how many emergency situations have you participated in fire suppression*.**

<10 11-25 26-50 51-75 76-100 101-150 >150

Number of live fire training exercise you have participated in before.

<5 6-10 11-20 21-30 31-40 41-50 51-75 76-100 101-150 >150

Please answer the following questions by checking the most appropriate block.

	Class A Structure	Class B Structure
Which structure provided the most realistic fires?		
Which structure offered the greatest challenge in suppressing the fire?		
Which structure provided the best training in hose stream application practices?		
Which structure provided the best training in ventilation practices?		
Which structure provided the best training in overhaul practices?		
Which structure provided the best training in coordinating fire attacks?		
Which structure provided the best training in SCBA practices?		
Overall, which structure offered the better training opportunity to increase your skill as a fire fighter?		

Please make any comments you feel appropriate on the back of this form.

THANKS FOR YOUR HELP.

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