Appendix A. Sample Forms/Checklists

Figure A.1 - Abbreviated Statement of Work (Checklist)

Contracting Agency: _____ (HUD field office) _____ _____		Responsible Agent: _____ Telephone: _____	
Property Location:			
Property Category:	(✓)		(✓)
New Multifamily	_____	Alarm/Detection	_____
Existing Multifamily	_____	Automatic Sprinklers	_____
Other Dwelling Unit	_____		
Building Height: Floors Above Grade	_____		
Floors Below Grade	_____		
Description of Services: (narrative)			
_____			
_____			
_____			
_____			
_____			

Scope of Services Includes The Following:

Basic Services	(✓)
Preliminary Design/Specifications	
Detailed Design/Installation	
Acceptance Testing and Approvals	
Scheduled Maintenance (specify)	

Other Services	(✓)

Contractor Responsibilities	(✓)
Preliminary Design/Specifications Documents	
"As-Built" Installation Drawings	
Acceptance Test Results:	
AHJ Approval Documentation	
Hydraulic Calculations (Sprinklers)	
Testing/Maintenance Records	

FIRE DETECTION AND ALARM SYSTEMS

FORM 1-A

Monthly Inspection

SYSTEM _____

DATE _____

INSPECTOR _____

YES = SATISFACTORY
NO = UNSATISFACTORY (EXPLAIN ON REVERSE)
N/A = NOT APPLICABLE

	YES	NO	N/A
Fire alarm panel appears operational.			
Lights and LEDs on fire alarm and annunciator panels are operational.			
Battery electrolyte level is satisfactory.			
All heat detectors appear operational.			
All smoke detectors appear operational.			
All flame detectors appear operational.			
All manual stations appear operational.			
All bells or horns appear operational.			
All speakers appear operational.			
Pre-amplifier appears operational.			
Amplifier appears operational.			
Voice tape appears operational.			
Power supplies appear operational.			
All radio fire alarm transmitting equipment appears operational.			
All radio fire alarm receiving equipment appears operational.			
All telegraphic fire alarm transmitting equipment appears operational.			
All telegraphic fire alarm receiving equipment appears operational.			

FIRE DETECTION AND ALARM SYSTEMS
Semi-Annual Inspection

FORM 1-B

YES = SATISFACTORY
NO = UNSATISFACTORY (EXPLAIN ON REVERSE)
N/A = NOT APPLICABLE

SYSTEM _____

YEAR _____

DATE	**INSPECTOR**	**YES**	**NO**	**N/A**
Fuse ratings were checked and are satisfactory.				

COMMENTS _____

Rechargeable battery cell voltages are satisfactory.

COMMENTS _____

DATE	**INSPECTOR**	**YES**	**NO**	**N/A**
Fuse ratings were checked and are satisfactory.				

COMMENTS _____

Rechargeable battery cell voltages are satisfactory.

COMMENTS _____

FIRE DETECTION AND ALARM SYSTEMS
Monthly Tests and Maintenance

FORM 1-C

YES = SATISFACTORY
NO = UNSATISFACTORY (EXPLAIN ON REVERSE)
N/A = NOT APPLICABLE

SYSTEM _____
DATE _____
INSPECTOR _____

	YES	NO	N/A
The recorded message was tested and is operational.			
All engine-driven generators for fire alarm systems are tested weekly and a log of the tests is kept.			
Radio fire alarm signal receiving equipment was tested hourly and a log of the tests is kept.			
All radio fire alarm boxes transmit a test alarm daily and a log of the tests is kept.			
Telegraphic fire alarm signal receiving equipment was tested daily and a log of the tests is kept.			
All telegraphic fire alarm boxes are tested bi-monthly and are operational.			
One initiating device on each circuit was tested and all circuits are operational:			
_____			
_____			
_____			
Each indicating appliance circuit was tested and all circuits are operational:			
_____			
_____			
_____			
Each speaker circuit was tested and all circuits are operational:			
_____			
_____			
_____			
One device on each two-way communication circuit was tested and each circuit is operational.			
Test each supervisory device circuit by removing a wire from its terminal.			

FIRE DETECTION AND ALARM SYSTEMS

FORM 1-D

Bi-Monthly Inspection

YES = SATISFACTORY
NO = UNSATISFACTORY (EXPLAIN ON REVERSE)
N/A = NOT APPLICABLE

SYSTEM _____

DATE _____

INSPECTOR _____

	YES	NO	N/A
Sprinklers water flow circuits were tested and are operational.			
Each telegraphic fire alarm box was tested and is operational.			

COMMENTS _____

FIRE DETECTION AND ALARM SYSTEMS

FORM 1-E

Semi-Annual Tests and Maintenance

YES = SATISFACTORY
NO = UNSATISFACTORY (EXPLAIN ON REVERSE)
N/A = NOT APPLICABLE

SYSTEM _____

YEAR _____

DATE												
INSPECTOR												
	YES	NO	N/A	YES	NO	N/A	YES	NO	N/A	YES	NO	N/A
The two-way communications system was tested and is operational.												
Speaker circuits were tested and are operational. (25% of speakers each quarter).												
Batteries in the telegraphic fire alarm systems were cleaned.												
Lead-acid batteries in telegraphic fire alarm systems have a satisfactory float voltage in each cell.												
Nickel-cadmium battery open circuit voltage measured and recorded.												
Nickel-cadmium battery connection cleaned.												
Test the secondary power supply for the system by disconnecting the power supply.												

COMMENTS _____

FIRE DETECTION AND ALARM SYSTEMS

FORM 1-F

Semi-Annual Tests and Maintenance

YES = SATISFACTORY
NO = UNSATISFACTORY (EXPLAIN ON REVERSE)
N/A = NOT APPLICABLE

SYSTEM _____

YEAR _____

DATE						
INSPECTOR						
	YES	NO	N/A	YES	NO	N/A
Remote annunciator was tested and is operational.						
Extinguishing system alarm switches were tested and are operational.						
Supervisory signal initiating devices were tested and are operational.						
Pneumatic line type heat detection system was tested and is operational.						
10 percent of the rate-of-rise detectors were tested and are operational.						
10 percent of the rate compensation heat detectors were tested and are operational.						
Smoke detectors were tested and are operational.						
Flame detectors were tested and are operational.						
Flame detector sensitivities verified or detectors re-calibrated.						
Manual stations were tested and are operational.						
Lead-acid batteries had the specific gravity in each cell tested and are satisfactory.						
Nickel-cadmium batteries had the state of charge checked and are satisfactory.						
Lead-acid batteries had open circuit voltage measured and recorded.						
Lead-acid batteries had connections cleaned.						

FORM 1-G

FIRE DETECTION AND ALARM SYSTEMS
Annual Tests and Maintenance

YES = SATISFACTORY
NO = UNSATISFACTORY (EXPLAIN ON REVERSE)
N/A = NOT APPLICABLE

SYSTEM _____

YEAR _____

DATE **INSPECTOR**	YES	NO	N/A
Alarm indicating appliances (visual and audible) were tested and are operational.			
The primary power supply was tested and is operational.			
The secondary power supply was tested and is operational.			
The lamp and LED circuits were tested and are satisfactory.			
Smoke detectors were recalibrated and operate satisfactorily.			
Batteries were discharged for two hours and remain operational.			
Battery charging devices were tested for proper operation.			
Battery voltage was measured under full load with charger disconnected.			
The meters for monitoring the power supply adequacy in telegraphic fire alarm systems were recalibrated and are accurate.			
Batteries had the float voltage measured in each cell and are satisfactory.			
Bell or horns were tested and are operational.			
Annunciators were tested and are operational.			
Control units were tested and all functions are operational.			
Voice alarm system components were tested and are operational.			
Each initiating and signaling circuit was tested for trouble signals.			
The following test must be conducted at 15 years and every 5 years thereafter.			
Two fixed temperature heat detectors for every 100 present were removed and satisfactorily tested by a testing laboratory. The two fixed temperature detectors were replaced with new fixed temperature heat detectors.			

DATE THE SYSTEM WAS INSTALLED: _____

DATE THE FIXED TEMPERATURE HEAT DETECTORS WERE LAST TESTED: _____

NOTE: If the tested fixed temperature heat detectors fail, all fixed temperature heat detectors in the building must be replaced.

AUTOMATIC SPRINKLER SYSTEMS

FORM 2-J
(Page 1 of 2)

CONTRACTOR'S MATERIAL AND TEST CERTIFICATE FOR ABOVEGROUND PIPING

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

PROPERTY NAME | DATE

PROPERTY ADDRESS

PLANS

ACCEPTED BY APPROVING AUTHORITY('S) NAMES

ADDRESS

INSTALLATION CONFORMS TO ACCEPTED PLANS ☐ YES ☐ NO

EQUIPMENT USED IS APPROVED ☐ YES ☐ NO

IF NO, EXPLAIN DEVIATIONS

INSTRUCTIONS

HAS PERSON IN CHARGE OF FIRE EQUIPMENT BEEN INSTRUCTED AS TO LOCATION OF CONTROL VALVES AND CARE AND MAINTENANCE OF THIS NEW EQUIPMENT ☐ YES ☐ NO
IF NO, EXPLAIN

HAVE COPIES OF APPROPRIATE INSTRUCTIONS AND CARE AND MAINTENANCE CHARTS AND NFPA 13A BEEN LEFT ON PREMISES ☐ YES ☐ NO
IF NO, EXPLAIN

LOCATION OF SYSTEM

SUPPLIES BLDGS.

SPRINKLERS

MAKE	MODEL	YEAR OF MANUFACTURE	ORIFICE SIZE	QUANTITY	TEMPERATURE RATING

PIPE AND FITTINGS

PIPE CONFORMS TO _____ STANDARD ☐ YES ☐ NO

FITTINGS CONFORM TO _____ STANDARD ☐ YES ☐ NO
IF NO, EXPLAIN

ALARM VALVE OR FLOW INDICATOR

ALARM DEVICE			MAXIMUM TIME TO OPERATE THROUGH TEST PIPE	
TYPE	MAKE	MODEL	MIN.	SEC.

DRY VALVE			Q.O.D.		
MAKE	MODEL	SERIAL NO.	MAKE	MODEL	SERIAL NO.

DRY PIPE OPERATING TEST

	TIME TO TRIP THRU TEST PIPE*		WATER PRESSURE	AIR PRESSURE	TRIP POINT AIR PRESSURE	TIME WATER REACHED TEST OUTLET*		ALARM OPERATED PROPERLY	
	MIN.	SEC.	PSI	PSI	PSI	MIN.	SEC.	YES	NO
Without Q.O.D.									
With Q.O.D.									

IF NO, EXPLAIN

*MEASURED FROM TIME INSPECTOR'S TEST PIPE IS OPENED.

AUTOMATIC SPRINKLER SYSTEMS

FORM 2-J
(Page 2 of 2)

DELUGE & PREACTION VALVES

OPERATION ☐ PNEUMATIC ☐ ELECTRIC ☐ HYDRAULIC

PIPING SUPERVISED ☐ YES ☐ NO | DETECTING MEDIA SUPERVISED ☐ YES ☐ NO

DOES VALVE OPERATE FROM THE MANUAL TRIP AND/OR REMOTE CONTROL STATIONS ☐ YES ☐ NO

IS THERE AN ACCESSIBLE FACILITY IN EACH CIRCUIT FOR TESTING ☐ YES ☐ NO | IF NO, EXPLAIN

MAKE	MODEL	DOES EACH CIRCUIT OPERATE SUPERVISION LOSS ALARM		DOES EACH CIRCUIT OPERATE VALVE RELEASE		MAXIMUM TIME TO OPERATE RELEASE	
		YES	NO	YES	NO	MIN.	SEC.

TEST DESCRIPTION

HYDROSTATIC: Hydrostatic tests shall be made at not less than 200 psi (13.6 bars) for two hours or 50 psi (3.4 bars) above static pressure in excess of 150 psi (10.2 bars) for two hours. Differential dry-pipe valve clappers shall be left open during test to prevent damage. All aboveground piping leakage shall be stopped.
FLUSHING: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 400 GPM (1514 L/min) for 4-inch pipe, 600 GPM (2271 L/min) for 5-inch pipe, 750 GPM (2839 L/min) for 6-inch pipe, 1000 GPM (3785 L/min) for 8-inch pipe, 1500 GPM (5678 L/min) for 10-inch pipe and 2000 GPM (7570 L/min) for 12-inch pipe. When supply cannot produce stipulated flow rates, obtain maximum available.
PNEUMATIC: Establish 40 psi (2.7 bars) air pressure and measure drop which shall not exceed 1-½ psi (0.1 bars) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop which shall not exceed 1-½ psi (0.1 bars) in 24 hours.

TESTS

ALL PIPING HYDROSTATICALLY TESTED AT _____ PSI FOR _____ HRS. | IF NO, STATE REASON

DRY PIPING PNEUMATICALLY TESTED ☐ YES ☐ NO

EQUIPMENT OPERATES PROPERLY ☐ YES ☐ NO

DRAIN TEST | READING OF GAGE LOCATED NEAR WATER SUPPLY TEST PIPE: STATIC PRESSURE: _____ PSI | RESIDUAL PRESSURE WITH VALVE IN TEST PIPE OPEN WIDE _____ PSI

Underground mains and lead in connections to system risers flushed before connection made to sprinkler piping.

VERIFIED BY COPY OF THE U FORM NO. 85B ☐ YES ☐ NO | OTHER EXPLAIN

FLUSHED BY INSTALLER OF UNDERGROUND SPRINKLER PIPING ☐ YES ☐ NO

BLANK TESTING GASKETS

NUMBER USED	LOCATIONS	NUMBER REMOVED

WELDING

WELDED PIPING ☐ YES ☐ NO

IF YES . . .

DO YOU CERTIFY AS THE SPRINKLER CONTRACTOR THAT WELDING PROCEDURES COMPLY WITH THE REQUIREMENTS OF AT LEAST AWS D10.9, LEVEL AR-3 ☐ YES ☐ NO

DO YOU CERTIFY THAT THE WELDING WAS PERFORMED BY WELDERS QUALIFIED IN COMPLIANCE WITH THE REQUIREMENTS OF AT LEAST AWS D10.9, LEVEL AR-3 ☐ YES ☐ NO

DO YOU CERTIFY THAT WELDING WAS CARRIED OUT IN COMPLIANCE WITH A DOCUMENTED QUALITY CONTROL PROCEDURE TO INSURE THAT ALL DISCS ARE RETRIEVED, THAT OPENINGS IN PIPING ARE SMOOTH, THAT SLAG AND OTHER WELDING RESIDUE ARE REMOVED, AND THAT THE INTERNAL DIAMETERS OF PIPING ARE NOT PENETRATED ☐ YES ☐ NO

HYDRAULIC DATA NAMEPLATE

NAMEPLATE PROVIDED ☐ YES ☐ NO | IF NO, EXPLAIN

REMARKS

DATE LEFT IN SERVICE WITH ALL CONTROL VALVES OPEN:

SIGNATURES

NAME OF SPRINKLER CONTRACTOR

TESTS WITNESSED BY

FOR PROPERTY OWNER (SIGNED)	TITLE	DATE

FOR SPRINKLER CONTRACTOR (SIGNED)	TITLE	DATE

ADDITIONAL EXPLANATION AND NOTES

AUTOMATIC SPRINKLER SYSTEMS

FORM 2-K
(Page 1 of 2)

CONTRACTOR'S MATERIAL AND TEST CERTIFICATE FOR UNDERGROUND PIPING

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

PROPERTY NAME | DATE

PROPERTY ADDRESS

PLANS

ACCEPTED BY APPROVING AUTHORITY('S) NAMES

ADDRESS

INSTALLATION CONFORMS TO ACCEPTED PLANS ☐ YES ☐ NO

EQUIPMENT USED IS APPROVED ☐ YES ☐ NO

IF NO, STATE DEVIATIONS

INSTRUCTIONS

HAS PERSON IN CHARGE OF FIRE EQUIPMENT BEEN INSTRUCTED AS TO LOCATION OF CONTROL VALVES AND CARE AND MAINTENANCE OF THIS NEW EQUIPMENT ☐ YES ☐ NO
IF NO, EXPLAIN

HAVE COPIES OF APPROPRIATE INSTRUCTIONS AND CARE AND MAINTENANCE CHARTS BEEN LEFT ON PREMISES ☐ YES ☐ NO
IF NO, EXPLAIN

LOCATION

SUPPLIES BLDGS.

UNDERGROUND PIPES AND JOINTS

PIPE TYPES AND CLASS | TYPE JOINT

PIPE CONFORMS TO _____ STANDARD ☐ YES ☐ NO

FITTINGS CONFORM TO _____ STANDARD ☐ YES ☐ NO
IF NO, EXPLAIN

JOINTS NEEDING ANCHORAGE CLAMPED, STRAPPED, OR BLOCKED IN ☐ YES ☐ NO

ACCORDANCE WITH _____ STANDARD
IF NO, EXPLAIN

TEST DESCRIPTION

FLUSHING. Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 400 GPM (1514 L/min) for 4-inch pipe, 600 GPM (2271 L/min) for 5-inch pipe, 750 GPM (2839 L/min) for 6-inch pipe, 1000 GPM (3785 L/min) for 8-inch pipe, 1500 GPM (5678 L/min) for 10-inch pipe and 2000 GPM (7570 L/min) for 12-inch pipe. When supply cannot produce stipulated flow rates, obtain maximum available.

HYDROSTATIC. Hydrostatic tests shall be made at not less than 200 psi (13.8 bars) for two hours or 50 psi (3.4 bars) above static pressure in excess of 150 psi (10.3 bars) for two hours.

LEAKAGE. New pipe laid with rubber gasketed joints shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 qts. per hr. (1.89 L/h) per 100 joints irrespective of pipe diameter. The leakage shall be distributed over all joints. If such leakage occurs at a few joints the installation shall be considered unsatisfactory and necessary repairs made. The amount of allowable leakage specified above may be increased by 1 fl oz per in. valve diameter per hour (30 mL/25 mm/h) for each metal seated valve isolating the test section. If dry barrel hydrants are tested with the main valve open, so the hydrants are under pressure, an additional 5 oz per minute (150 mL/min) leakage is permitted for each hydrant.

FLUSHING TESTS

NEW UNDERGROUND PIPING FLUSHED ACCORDING TO _____ STANDARD ☐ YES ☐ NO

BY (COMPANY)
IF NO, EXPLAIN

HOW FLUSHING FLOW WAS OBTAINED
☐ PUBLIC WATER ☐ TANK OR RESERVOIR ☐ FIRE PUMP

THROUGH WHAT TYPE OPENING
☐ HYDRANT BUTT. ☐ OPEN PIPE

LEAD-INS FLUSHED ACCORDING TO _____ STANDARD ☐ YES ☐ NO

BY (COMPANY)
IF NO, EXPLAIN

HOW FLUSHING FLOW WAS OBTAINED
☐ PUBLIC WATER ☐ TANK OR RESERVOIR ☐ FIRE PUMP

THROUGH WHAT TYPE OPENING
☐ Y CONN. TO FLANGE & SPIGOT ☐ OPEN PIPE

AUTOMATIC SPRINKLER SYSTEMS

FORM 2-K
(Page 2 of 2)

HYDROSTATIC TEST

ALL NEW UNDERGROUND PIPING HYDROSTATICALLY TESTED AT _____ PSI FOR _____ HOURS

JOINTS COVERED ☐ YES ☐ NO

LEAKAGE TEST

TOTAL AMOUNT OF LEAKAGE MEASURED _____ GALS. _____ HOURS

ALLOWABLE LEAKAGE _____ GALS. _____ HOURS

HYDRANTS

NUMBER INSTALLED	TYPE AND MAKE	ALL OPERATE SATISFACTORILY
		☐ YES ☐ NO

CONTROL VALVES

WATER CONTROL VALVES LEFT WIDE OPEN ☐ YES ☐ NO
IF NO, STATE REASON

HOSE THREADS OF FIRE DEPARTMENT CONNECTIONS AND HYDRANTS INTERCHANGEABLE WITH THOSE OF FIRE DEPARTMENT ANSWERING ALARM ☐ YES ☐ NO

REMARKS

DATE LEFT IN SERVICE

SIGNATURES

NAME OF INSTALLING CONTRACTOR

TESTS WITNESSED BY

FOR PROPERTY OWNER (SIGNED)	TITLE	DATE

FOR INSTALLING CONTRACTOR (SIGNED)	TITLE	DATE

ADDITIONAL EXPLANATION AND NOTES

AUTOMATIC SPRINKLER SYSTEMS
GENERAL INFORMATION

FORM 2-A

DATE _____

INSPECTOR _____

GENERAL

System Designation _____
Building _____
Location of sprinkler valve _____
Type of sprinkler system ☐ Wet ☐ Dry ☐ Deluge ☐ Preaction
Make and model of sprinkler valve _____
Is building fully sprinklered? ☐ Yes ☐ No
Is entire sprinkler system in service? ☐ Yes ☐ No
Has sprinkler system been modified since last inspection? ☐ Yes ☐ No

VALVES

How are valves supervised? ☐ Sealed ☐ Locked ☐ Tamper Switch
Are valves identified with signs? ☐ Yes ☐ No

WATER SUPPLY *(see Chapter 8)*

When was last water supply test made? _____
Are reservoirs, tanks or pressure tanks in good condition? ☐ Yes ☐ No

PUMPS *(see Chapter 7)*

Is fire pump ☐ Diesel ☐ Electric ☐ Gasoline ☐ None?
When was pump last inspected? _____
Is pump in good condition? ☐ Yes ☐ No

FIRE DEPARTMENT CONNECTIONS

Location _____
_____
_____

Are identification signs provided? ☐ Yes ☐ No

WET SYSTEMS

Is building adequately heated? ☐ Yes ☐ No
Is system hydraulically calculated? ☐ Yes ☐ No
If yes, is hydraulic information sign provided at valve? ☐ Yes ☐ No

DRY SYSTEMS

Is dry pipe valve in heated room? ☐ Yes ☐ No

DELUGE SYSTEM *(see Chapter 1 of this manual for discussion of detection systems.)*

PREACTION SYSTEM *(see Chapter 1 of this manual for discussion of detection systems.)*

COMMENTS _____
_____
_____

AUTOMATIC SPRINKLER SYSTEMS

FORM 2-B

Weekly Inspection

SYSTEM _____

DATE _____

This form covers a 6-month period.

1. Date of inspection.
2. Inspector's name, initials or badge number.
3. If valves are sealed, note "yes" in this block. If any are not sealed, reseal and note "resealed" in this block.
4. If all sprinklers are in good condition and storage is maintained at least 18 in. below the sprinklers, note "yes" in block. If not, see that corrections are made and briefly describe under "notes."

5 - 8. Record pressure readings (psi). A loss of more than 10% should be investigated.

9. Record any notes about the system which the inspector believes to be significant. Use separate sheet.

1 DATE	2 INSPECTOR	3 VALVE(S) SEALED	4 SPRINKLERS OK	5 ALARM VALVE OK	6 DRY PIPE VALVE		7 PREACTION VALVE		8 DELUGE VALVE WATER PRESSURE	9 NOTES
					Air Pres.	Water Pres.	Air Pres.	Water Pres.		

AUTOMATIC SPRINKLER SYSTEMS

FORM 2-C

Monthly Inspection

SYSTEM _____

YEAR _____

1. Date of inspection.
2. Inspector's name, initials or badge number.
3. If fire department connections are unobstructed and in good condition, note "OK" in block. If not, see that corrections are made and briefly describe under "notes."
4. If valves are locked, note "yes" in this block. If any are not locked, relock and note "relocked" in this block.
5. Inspect alarm valves to assure no leakage from retard chamber or alarm drains.
6. Assure there is proper number and type of sprinklers and a sprinkler wrench.
7. Check for physical damage and that electrical connections are secure.
8. Record pressure readings (psi). A loss of more than 10% should be investigated.
9. Record any notes about the system which the inspector believes to be significant. Place a number in this block and number the corresponding note at the end of the inspection form.

1 DATE	2 INSPECTOR	3 FIRE DEPARTMENT CONNECTIONS	4 VALVES LOCKED	5 ALARM VALVES	6 SPARE SPRINKLERS	7 ALARM DEVICES	8 WATER PRES.	9 NOTES

NOTES _____

AUTOMATIC SPRINKLER SYSTEMS
Quarterly Inspection and Tests

FORM 2-D

SYSTEM _____

DATE _____

DATE				
INSPECTOR				
MAIN DRAIN TEST Conduct a main drain test as follows: 1. Record the static water supply pressure (psi) as indicated on the lower pressure gauge. 2. Open the main drain and allow water flow to stabilize. 3. Record the residual water supply pressure while water is flowing from the 2-inch main drain as indicated on the lower pressure gauge. 4. Close the main drain (slowly).				
WET PIPE SYSTEM FLOW ALARM Test water flow alarms by opening the inspectors test valve.				
DRY PIPE PRIMING LEVEL Check dry valve priming water level by opening the test valve and checking for a small amount of water to discharge. If no water flows out of the test line, add priming water.				
DRY PIPE SYSTEM LOW AIR PRESSURE ALARM Close the water supply valve, carefully open inspector test valve to reduce air pressure slowly (Do not reduce air pressure sufficiently to trip the dry pipe valve). Confirm operation of low pressure alarm, record air pressure at which low pressure alarm activated, close inspector test, allow air pressure to rise to normal, then open water supply valve.				
DRY PIPE SYSTEM FLOW ALARM Open the alarm by-pass valve.				
PREACTION SYSTEM FLOW ALARM Open the alarm by-pass valve.				
DELUGE SYSTEM FLOW ALARM Open the alarm by-pass valve.				
CONTROL VALVES Close valves and reopen until spring or tension is felt – back valve 1/4 turn.				
HYDRAULIC NAME PLATE If system was hydraulically calculated, assure nameplate is legible and securely attached to riser.				

COMMENTS _____

_____

_____

_____

_____

_____

_____

FORM 2-E

AUTOMATIC SPRINKLER SYSTEMS
Semi-Annual Inspection and Tests

SYSTEM _____ **YEAR** _____

DATE		
INSPECTOR		
COLD WEATHER VALVES Cold weather valve, if used, should be closed before freezing weather, and piping drained. Valve should be opened in Spring. Use "O" for Open–"C" for Closed.		
DRY PIPE SYSTEMS Quick opening devices and accelerators, if provided, should be tested semi-annually.		
Low point drains should be drained thoroughly before cold weather and after any system trip.		
DELUGE SYSTEM Test fire detection system for proper operation (See Chapter 1).		
PREACTION SYSTEM Test fire detection system for proper operation (See Chapter 1).		
Record any notes about the system which the inspector believes to be significant. Place a number in this block and number the corresponding note at the end of the inspection form.		

COMMENTS _____

AUTOMATIC SPRINKLER SYSTEMS

FORM 2-F

Annual Inspection, Tests and Maintenance

SYSTEM _____

INSPECTOR _____ **DATE** _____

GENERAL CONDITION Inspect sprinklers, sprinkler piping, pipe hangers and seismic braces to make sure they are in good condition.	
FREEZING Before freezing weather, inspect building to assure exterior wall openings will not expose sprinkler piping to freezing temperature.	
MAINTAIN VALVES Valves should be maintained, including exercising each valve and lubricating each valve stem.	
CLEAN STRAINERS Shut the water supply valve and remove the strainer for thorough cleaning.	
TEST ANTIFREEZE Wet pipe systems with antifreeze solution should have the solution checked for proper freeze level. Record freezing point.	
DRY PIPE SYSTEM Trip test the dry pipe valve. Record the time from opening the inspectors test valve until the dry pipe valve trips.	
Internally inspect dry pipe valve.	
Test air pressure maintenance device.	
PREACTION SPRINKLER SYSTEM Trip test the preaction system. (Refer to manufacturer's instructions.)	
Internally inspect preaction valve.	
DELUGE SPRINKLER SYSTEM Trip test the deluge system. (Refer to manufacturer's instructions.)	
Record time from activation of detector until water in discharged.	
Check to see that water discharge pattern is adequate.	
Record water pressure at hydraulically most remote sprinkler.	
Record water pressure at deluge valve.	
Internally inspect deluge valve.	
COOKING EQUIPMENT SPRINKLERS Replace sprinklers with fusible links.	

COMMENTS _____

_____

_____

AUTOMATIC SPRINKLER SYSTEMS
5-Year Inspection

FORM 2-G

SYSTEM _____

INSPECTOR _____ **DATE** _____

ALARM VALVE INTERNAL INSPECTION Verify that all components operate properly, move freely, and are in good condition.	
CHECK VALVE INTERNAL INSPECTION Verify that all components operate properly, move freely, and are in good condition.	

COMMENTS _____

AUTOMATIC SPRINKLER SYSTEMS
3-Year Tests

FORM 2-H

DATE _____

SYSTEM _____ **INSPECTOR** _____

DRY PIPE VALVE FULL FLOW TRIP TEST

Trip test the dry pipe valve by opening the inspector's test valve. Allow water to flow until clean water flows from the inspector's test connection. Record time from opening inspector's test valve until water flows from test outlet.

COMMENTS

Record any notes about the system which the inspector believes to be significant.

Appendix B. Equivalent Level of Safety Analysis

General Services Administration
41 CFR Part 101-6
[FPMR Amendment A-]
RIN: 3090-AE93
Fire Protection (Firesafety) Engineering

AGENCY: Public Buildings Service (PBS), GSA.

ACTION: Final rule.

SUMMARY: This regulation establishes a further definition of the term *equivalent level of safety*. The Federal Fire Safety Act of 1992 amended the Fire Prevention and Control Act of 1974 to require sprinklers or an *equivalent level of safety*, in certain types of Federal employee office buildings, Federal employee housing units, and Federally assisted housing units. This rule identifies certain performance criteria which an alternative approach must satisfy in order to be judged equivalent. The criteria have been selected to provide the level of life safety prescribed in the Act.

EFFECTIVE DATE: October 26, 1994.

FOR FURTHER INFORMATION CONTACT:
Director, Safety and Environmental Management Division (PMS), General Services Administration, 18th & F Streets, NW, Washington, DC 20405, (202) 501-1464.

SUPPLEMENTARY INFORMATION:

I. General Requirements of the Act

The Fire Administration Authorization Act of 1992 (Public Law 102-522) was signed into law by the President on October 26, 1992. Section 106, Fire Safety Systems in Federally Assisted Buildings, of Title I - United States Fire Administration, is commonly referred to as the Federal Fire Safety Act of 1992. This section amends the Fire Prevention and Control Act of 1974 (15 U.S.C. 2201 et seq.) to require sprinklers or an *equivalent level of safety*, in certain types of Federal employee office buildings, Federal employee housing units, and Federally assisted housing units. The Act's applicability and requirements are very complex. They are summarized as follows:

In **Federal employee office buildings** with more than 25 Federal employees that are newly constructed, purchased, renovated, or leased (with the Government occupying 35,000 sq. ft. or more and some portion on or above the sixth floor):

- Buildings with 6 or more stories must have sprinklers (or an *equivalent level of safety*) throughout.
- All other buildings must have sprinklers (or an *equivalent level of safety*) in hazardous areas, as defined in National Fire Protection Association Standard 101, *Life Safety Code*®.

In **Federal employee housing:**

- New or rebuilt multifamily housing must have sprinklers (or an *equivalent level of safety*) throughout, and hard wired smoke detectors.
- All other housing requires hard wired smoke detectors on tenant change or no later than October 26, 1995.

In **Federally assisted housing:**

- New multifamily housing, 4 or more stories above ground level, must have sprinklers and hard wired smoke detectors.
- New multifamily housing in New York City, 4 or more stories above ground level, must have sprinklers (or an *equivalent level of safety*) and hard wired smoke detectors.
- Rebuilt multifamily property, 4 or more stories above ground level, must comply with the chapter on existing apartment buildings in National Fire Protection Association Standard 101, *Life Safety Code*®.
- All other housing must have hard wired or battery operated smoke detectors.

The requirements of the Act apply to all Federal agencies and all Federally owned and leased buildings in the United States, except those under the control of the Resolution Trust Corporation.

In addition, there are a number of definitions associated with the Act. The major definitions are summarized below:

- *Federal Employee Office Building* means any building, owned or leased by the Federal Government, that can be expected to house at least 25 Federal employees in the course of their employment.
- *Renovated* means the repairing or reconstructing of 50 percent or more of the current value of a Federal employee office building, not including the land on which the Federal employee office building is located.
- *Multifamily property* means a residential building consisting of more than 2 residential units under one roof housing Federal employees or their dependents or a residential building consisting of more than 4 residential units under one roof housing other persons.
- *Rebuilding* means the repairing or reconstructing of portions of a multifamily property where the cost of the alterations is 70 percent or more of the replacement cost of the completed multifamily property, not including the land on which the Federal employee office building is located.
- *Housing assistance* means assistance provided by the Federal Government for housing, in the form of a grant, contract, loan, loan guarantee, cooperative agreement, interest subsidy, insurance, or direct appropriation; but does not include assistance provided by the Secretary of Veterans Affairs; the Federal Emergency Management Agency; the Secretary of Housing and Urban Development under the single family mortgage insurance programs under the National Housing Act or the home ownership assistance program under section 235 of such Act; the National Homeownership Trust; the Federal Deposit Insurance Corporation under the affordable housing program under section 40 of the Federal Deposit Insurance Act; or the Resolution Trust Corporation under the affordable housing program under section 21A(c) of the Federal Home Loan Bank Act.
- *Hazardous areas* means those areas in a building referred to as hazardous areas in National Fire Protection Association Standard 101, *Life Safety Code*®, or any successor standard.
- *Smoke detectors* means single or multiple station, self-contained alarm devices designed to respond to the presence of visible or invisible particles of combustion, installed in accordance with the National Fire Protection Association Standard 74 or any successor standard.
- *Automatic sprinkler system* means an electronically supervised, integrated system of piping to which sprinklers are attached in a systematic pattern, and which, when activated by heat from a fire:

a) will protect human lives by discharging water over the fire area, in accordance with National Fire Protection Association Standard 13, 13D, or 13R, whichever is appropriate for the type of building and occupancy being protected, or any successor standard thereto; and
b) includes an alarm signaling system with appropriate warning signals (to the extent such alarm systems and warning signals are required by Federal, State, or local laws or regulations) installed in accordance with the National Fire Protection Association Standard 72, or any successor standard.

A critical issue regarding implementation of the Act involves the definition and determination of an *equivalent level of safety*. The Act defines the term as an alternative design or system (which may include automatic sprinkler systems), based upon fire protection engineering analysis, which achieves a level of safety equal to or greater than that provided by automatic sprinkler systems.

The General Services Administration is required to issue regulations to further define the term *equivalent level of safety*. The Act specifies that, to the extent practicable, these regulations be based upon nationally recognized codes. In addition to describing the physical characteristics of an automatic sprinkler system, the Act sets a performance objective for the system. According to the definition, automatic sprinkler systems installed in compliance with the Act must ***protect human lives***. This regulation, further defining the term *equivalent level of safety*, uses this performance objective to establish a quantifiable measure of the level of safety provided by sprinklers. In addition, a framework is presented for evaluating alternatives against the performance objective.

The Act did not address property protection or fire fighting. Thorough prefire planning, required by the Act, will allow firefighters to determine whether or not to enter a burning building solely to fight a fire. Therefore, the regulation does not directly address these issues either.

II. Objectives of the Legislation

Despite the widespread availability of affordable means of preventing fire losses, the United States continues to have one of the highest per capita fire death rates in the industrialized world. Fire is the fourth largest accidental killer in the United States, claiming at least 4,500 lives annually and injuring an additional 30,000 individuals. The fire vulnerability of office buildings and residential housing units can be reduced through strong firesafety measures. It is essential for the protection of life and property that effective technology be employed in detecting, containing and suppressing fires. When properly installed and maintained, automatic sprinklers and smoke detectors provide effective safeguards against loss of life and property from fire. According to the National Fire Protection Association (NFPA), there is no record of a multiple death fire (involving the loss of three or more people) in a completely sprinklered building where the system was properly operating, except in an explosion or flash fire or where industrial fire brigade members or employees were killed during fire suppression operations. The Federal Government, in addition to increasing the protection provided its own employees and individuals living in federally subsidized housing, can set an example in the area of firesafety and, by its own actions, encourage the private sector to use technology that has been proven to save lives.

The Federal Fire Safety Act of 1992 was created to serve as a model for local jurisdictions where the Congress believed not enough was being done to promote and provide for the firesafety of citizens. The evidence for the Congressional concern is clear. According to National Fire Protection Association data, there are about 30,000 fire departments in the country, yet, according to the National Fire Sprinkler Association, only 7 states and 34 local jurisdictions have sprinkler requirements that affect existing buildings. These ordinances have exclusions, applying to only specific occupancies. Most of them exclude residential occupancies, the occupancy where most fire deaths occur. The Federal government chose to lead by example without imposing requirements on the states and local communities.

Congress recognized the need to have legislation that proactively addressed protection of life from fire. Throughout hearings on the Act, many groups testified that sprinklers were not the only system component necessary for firesafety in buildings. In addition, Congress did not want the

legislation to inhibit the development of new technology. Therefore, the law does not simply mandate the installation of sprinklers. The law specifies certain life safety objectives to be achieved by the sprinkler systems. An equivalency clause was provided to allow for the use of alternatives which satisfied the identified life safety objectives.

III. Background

Use of automatic sprinklers may be the best, currently available approach to providing life safety. Sprinklers respond automatically to fire, limit fire size, and are also able to sound an alarm. In addition to enhancing life safety, sprinklers provide property protection and limit potential business interruption. Sprinklers can significantly reduce the hazards firefighters must face in combating a fire. The cost effectiveness of sprinklers for new construction cannot be overstated. Sprinkler protection can be added with minimal impact on overall project cost while significantly improving the level of firesafety. In recognition of the many benefits and relatively low cost of sprinkler protection, the General Services Administration has instituted a policy of providing sprinklers in its new construction projects.

The issue of providing sprinkler protection in existing buildings is not as clear cut. Typically, the cost of providing protection is higher in existing buildings. It may not be possible to provide complete sprinkler protection due to existing physical conditions or competing requirements (e.g., historic preservation laws). The decision to provide sprinkler protection must be part of an integrated fire protection strategy. Existing building systems and applicable requirements must be considered in developing the strategy. Most model codes provide an equivalency concept which allows for use of alternative approaches or systems. This concept is provided in recognition of the fact that compliance with one prescribed solution may not be the best alternative in every case.

These alternative systems, methods, or devices can achieve a reasonable level of protection and can then meet the intent of the specific code requirement. Alternative methods which might be considered include using fire-rated enclosing barriers, low flame spread interior finish materials, low heat release rate furnishings, and low ignition tendency materials. In evaluating alternatives, consideration needs to be given to the reliability of the proposed approach over the life of a structure. In addition, enforcement and maintenance practices will vary significantly depending on the use (office, residence, store, factory, etc.) of the facility.

The Federal Fire Safety Act of 1992 requires that the General Services Administration, in cooperation with the United States Fire Administration, the National Institute of Standards and Technology, and the Department of Defense, issue regulations further defining the term *equivalent level of safety*. In developing the regulations, GSA held meetings with a working group composed of representatives from the agencies named in the legislation and other affected Federal agencies. The Department of Veterans Affairs, the Social Security Administration, the Department of Housing and Urban Development, and the U.S. Coast Guard were invited to participate because of the Act's potential impact on their office space or housing.

The group met several times during 1993 and discussed several issues key to the development of a definition of an *equivalent level of safety*. Ultimately, the group agreed that sprinklers provide a unique combination of fire detection and suppression, and that no current system could be considered equivalent. However, other systems in various combinations could provide a level of safety, especially life safety, equivalent to that provided by complete sprinkler protection. The group determined that reaction time is the significant difference between the two occupancy groups (office and residential) addressed by the Act. Reaction time is especially important in analyzing equivalency in housing. An occupant's ability to react to a fire and evacuate from the area exposed to fire effects can be influenced by a number of factors including physical ability, mental status, age, available warning systems, and training.

The question of whether or not the regulation should have a height threshold, specifically should it not apply to high rise buildings, was the most difficult for the group to deal with and a consensus was never reached. The group was divided between two opposing points of view. One portion of the group believed that the firesafety problems inherent in high rise buildings could only be addressed through complete sprinkler protection, and the Act was intended to require sprinklers in

high rise buildings. Therefore, the regulation should place a maximum height limit on the applicability of the *equivalent level of safety* provision. The opposing view held that no height threshold was necessary. In high rise buildings, fire fighting and egress will be more difficult. However, appropriate combinations of automatic detection, fire and smoke containment, egress facilities, and suppression could produce effective fire protection strategies in these buildings. An analysis, required as part of the *equivalent level of safety* regulation, could adequately address the firesafety problems associated with high rise buildings and lead to development of appropriate solutions.

Model codes support the use of equivalency concepts especially in existing buildings. The Congressional intent for an equivalency option was reinforced by the passage of an amendment to the original legislation providing an equivalency option in Federally assisted housing in New York City (Public Law 103-195). The legislation gives the General Services Administration the responsibility to develop the regulation defining an *equivalent level of safety*. GSA believes that the law is clear requiring high rise (6 or more stories) Federal employee office buildings to have sprinklers, or an *equivalent level of safety*. The regulation should not have specific thresholds.

IV. Summary of Proposed Rule

In order to evaluate whether or not a life safety equivalency has been achieved, the building systems must be defined, reasonable worst case scenarios developed, maximum probable loss estimated, time required for the space to become hazardous calculated, and time required for egress determined. A number of factors are critical in developing a life safety equivalency analysis. Rate of fire growth is controlled by the type and location of combustible items, the layout of the space, the materials used in construction of the rooms, openings and ventilation, and suppression capability. Detection time, occupant notification, occupant reaction time, occupant mobility, and means of egress are important considerations in evaluating egress time.

The proposed regulation established a general measure of building firesafety performance. Building environmental conditions were specified to ensure the life safety of building occupants outside the room of fire origin. The specified environmental conditions would be applicable whether or not the evaluation is conducted for the entire building or for just the hazardous areas. In the latter case, the room of origin would be the hazardous area while any room could be a room of origin in the entire building scenario.

Sprinklers would provide the level of life safety prescribed in the Act by controlling the spread of fire and its effects beyond the room of origin. In order to provide an *equivalent level of safety*, alternative methods must allow sufficient time for occupants to reach areas of safety by limiting the spread of the fire and its effects. A typical room fire will not pose a hazard to the rest of the building until flashover. A functioning sprinkler system should activate prior to the onset of flashover. Smoldering fires can have significant life safety impact beyond the room of origin. However, a typical sprinkler system would not activate in response to a smoldering fire. Therefore, the sprinkler system would have little or no impact on life safety in the smoldering fire.

Flashover is a phenomenon that occurs in many building fires. In the initial (preflashover) stages, fire development is controlled by the amount, type, and location of combustible materials in the area and the speed with which it spreads. As the fire develops, however, the hot smoke and fire gases accumulate at the ceiling, heating all of the un-ignited materials in the room. The hot ceiling gases radiate energy onto the burning fuel causing it to burn faster. As the fire grows, the available air cannot support the combustion of all of the fuel that is produced. The unburned fuel collects in the smoke layer; the smoke normally blackens at this time. When this combination of events reaches a temperature of about 550 to 600 °C (1000 to 1100 °F), the radiant heat from the hot gas layer will quickly ignite all of the exposed combustible material. Frequently any combustible gases accumulated in the smoke layer will find air and burn out at this time. When this rapid ignition of combustible material or gases occurs, the fire often violently erupts from the room of origin spreading flame, hot fuel laden gases, and toxic smoke into adjacent spaces. This transition is called flashover, and a fire that has undergone this transition is called a flashed over fire.

The proposed regulation established three endpoint criteria designed to achieve the level of life safety prescribed in the Act. To be equivalent, an office building or housing unit must be designed, constructed, and maintained to prevent flashover in the room of fire origin, limit fire size to no more than 1 megawatt (950 Btu/sec), or prevent flames from leaving the room of origin. For the purposes of this regulation, flashover is intended to describe a fire in which the upper layer temperature in a room reaches approximately 600 °C (1100 °F) and the heat flux at floor level exceeds 20 kW/m^2 (1.8 $Btu/ft^2/sec$). As with the prevent flashover criteria, the limitation on maximum heat release rate and the requirement to keep flames within the room of fire origin are designed to limit the size of the fire.

A 1 megawatt fire is approximately equivalent to a single burning easy chair or two burning 1.8 m (6 ft) tall Christmas trees. In a 3.6 m (12 ft) by 4.6 m (15 ft) gypsum board lined room with a 1.4 m (4 ft) wide open doorway, a fire growing proportionally with time will produce an upper gas temperature of 425 to 480 °C (800 to 900 °F) in 300 seconds. The fire heat release rate at 300 seconds would be approximately 1 megawatt assuming a medium growth rate *t-squared* fire as referenced in Appendix B of the National Fire Protection Association Standard 72, *National Fire Alarm Code*. This fire is about the largest that can occur in such a room without a substantial likelihood of flames discharging out the room doorway.

The person conducting a life safety equivalency analysis must be familiar with fire dynamics, building construction, hazard assessment, and human behavior in a crisis. The proposed regulation established minimum qualifications for the people expected to conduct the required analyzes. In addition, the regulation specified the Federal government official responsible for reviewing and accepting *equivalent level of safety* analyses.

The proposed rule did not address the life safety impact of a smoldering fire. Smoldering fires can represent a significant life safety hazard, however, typical sprinkler systems will not control this hazard. In addition, it did not attempt to provide guidance in determining acceptable levels of protection against property loss or business interruption.

V. Discussion of Comments

GSA published the proposed rule in the Federal Register (Vol. 59, No. 99, pp. 26768-26772) for public comment on May 24, 1994. On June 30, 1994, a notice of extension of the public comment period was published in the Federal Register (Vol. 59, No. 125, pg. 33724). The public had until July 25, 1994, to comment on the proposed rule.

In response to the proposed rule and subsequent extension, a total of 46 items of correspondence were received. Of these, 14 were from state fire marshals, 10 were from professional or trade associations, 7 were from Federal government entities, 3 were from private fire protection engineering consultants, 1 was from academia, and 11 were from private citizens. The comments ranged from general support or opposition to the concept of an *equivalent level of safety* to very specific comments related to technical details of the regulation. A summary of the comments, and our responses to them, follow.

A. Intent of Legislation

Comment: Several commenters indicated that defining an *equivalent level of safety* would provide a means to avoid the intent of the Act.

Response: As indicated in House Report 102-509, Part 1, the purpose of the Federal Fire Safety Act of 1992 was to set an example for state and local governments by mandating firesafety requirements for new or renovated federal office space and certain categories of federally-assisted housing. By prohibiting Federal funding for these buildings, the Act promotes the use of automatic sprinklers, or an *equivalent level of safety*. The Act defines the term *equivalent level of safety* as an alternative design or system (which may include sprinkler systems), based upon fire protection engineering analysis, which achieves a level of safety equal to or greater than that provided by automatic sprinkler systems. The Congress had a number of expectations concerning the definition.

The alternative would provide flexibility in instances where fire protection engineering analyses demonstrated that other means would yield the same level of life safety as that provided in a fully sprinklered building. In many situations, there would be no effective *equivalent level of safety* in comparison to the life safety protection afforded by a building conforming with the requirements of current building design criteria for a fully sprinklered building. In addition, several factors were to be considered in further defining *equivalent level of safety*: the provisions of nationally recognized model codes and the firesafety guidelines followed by the General Services Administration for sprinklered buildings; analyses of potential fire loss exposures and adverse conditions related to the firesafety of a building, and analyses of safety alternatives for a building; and current technical research, including the study "on the use, in combination, of fire detection, fire suppression systems, and compartmentation," of the National Institute of Standards and Technology. The intent of the Act is very clear in requiring an *equivalent level of safety* option for all situations.

Comment: A number of commenters wanted sprinklers to be the only option.

Response: It should not be taken lightly that this legislation originated in the House Committee on Science, Space, and Technology and that one intent of the Act (as specifically articulated in the report language) was to encourage the development and use of new technology. The Congress recognized that the intent of the Act could not be met by specifying only one type of currently available fire technology. The concept of *equivalent level of safety* has and will continue to promote the development of new firesafety technologies. Providing for an *equivalent level of safety* is in keeping with equivalency clauses contained in the model building and fire codes. For example, section 1-5.1 of National Fire Protection Association Standard No. *101®, Life Safety Code®*, states

> "Nothing in this *Code* is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety as alternatives to those prescribed by this *Code*, provided technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency, and the system, method, or device is approved for the intended purpose."

The regulation provides a means for demonstrating equivalency based on a technical evaluation.

Comment: A few Federal agencies indicated that defining an *equivalent level of safety* could jeopardize their automatic sprinkler system installation programs.

Response: The public law sets a standard. This regulation provides a means to achieve the standard while maintaining a degree of flexibility. Use of this *equivalent level of safety* option is not mandatory. As outlined in this regulation, there are numerous reasons for installing automatic sprinkler systems in buildings. These reasons cover issues well beyond the very limited scope of this regulation. Full compliance with the sprinkler requirements contained in the Federal Fire Safety Act will be the easiest solution, especially when Federal agencies lack the fire protection engineering expertise to evaluate an equivalency.

B. Scope of the Regulation

Comment: A number of comments reflected confusion concerning the scope of the regulation.

Response: This regulation is intended solely to define an *equivalent level of safety* appropriate for judging compliance with the requirements of the Federal Fire Safety Act of 1992. It does not necessarily apply to the evaluation of equivalency to other building and fire code requirements. In order to address this issue, the scope of the regulation has been refined and clarified.

Comment: Several commenters expressed concern over the decision to exclude firefighter safety from the regulation especially when rescue of building occupants is required.

Response: The concept presented in the proposed regulation was not intended to totally exclude consideration of firefighter safety. The need for the fire department to conduct rescue operations must be considered in an *equivalent level of safety* analysis. If rescue operations are expected, then the firefighters conducting them must be protected. Firefighter safety is not considered from the standpoint of them entering a building solely to fight a fire and limit property loss.

Comment: A few commenters questioned the impact of the proposed rule on local codes.

Response: Legally, buildings built on Federal property are exempt from local building codes. In the case of buildings developed on private land to be leased by the Federal government, the applicable local codes govern. Public Law 100-678 requires, among other things, that Federal agencies comply "to the maximum extent feasible" with "one of the nationally recognized model building codes and with other applicable nationally recognized codes" when constructing or altering Federal buildings. This law also directs agencies to comply with state and local zoning laws to submit plans for buildings being altered or constructed to state or local officials for review prior to construction, and to permit local officials to inspect Federal buildings while under construction or alteration. However, the law places limitations on the obligations of Federal agencies; for example, agencies can limit the time local officials have for plans review to 30 days, are not required to follow the recommendations of local officials, and are not allowed to pay any fees or fines to local governments. The impact of the Federal Fire Safety Act will primarily be an as additional requirement with which Federal buildings, both owned and leased, will have to comply. However, firesafety protection measures required in order to comply with local codes or other requirements can and should be considered in assessing the existence of an ***equivalent level of safety***.

Comment: Some commenters questioned the applicability of existing equivalency clauses in currently available consensus standards and their relationship to the proposed rule.

Response: Equivalency as described in national standards requires approval by an authority having jurisdiction. No specific performance measures are provided for making the judgment as to the level of equivalency, leading to non-uniform application and acceptance. The rule provides a performance definition, as required by the law. It is possible the philosophy outlined in the proposed rule could form the basis for further development and adoption of performance-based equivalency measures in the national consensus codes.

C. Technical Issues

Comment: Several commenters recommended the establishment of a threshold height limit above which only total sprinkler protection would be acceptable. However, other commenters indicated that the height issue could be addressed in the required engineering analysis.

Response: The objective was not to rewrite the law. The Act requires that the General Services Administration further define the term *equivalent level of safety*. By specifying a maximum height threshold, the equivalency option specifically intended by Congress would be eliminated without their consent. The intent of Congress to provide an equivalency option without height limitations is further evidenced by the addition of an equivalency option after the bill had been passed (Public Law 103-195).

Comment: A number of comments were received concerning whether or not meeting one or all of the selected equivalency criteria was sufficient. These commenters recommended replacing the word ***or*** in the phrase "prevent flashover in the room of origin, limit fire size to no more than 1 megawatt (950 Btu/sec), **or** prevent flames from leaving the room of origin" with the word ***and***.

Response: The word ***or*** was chosen specifically in preference to ***and***. The intent of this statement was that the condition or conditions producing the most hazardous exposure to building occupants be selected for measuring equivalency. For example, it could be concluded that an acceptable level of safety had been achieved if flames did not extend beyond the room of origin. If flashover or the 1 MW fire represented a more severe hazard to building occupants, this conclusion would not be valid.

Comment: Many commenters raised issues associated with the definition of the *room of origin*, specifically raising concerns related to establishing an appropriate size. Is it appropriate to use a closet as the *room of origin*? What would the *room of origin* be in an area with open plan space?

Response: The concept of *room of origin* was deliberately left open to encourage comments. Based on comments received, the definition of *room of origin* is being refined to include a maximum area limitation of 200 m^2 (2000 ft^2). Fires involving areas greater than 200 m^2 pose substantial difficulties for firefighters and threaten occupants, especially those located on upper levels of high-rise structures. Exit paths are easily jeopardized by fires involving 200 or more square meters of floor area. In order to provide equivalent life safety, especially in high-rise structures, no fire area

should be permitted to exceed 200 m^2. Fire separations or other protective measures should be provided to limit potential fire areas.

Comment: A few commenters questioned the use of flashover as an endpoint criteria.

Response: Flashover was selected as an endpoint for two reasons. First, the potential for flashover can have a significant impact on required notification time. Prior to flashover, a fire represents a hazard primarily to occupants in the room of origin. The energy released by the fire is insufficient to "drive" significant quantities of products of combustion beyond the room of origin. Any smoke that leaves is low temperature and contains minimal amounts of toxic gases. Based on a series of fire tests in mobile homes, researchers at the National Bureau of Standards (now the National Institute of Standards and Technology) concluded "Limiting conditions adverse to life safety are likely to be reached in the living room at the end of the mobile home remote from the bedroom where the fire started at approximately the same time that flashover occurs in the bedroom. Limiting levels of carbon monoxide and oxygen are less likely to be reached in the living room if flashover does not occur in the bedroom." (Budnick, E.K., Klein, D.P., and O'Laughlin, R.J., "Mobile Home Bedroom Fire Studies: The Role of Interior Finish," NBSIR 78-1531, National Bureau of Standards Center for Fire Research, September 1978.) Occupants in the room of origin should be able to detect a fire and leave prior to flashover. If flashover is expected, the use of sophisticated fire alarm systems will be required to provide sufficient egress time for building occupants outside the room of origin.

A second reason for flashover as an endpoint is its use as a firesafety performance objective in the national consensus standards. Two of the three sprinkler installation standards referenced in the Federal Fire Safety Act use flashover as an objective. These two standards (NFPA 13D and 13R) indicate that a sprinkler system "installed in accordance with this standard is expected to prevent flashover (total involvement) in the room of fire origin, where sprinklered, and to improve the chance for occupants to escape or be evacuated." The third standard (NFPA 13) simply states that its objective is "to provide a reasonable degree of protection for life and property from fire." Currently, compliance with the specifications contained in the standard is the only way to judge whether or not the proposed performance objective has been achieved. Several large loss fires have indicated that complying with the requirements in the standard may not always adequately protect the specific hazard and ensure attainment of the firesafety objective. In recognition of this, the NFPA has recently formed a group, composed of members of the sprinkler installation standard committee, to develop a fully performance oriented sprinkler installation standard. In addition, the NFPA has established a project, under the Committee on Hazard and Risk of Contents and Furnishings, to develop a document on prevention of flashover titled *Guide on Methods for Decreasing the Probability of Flashover*.

Comment: A number of commenters questioned the definition of *reasonable worst case scenario* and several provided recommendations for improving the definition.

Response: The *reasonable worst case scenario* definition was not intended to be an all inclusive listing of things to be considered in conducting an equivalency analysis. Based on comments received, the definition is being expanded to identify additional items which should be considered in establishing *reasonable worst case scenarios*. Specific issues to be considered as part of a worst case scenario are types of fuel (paper, plastics, chemicals), form and arrangement of fuel (furniture, shredded newspaper, stacked chairs), availability of suppression systems (sprinkler system, fire department), capability of suppression systems (proper sprinkler system design, fire department manning, fire department response time) and capability of occupants (awake, asleep, intoxicated, physically or mentally impaired).

Comment: A few commenters suggested identifying recommended alternatives to complete sprinkler protection such as specific compartmentation or detection system requirements.

Response: The Act specifies one method, complete sprinkler protection, of achieving a prescribed level of life safety. The *equivalent level of safety* option is the exception to the general rule of complete sprinkler protection. If a list of alternatives was provided, sprinkler protection would become one of several options instead of the intended primary choice. In applying the *equivalent level of safety* provision, each building must be evaluated on its own merits and an individualized fire protection strategy developed. Each application of the *equivalent level of safety*

option will involve a different set of circumstances. A list of recommended alternatives would not provide the necessary flexibility or allow for scientific and technological advancements.

Comment: A few commenters expressed concern that the regulation attempts to force the use of computer based fire models which the commenters suggested were in the infancy stages of development and produced inconsistent results.

Response: The law is explicit that equivalency be based on a fire protection engineering analysis. The proposed rule suggests several tools that can be chosen based on the specific situation, including fire models. The decision of which tools to use is left to the engineer and agency to decide, based on the needs of each case. The use of engineering calculation methods is encouraged, models are but one way of efficiently applying first principles.

From a public policy perspective, the use of engineering applications must be encouraged to better prepare the engineering community for global competition. A *Conference on Firesafety Design in the 21st Century*, held in May 1991 at Worcester Polytechnic Institute, graphically illustrated how far the United States had lagged behind other countries in developing performance-based building codes and applying analytical measurement techniques. Computer based models are readily accepted for use in a variety of countries, including Japan, United Kingdom, New Zealand, and Australia. These countries have embraced these design concepts and are capable of building and operating better performing and more cost effective facilities. Recognizing this fact, the National Fire Protection Association has established a task force on its Board of Directors to expedite its activities in the development and dissemination of computational methods.

These computational methods are no longer research and development activities. A variety of validation tests on many different models have been reported and indicate very good correlation with full scale fire tests and experience. Calculation procedures, including computer models, have been used in fire reconstruction with excellent results in determining the course of events. New information is being developed almost daily, supporting the use of calculation methods and models to develop sound engineering solutions to fire protection problems.

Finally, the various tools suggested in the proposed rule have a wide variety of support. The Fire Safety Evaluation System, for example, is codified in the manual *Alternative Approaches to Life Safety* (NFPA 101M), which is developed and accepted through the national consensus standards process. Numerous calculation methods have been accepted and compiled in the *Handbook of Fire Protection Engineering,* the source document for engineering methods for the fire protection engineering profession. The use of calculation methods and computer models is commonplace in other engineering disciplines. If fire protection engineering is to be accepted as an engineering discipline, it must accept, understand, and use these analytical tools.

D. Qualifications and Consistency Issues

Comment: Several comments were received regarding the qualifications of the personnel conducting the *equivalent level of safety* analyses.

Response: The required years of experience factor has been increased from two to four. This modification brings the three qualification options into closer agreement. The education requirement has been modified to reflect technical differences between undergraduate and graduate engineering programs. In addition, it has been revised to allow for engineers trained outside the United States.

Comment: A number of commenters inquired as to who should or could review *equivalent level of safety* analyses.

Response: As stated in the proposed rule, the head of the agency making facility improvements or providing Federal assistance is ultimately responsible for determining the acceptability of an *equivalent level of safety* analysis. In developing this determination, an independent review of the analysis by Government fire protection engineering professionals will be required. However, a few fire protection engineering professionals, employed by Federal government agencies, indicated they did not have the expertise to conduct the required reviews. This concern was not shared by other fire protection engineers, including those working for private consulting firms. Comments from these engineers indicated they could conduct and review the analyses as appropriate. It may be necessary for Government agencies who lack in-house professional expertise to contract with

private firms or other Government agencies (General Services Administration Central Office for example) for services to review *equivalent level of safety* analyses.

Several commenters expressed a desire to have a specific Federal government agency, the General Services Administration, responsible for the review of all *equivalent level of safety* analyses. Discussion of the issues associated with this option is beyond the scope of this regulation. As resources permit, the General Services Administration will develop and distribute, from time to time, information on conducting and evaluating *equivalent level of safety* analyses. In addition, the GSA will maintain a library of its own successful analyses and will seek to establish a dialog with other agencies concerning determining an *equivalent level of safety*. Other Federal agencies should consider maintaining their own libraries of *equivalent level of safety* analyses.

A final issue associated with review of *equivalent level of safety* analyses concerns the involvement of local jurisdictions. Implementation of the Federal Fire Safety Act and this regulation cannot place a burden on local jurisdictions. Local jurisdictions cannot be required to review or evaluate an *equivalent level of safety* analysis. However, the *equivalent level of safety* analysis should be provided to the local jurisdiction as part of the required prefire planning.

Comment: Some comments were received concerning the consistency to be expected from the *equivalent level of safety* analyses.

Response: Any engineering analysis is dependent on a variety of assumptions. Individuals are likely to make different assumptions. Even in the interpretation of written words in a code book, different courses of action are recommended by different individuals. Uniformity of application is an issue inherent in dealing with human beings, and not unique to engineering analyses. An analysis based on the application of science-based first principles should provide consistent results. While the recommended corrective actions may differ, the use of personnel with the minimum qualifications identified in the regulation will ensure that the technical support for the recommendations is consistent with the governing principles of physics and chemistry.

E. Miscellaneous

Comment: A number of commenters identified editorial corrections or provided updated or corrected statistical data.

Response: These comments have been adopted to the extent the referenced section of the regulation remains in the final rule.

VI. Summary of Changes

As a result of the public comments, a number of changes were made to the regulation. These changes are briefly outlined in this section.

1. The scope of the regulation has been modified and expanded to clarify the intent of this regulation and its impact on local codes and standards.
2. The qualification requirements have been modified to bring the three alternatives into closer alignment, clarify some issues, and provide opportunities for engineers educated in other countries.
3. The *room of origin* has been defined to set a maximum limit on the potential size of an involved area.
4. The definition of *reasonable worst case scenario* has been expanded to clarify its meaning.
5. The equivalency criteria have been changed to better link the equivalency measurement to the mandated baseline level of safety associated with complete sprinkler protection.

The General Services Administration (GSA) has determined that this rule is a significant regulatory action for the purposes of Executive Order 12866. The rule is written to ensure maximum benefits to Federal agencies. This Governmentwide management regulation will have little or no cost effect on society. Therefore, the rule will not have a significant economic impact on a substantial number of small entities under the Regulatory Flexibility Act (U.S.C. 601 et seq.).

List of Subjects in 41 CFR 101-6

Civil rights, Government property management, Grant programs, Intergovernmental relations, Surplus Government property, Relocation assistance, Real property acquisition, Fire protection

For the reasons set out in the preamble, 41 CFR Part 101-6 is amended as follows:

PART 101-6 MISCELLANEOUS REGULATIONS

1. The authority citation for 41 CFR Part 101-6 continues to read as follows:

AUTHORITY: Sec 205(c), 63 Stat. 390; 40 U.S.C. 486(c)

SUBPART 101-6.6 FIRE PROTECTION (FIRESAFETY) ENGINEERING

2. Subpart 101-6 is added to read as follows:

§101-6.600 Scope of subpart.

This subpart provides the regulations of the General Services Administration (GSA) under Title I of the Fire Administration Authorization Act of 1992 concerning definition and determination of *equivalent level of safety*. The primary objective of this regulation is to provide a quantifiable means for determining compliance with the requirements of the Act. It is not a substitute for compliance with building and fire code requirements typically used in construction and occupancy of buildings.

§101-6.601 Background.

(a) The Fire Administration Authorization Act of 1992 (Public Law 102-522) was signed into law by the President on October 26, 1992. Section 106, Fire Safety Systems in Federally Assisted Buildings, of Title I - United States Fire Administration, is commonly referred to as the Federal Fire Safety Act of 1992. This section amends the Fire Prevention and Control Act of 1974 (15 U.S.C. 2201 et seq.) to require sprinklers or an *equivalent level of safety*, in certain types of Federal employee office buildings, Federal employee housing units, and Federally assisted housing units.

(b) The definition of an automatic sprinkler system is unique to the Act. In addition to describing the physical characteristics of an automatic sprinkler system, the definition sets a performance objective for the system. Automatic sprinkler systems installed in compliance with the Act must ***protect human lives***. Sprinklers would provide the level of life safety prescribed in the Act by controlling the spread of fire and its effects beyond the room of origin. A functioning sprinkler system should activate prior to the onset of flashover.

(c) This regulation establishes a general measure of building firesafety performance. To achieve the level of life safety specified in the Act, the structure under consideration must be designed, constructed, and maintained to minimize the impact of fire. As one option, building environmental conditions are specified in this regulation to ensure the life safety of building occupants outside the room of fire origin. They should be applicable independent of whether or not the evaluation is being conducted for the entire building or for just the hazardous areas. In the latter case, the room of origin would be the hazardous area while any room, space, or area could be a room of origin in the entire building scenario.

(d) The *equivalent level of safety* regulation does not address property protection, business interruption potential, or firefighter safety during fire fighting operations. In situations where firefighters would be expected to rescue building occupants, the safety of both firefighters and occupants must be considered in the *equivalent level of safety* analysis. Thorough prefire planning will allow firefighters to choose whether or not to enter a burning building solely to fight a fire.

§101-6.602 Application.

The requirements of the Act and these regulations apply to all Federal agencies and all Federally owned and leased buildings in the United States, except those under the control of the Resolution Trust Corporation.

§101-6.603 Definitions.

(a) *Qualified fire protection engineer* is defined as an individual, with a thorough knowledge and understanding of the principles of physics and chemistry governing fire growth, spread, and suppression, meeting one of the following criteria:

(1) an engineer having an undergraduate or graduate degree from a college or university offering a course of study in fire protection or firesafety engineering, plus a minimum of four (4) years work experience in fire protection engineering,

(2) a professional engineer (P.E. or similar designation) registered in Fire Protection Engineering, or

(3) a professional engineer (P.E. or similar designation) registered in a related engineering discipline and holding Member grade status in the international Society of Fire Protection Engineers.

(b) *Flashover* means fire conditions in a confined area where the upper gas layer temperature reaches 600 °C (1100 °F) and the heat flux at floor level exceeds 20 kW/m^2 (1.8 Btu/ft^2/sec).

(c) *Reasonable worst case fire scenario* means a combination of an ignition source, fuel items, and a building location likely to produce a fire which would have a significant adverse impact on the building and its occupants. The development of *reasonable worst case scenarios* must include consideration of types and forms of fuels present (e.g., furniture, trash, paper, chemicals), potential fire ignition locations (e.g., bedroom, office, closet, corridor), occupant capabilities (e.g., awake, intoxicated, mentally or physically impaired), numbers of occupants, detection and suppression system adequacy and reliability, and fire department capabilities. A quantitative analysis of the probability of occurrence of each scenario and combination of events will be necessary.

(d) *Room of origin* means an area of a building where a fire can be expected to start. Typically, the size of the area will be determined by the walls, floor, and ceiling surrounding the space. However, this could lead to unacceptably large areas in the case of open plan office space or similar arrangements. Therefore, the maximum allowable fire area should be limited to 200 m^2 (2000 ft^2) including intervening spaces. In the case of residential units, an entire apartment occupied by one tenant could be considered as the *room of origin* to the extent it did not exceed the 200 m^2 (2000 ft^2) limitation.

§101-6.604 Requirements.

(a) The equivalent level of life safety evaluation is to be performed by a qualified fire protection engineer. The analysis should include a narrative discussion of the features of the building structure, function, operational support systems and occupant activities which impact fire protection and life safety. Each analysis should describe potential reasonable worst case fire scenarios and their impact on the building occupants and structure. Specific issues which must be addressed include rate of fire growth, type and location of fuel items, space layout, building construction, openings and ventilation, suppression capability, detection time, occupant notification, occupant reaction time, occupant mobility, and means of egress.

(b) To be acceptable, the analysis must indicate that the existing and/or proposed safety systems in the building provide a period of time equal to or greater than the amount of time available for escape in a similar building complying with the Act. In conducting these analyses, the capability, adequacy, and reliability of all building systems impacting fire growth, occupant knowledge of the fire, and time required to reach a safety area will have to be examined. In particular, the impact of sprinklers on the development of hazardous conditions in the area of interest will have to be assessed. Three options are provided for establishing that an *equivalent level of safety* exists.

(1) In the first option, the margin of safety provided by various alternatives is compared to that obtained for a code complying building with complete sprinkler protection. The margin of safety is

the difference between the available safe egress time and the required safe egress time. Available safe egress time is the time available for evacuation of occupants to an area of safety prior to the onset of untenable conditions in occupied areas or the egress pathways. The required safe egress time is the time required by occupants to move from their positions at the start of the fire to areas of safety. Available safe egress times would be developed based on analysis of a number of assumed *reasonable worst case fire scenarios* including assessment of a code complying fully sprinklered building. Additional analysis would be used to determine the expected required safe egress times for the various scenarios. If the margin of safety plus an appropriate safety factor is greater for an alternative than for the fully sprinklered building, then the alternative should provide an *equivalent level of safety*.

(2) A second alternative is applicable for typical office and residential scenarios. In these situations, complete sprinkler protection can be expected to prevent flashover in the room of fire origin, limit fire size to no more than 1 megawatt (950 Btu/sec), and prevent flames from leaving the room of origin. The times required for each of these conditions to occur in the area of interest must be determined. The shortest of these three times would become the time available for escape. The difference between the minimum time available for escape and the time required for evacuation of building occupants would be the target margin of safety. Various alternative protection strategies would have to be evaluated to determine their impact on the times at which hazardous conditions developed in the spaces of interest and the times required for egress. If a combination of fire protection systems provides a margin of safety equal to or greater than the target margin of safety, then the combination could be judged to provide an *equivalent level of safety*.

(3) As a third option, other technical analysis procedures, as approved by the responsible agency head, can be used to show equivalency.

(c) Analytical and empirical tools, including fire models and grading schedules such as the Fire Safety Evaluation System (*Alternative Approaches to Life Safety*, NFPA 101M) should be used to support the life safety equivalency evaluation. If fire modeling is used as part of an analysis, an assessment of the predictive capabilities of the fire models must be included. This assessment should be conducted in accordance with the American Society for Testing and Materials *Standard Guide for Evaluating the Predictive Capability of Fire Models* (ASTM E 1355).

§101-6.605 Responsibility.

The head of the agency responsible for physical improvements in the facility or providing Federal assistance or a designated representative will determine the acceptability of each *equivalent level of safety* analysis. The determination of acceptability must include a review of the fire protection engineer's qualifications, the appropriateness of the fire scenarios for the facility, and the reasonableness of the assumed maximum probable loss. Agencies should maintain a record of each accepted *equivalent level of safety* analysis and provide copies to fire departments or other local authorities for use in developing prefire plans.

Dated: September 29, 1994

Julia M. Stasch
Acting Administrator
General Services Administration

Appendix C. Available Resources

Additional Readings

Bukowski, R.W. and O'Laughlin, R.J., Fire Alarm Signaling Systems (2nd ed), National Fire Protection Association and The Society of Fire Protection Engineers, Quincy, MA (1994).

Carson, W.G. and Klinker, R.L., Fire Protection Systems (2nd ed), Inspection, Test & Maintenance Manual, National Fire Protection Association, Quincy, MA (1994).

Bryan, J.L., Automatic Sprinkler and Standpipe Systems (2nd ed), National Fire Protection Association, Quincy, MA (1990).

Budnick, E.K., DiNenno, P.J., and Scheffey, J.L., "Sprinklers and Other Fire Control Methods," in The Encyclopedia of Architecture, Vol. 4 (Joseph Wilkes, ed), John Wiley & Sons, NY (1989).

Coleman, R.J., Residential Sprinkler Systems, Protecting Life and Property, National Fire Protection Association, Quincy, MA (1991).

NFPA Fire Protection Handbook (17th ed), National Fire Protection Association, Quincy, MA (1991).

Quality Control of Residential Sprinkler Installations to Ensure Reliability, Operation Life Safety Washington, DC; sponsored by the U.S. Fire Administration and the Allstate Foundation (1989).

Express Residential Fire Sprinkler Design Guide, Prince George's County Fire Department and the National Association of Home Builders Research Center, Inc., Upper Marlboro, MD; sponsored by the U.S. Fire Administration (1995).

Hart, F.L., Till, R., Nardfini, C. And Bisson, D., Backflow Protection for Residential Sprinkler Systems, sponsored by the U.S. Fire Administration, Emmitsburg, MD (1993).

Notarianni, K.A. and Jackson, M.A., Comparison of Fire Sprinkler Piping Materials: Steel, Copper, Chlorinated Polyvinyl Chloride and Polybutylene, in Residential and Light Hazard Installations, NISTIR 5339, National Institute of Standards and Technology, Gaithersburg, MD (1994).

Organizations

Federal Government Agencies

Building & Fire Research Laboratory
National Institute of Standards and Technology
U.S. Department of Commerce
Gaithersburg, MD 20899
(301) 975-6850

U.S. Fire Administration
Federal Emergency Management Agency
500 C Street, S.W.
Washington, DC 20472
(202) 646-4600

U.S. Department of Housing & Urban Development
451 7th Street, S.W.
Washington, DC 20410
(202) 708-0980

Building Code Agencies

Building Officials & Code Administrators (BOCA)
(National Building Code)
4051 West Flossmoor Road
Country Club Hills, IL 60477
(800) 323-1103

Int'l Conference of Building Officials (ICBO)
(Uniform Building Code)
5360 S. Workman Mill Road
Whittier, CA 90601
(213) 699-0124

Southern Building Code Congress Int'l Inc. (SBCCI)
(Standard Building Code)
900 Montclair Road
Birmingham, AL 35213-1206
(800) 877-2224

Private Organizations

American Water Works Association
6666 W. Quincy Avenue
Denver, CO 80235
(303) 794-7711

International Association of Fire Chiefs
Operation Life Safety (OLS)
1329 18th Street, N.W.
Washington, DC 20036
(202) 452-0684

National Association of Home Builders
1st & M Streets, N.W.
Washington, DC 20036
(202) 822-0200

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269-9101
(617) 770-3000

National Fire Sprinkler Association
Robin Hill Corporate Park
Route 22
P.O. Box 1000
Patterson, NY 12563
(914) 878-4200

National Institute for Certification in Engineering Technologies (NICET)
1420 King Street
Alexandria, VA 22314
(703) 684-2835

Underwriters Laboratories (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096
(708) 272-8800