Residential Sprinklers in One and Two Family Dwellings and Townhouses

NYSDOS Residential Sprinkler Committee Findings

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Committee purpose

December 12, 2007, the New York State Fire Prevention and Building Code Council (Code Council) created the Residential Sprinkler Committee to gather *facts, information and data* regarding automatic fire suppression systems in one and two family residences, hereafter called sprinklers.

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Presentation format

Executive summary of scope

followed by overview of each section

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Committee scope & layout of the report:

1. Historical data
2. Statistical safety of residents and firefighters
3. Sprinkler system options and technical issues
4. Cost of sprinkler systems
5. Potential impact on housing market
6. Potential impact on insurance premiums
7. Survey of NYS jurisdictions mandating sprinklers in 1&2-family residences, and case studies elsewhere
8. Additional impacts - system maintenance and leakage
9. Construction inspection and contractor availability (was added by the committee)

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Committee members

- **NYS Codes Coalition to Protect and Preserve our Communities –** Steven McDaniel, Wayne Cichon (alternate)
- **Fire Service Representative -** Julius Ballanco, P.E.
- **NYS Builders Association -** John Hofelich , Philip LaRocque (alternate)
- **National Asso. of Home Builders –** Richard Schunk, Steven Orlowski (alternate)
- **Fire Sprinkler Industry –** Dominick Kasmauskas, C.F.P.S., NFSA
- **Insurance Industry** – Thomas White, Community Mutual Insurance Co
- **Plumbing Industry -** David Kaufmann, Campito Plumbing & Heating , Inc.,
- **Fire Protection Engineer –** Timothy DeRuyscher, P.E., Robson & Woese, Inc.,
- **Department of State Facilitators –** Raymond Andrews, R.A., Codes Division &John Mueller, Office of Fire Prevention and Control; and staff, Miriam McGiver, P.E., Codes Division

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Executive summary - process

Committee members reviewed a large amount of literature & data, and compiled this report of relevant information found during that research.

The committee did not include aspects beyond their scope, including future possibilities.

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Resource documents

- Adirondack Insurance Exchange (August 23, 2007). ***"Policy for NY"***
- 1A. Ahrens, Marty (Sept. 2007). **Home Structure Fires.** Quincy, MA: National Fire Protection Association.
- Ahrens, Marty (Sept 2007). ***Trends and Patterns of U. S. Fire Losses.*** National Fire Protection Association.
- Ahrens, Marty (April 2007). ***U.S. Experience With Smoke Alarms And Other Fire Detection/Alarm Equipment***. Fire Analysis and Research Division National Fire Protection Association.
- Brown, Heyden (2005). ***Economic Analysis of Residential Fire Sprinkler Systems.*** Gaithersburg: U.S. Department of Commerce Technology Administration, National Institute of Standards and Technology
- Butry, D. T.; Brown, M. H.; Fuller, S. K. (Oct 2007). ***Benefit-Cost Analysis of Residential Fire Sprinklers.*** U.S. Dept. of Commerce; National Institute of Standards and Technology
- Bukowski, Richard W. et al. (February 2008). ***Performance of Home Smoke Alarms: Analysis of the Response of Several Available Technologies in Residential Fire Settings.*** Washington, DC: US Dept of Commerce, Fire Research Division, Building and Fire Research Laboratory. Technical note 1455-1.
- CHUBB (2007). Masterpiece® ***Insurance Guide to Discounts***
- 7A. Cramer, Steven and White , Robert (2004). **Fire Resistant Design in Housing – Status and Opportunities.** National Science Foundation – Partnership for Advancing Technology in Housing.
- Dewar, Buddy, (July 31, 2006). ***Fire Protection System Water Supply Issues – A White Paper***. National Fire Sprinkler Association.
- Dewar, Buddy (Feb 25, 2001). ***Residential Fire Sprinklers for Life Safety: An Economic and Insurance Perspective.*** National Fire Sprinkler Association.
- Eisenberg, Elliot, Ph.D. (2005). ***Fire Deaths in the United States: How Best to Keep Reducing Them.*** Magazine of the Society of Fire Protection Engineers, Winter 2005.
- Eisenberg, Elliot F. (Nov 2002). ***House Fire Deaths.*** Housing Economics, Nov 2002, pg 11-13.
- Fahy, Rita F.; LeBlanc, Paul R.; Molis, Joseph L.; (June 2007). ***What's Changed Over The Past 30 Years?.*** Fire Analysis and Research Division, National Fire Protection Association;
- Federal Emergency Management Administration (June 2002). **America at Risk: America Burning Recommissioned**. FEMA, FA-223.
- Fleming, Russell, PE (Sept 2008). ***Headsup - A 33-Year Journey to Dwelling Sprinklers.*** NFPA Journal Sept 2008.
- Fleming, Russell, PE (Nov/Dec 2002). ***What drives the cost of residential sprinklers?*** NFPA Journal Nov/Dec 2008.
- Firebureau.com (July 20, 2008). ***Insurance Services Office Considers Changes to Fire Suppression Rating Schedule.***
- Ford, Jim (1997). ***Saving Lives, Saving Money: Automatic Sprinklers: a 10 Year Study in Scottsdale, Arizona.*** Frankfort: Home Fire Sprinkler Coalition.
- .....ETC.

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Executive summary

There has been an ongoing national process to develop fire sprinklers that enhance life safety and are affordable, and to determine effectiveness and cost of residential sprinklers.

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Executive summary - effectiveness

Many reports discuss effectiveness with differing results *and* ways of looking at effectiveness.

Six documents that assessed effectiveness found:

1. Insufficient data to evaluate *in 1 & 2 family homes*
2. Death rates *in apartments* with sprinklers down 57%
3. Response in 126 to 246 seconds for flaming fires; if smoldering, shortly after flaming (Smoke alarm respond in about 50 seconds)

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Executive summary - effectiveness

More reports:

4. They operate "effectively in 91% of *all reported fires* where sprinklers were present in the fire area and fire was large enough to activate them"
5. 'Chances of dying' reduced 69% if sprinklers installed ; 82% if both sprinklers and smoke detectors installed; 63% if smoke detectors installed
6. Nationally, sprinklers in 3% of residential structure fires & 2% of residential structure fatal fires (includes multifamily)

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Executive summary - cost

- Wide range of cost estimates & cost assumptions.
- Study by NFPA's Fire Protection Research Foundation of 30 houses found total costs for total systems from $2,386 - $16,060; & costs per square foot from $0.38 - $3.66
- Other estimates: ranged from under a dollar / SF to $11.20 / SF
- Sample homes in NYS: $6,210 to $23,065. That's $3.18 to $8.56 per conditioned square foot

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Executive summary - cost

- Lowest costs - simple small homes on municipal water
- Things that raise cost:
  - cathedral ceilings,
  - seasonal use,
  - water meters,
  - backflow preventers,
  - water service lines,
  - private water (booster pumps & storage tanks),
  - high or low pressure water supply,
  - maintenance required

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Executive summary – housing market impacts

- NYS Communities that require sprinklers in 1 & 2 family homes didn't identify housing market impacts; they tended to high end homes, aggressive markets.
- National Association of Home Builders (NAHB) looked at ability to get mortgage in 12 NYS metro areas, & concluded 0.17% of buyers, on average, priced out of the market for a median priced new home by $1,000 increase in selling price.

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Executive summary – manufactured homes

- Manufactured homes could see price rise 16% to 19% if sprinklers required.
- This segment of market has least ability to afford homes.
- Fire fatality similar in manufactured & other homes
- In U.S. from 2001 to 2007, manufactured homes 7 to 13% of market, modulars 9 to 11%. (US Census)

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Executive summary – home affordability

- Home affordability in U.S. has steadily declined from 1984 to 2004
- U.S. share of income going to housing is increasing.
- Source: U. S. Census

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Executive summary – insurance

- Most insurance companies have policies to discount premiums due to fire sprinklers, ranging from 5 – 10%. The actual discount may be none due to upper limit on discounts. No insurance company had a penalty for fire sprinklers. Water damage is generally covered as long as the owner takes measures to prevent freezing.

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Executive summary other issues

To minimize problems, especially in unconditioned spaces due to freezing, systems must be properly:

- designed
- installed
- Inspected

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1. Historical data regarding sprinklers and structural fires

1881 Early automatic sprinkler by Grinnell

- Early US history of sprinklers
- Recent US history
- Current codes in NYS
- Structure fire trends in NYS

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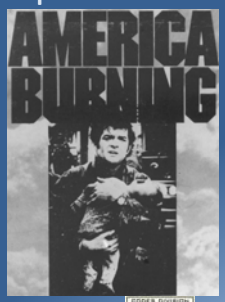
Early US history of fire sprinklers

- Late 1800's -Automatic fire sprinkler first developed to protect property.
- 1973 - "America Burning" (by National Commission on Fire Prevention and Control) identified life safety aspects of sprinklers



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Recent US history – NFPA standards

In 1975, NFPA first published 13D.

- Standard for low cost residential sprinkler system to prevent flashover in the room of fire origin.
- Goal is, first, life safety, and to aid in fire control and improve protection against injury & property damage.
- Compatible with residential construction

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Recent US history – ICC design

2007 - ICC developed a simplified "cookbook design" (IRC P2904) consistent with NFPA 13D

- Lists exempt areas - some attics, crawl spaces, closets, bathrooms, garages, porches, mud rooms
- Stand-alone & multipurpose wet systems, no antifreeze
- Has tables to select pipe size based on flow, pressure, head losses, pipe lengths & materials

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Current code in NYS

- For residential structures, 13D sprinklers are required throughout buildings of 3 stories, not counting basement
- HUD standards for manufactured homes do not address sprinklers. Whatever the current state code requires is in effect
- Sprinklers are not required in relocated homes or buildings, per Residential Code appendices E and J & Existing Bldg Code

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US residential fire trends

"Trends for one- and two-family residential building fires, deaths, and injuries declined during the 3-year period (2003–2005), 1, 10, and 3 percent respectively. Property loss increased 5 percent"

Source: USFA (2008). Residential Structure and Building Fires.

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US residential fire trends

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From Residential Structure and Building Fires (USFA, 2008)
US Trends in Fires and Fire Losses (1996–2005) , All Fires

Year	# of fires	Deaths	Injuries	Loss in Billions
1996	428,000	4,080	19,300	$6.2
2005	396,000	3,055	13,825	$6.9
10-Year Trend (%)	–1.2%	–18.1%	–28.9%	17.1%
9 year average	398,450	3,237	15,978	$6.2

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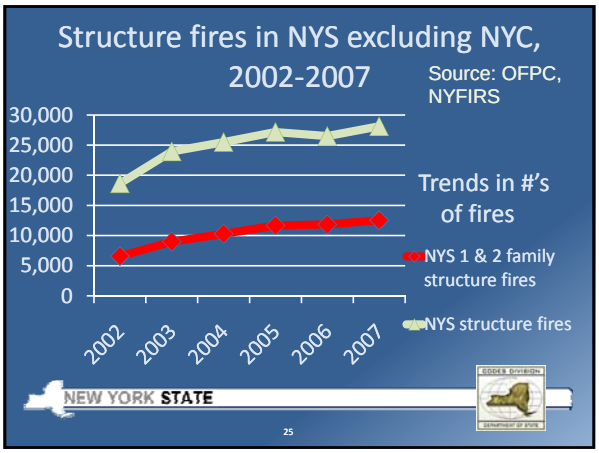
Structure fires in NYS excluding NYC, 2002-2007
Source: OFPC, NYFIRS
30,000
25,000
20,000
15,000
10,000
5,000
0
2002
2003
2004
2005
2006
2007
Trends in #'s of fires
NYS 1 & 2 family structure fires
NYS structure fires
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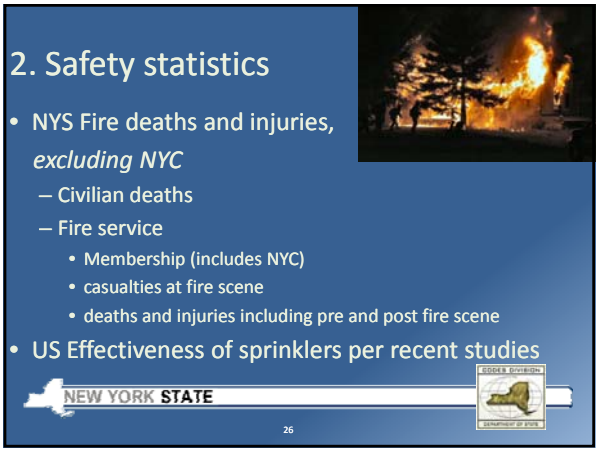
2. Safety statistics
• NYS Fire deaths and injuries, *excluding NYC*
– Civilian deaths
– Fire service
• Membership (includes NYC)
• casualties at fire scene
• deaths and injuries including pre and post fire scene
• US Effectiveness of sprinklers per recent studies
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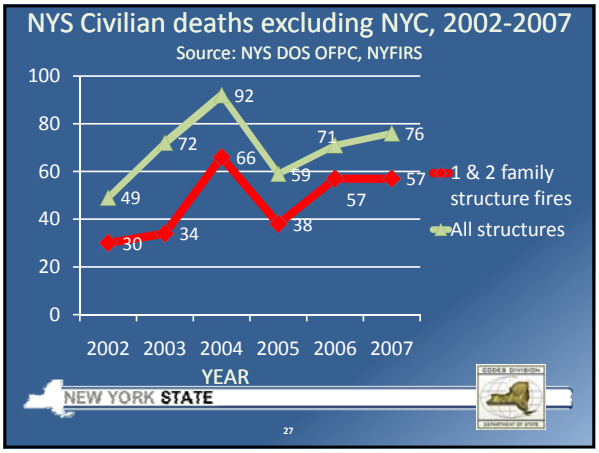
NYS Civilian deaths excluding NYC, 2002-2007
Source: NYS DOS OFPC, NYFIRS
100
80
60
40
20
0
49
72
92
59
71
76
30
34
66
38
57
57
2002
2003
2004
2005
2006
2007
YEAR
1 & 2 family structure fires
All structures
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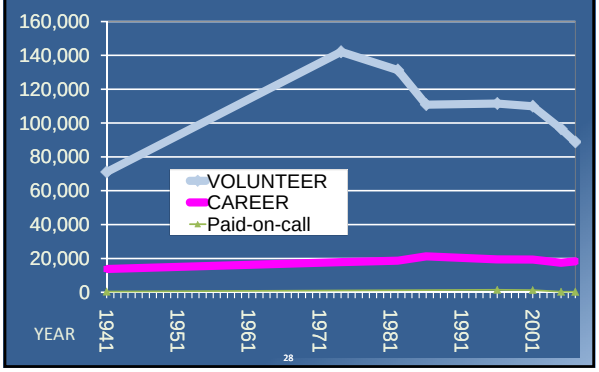
NYS fire service membership

Source: NYS DOS OFPC, Various sources. 1941- 2007



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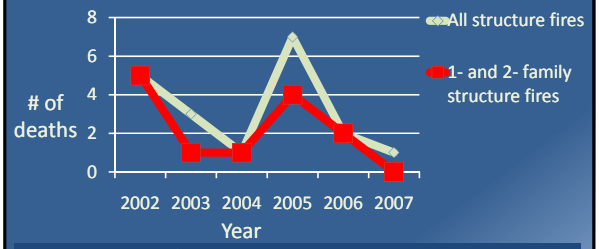
NYS Fire service casualties **while conducting interior firefighting operations** in 1 & 2-family dwellings, excluding NYC

Casualty and severity by year

	2005	2006	2007
Total injuries	155	149	107
No lost time	105	85	59
Moderate	47	60	47
Severe	3	4	1
Life threatening	0	0	0
Death	0	0	0

29 Source: OFPC, NYFIRS

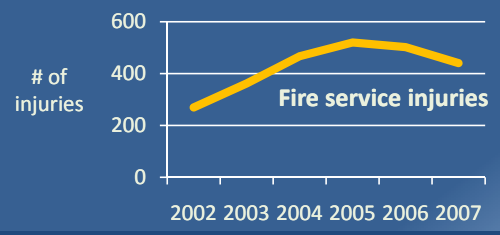
NYS Fire service deaths, including pre and post fire scene, excluding NYC



Includes all fatalities associated with structures fires, including pre and post fire scene such as heart attacks and traffic accidents

30 Source: OFPC, NYFIRS

NYS Fire service injuries, excluding NYC, including pre and post fire scene



Includes all fatalities associated with structures fires, including pre and post fire scene such as heart attacks and traffic accidents

Source: OFPC, NYFIRS

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Effectiveness of fire sprinklers

- Variety of reports of effectiveness
- Attempts to quantify are presented in Home Structure Fires (Ahrens, 2007), US Experience with Sprinklers and other Automatic Fire Extinguishing Equipment (Hall, 2008) and Residential Fire Sprinklers (USFA, 2008)
- Generally there aren't enough NFPA 13D systems in 1 & 2 family dwelling for good data

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Effectiveness in apartments

- Source: "Home Structure Fires" by Marty Ahrens (2007), published by NFPA
- 57% lower per 1,000 reported non-confined apartment fires when sprinkler systems were present compared to such fires without sprinklers
- Not enough data for one and two family homes

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Effectiveness of all types of sprinklers

- Operate "effectively in 91% of all reported fires where sprinklers were present in the fire area and fire was large enough to activate them," for all types of sprinkler systems
- Source: Hall, John R., Jr. (2009). US Experience with Sprinklers & other Automatic Fire Extinguishing Equipment. NFPA.

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Effectiveness of residential sprinklers

- 1 & 2 family dwellings – operate & are effective 89% (combined effectiveness) of time & confined fire to room of origin 83% of time where sprinklers in fire area, fire large enough to activate. Effectiveness is sprinklers ability to contain the fire until fire service arrives
- Source: Hall, John R., Jr. (2009). US Experience with Sprinklers & other Automatic Fire Extinguishing Equipment. NFPA.

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FEMA: residential fire sprinkler effectiveness

Source: USFA (2008). Residential Fire Sprinklers. FEMA.

Compared to homes without smoke detection or sprinklers, chances of dying are reduced by:

- 63% if smoke detection alone installed
- 69% if sprinkler alone installed,
- 82% if both sprinklers & smoke detection installed

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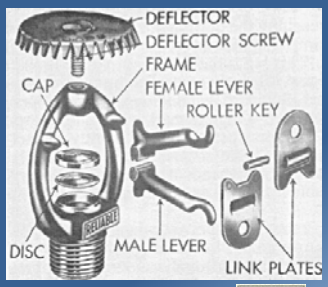
3. Fire suppression technical issues

- System components
- Standards
- General set-up
- Sprinkler heads
- Options
- Technical issues



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System components

- Sprinkler heads (sprinklers) – UL listed, residential, quick response
- Valves – Main control, drain, test valves
- Pipe – distribution in interior walls, insulated or antifreeze
- Alarm – smoke alarm, flow alarm, pressure alarm (in pressure tank), low water alarm
- Water supply – municipal or private

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Standards for 1 & 2 family homes

- Design standards developed in
  - NFPA 13D
  - the 2009 IRC section P2904
- Promote life safety while reducing costs relative to commercial systems

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NFPA 13D Standards for 1 & 2 family homes Purpose

- "The purpose of this standard shall be to provide a sprinkler system that aids in the detection and control of residential fires and thus provides improved protection against injury, life loss, and property damage.

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NFPA 13D Standards for 1 & 2 family homes Design

- Systems are: "expected to prevent flashover … in the room of fire origin, where sprinklered, and to improve the chance for occupants to escape or be evacuated."

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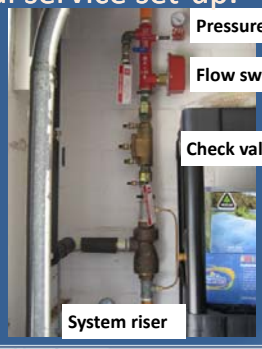
General service set-up:



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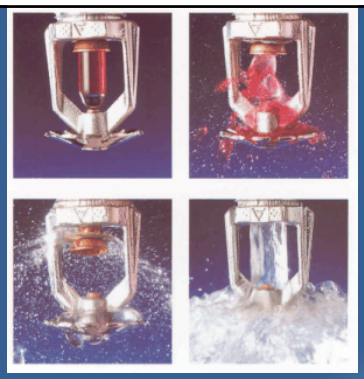

Sprinkler activation

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Sprinkler heads – exposed versus covered

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Possible materials & configurations

- Variety of options – copper or plastic, etc.
- Currently water based in residential systems per NFPA 13D or IRC P2904
- Antifreeze can be used in dedicated plumbing
- Potable water must be protected from stagnant water and antifreeze in sprinkler system

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Possible water supply issues - municipal

Municipalities may require ($):

- Separate service lines
- Backflow prevention – double check or reduce pressure ??
- Pressure reduction due to high pressure service – before or after water meter ???
- Separate meters or more costly meters to handle wide flow range (fire vs. residential)

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Possible water supply issues – Private wells

Adding a sprinkler systems is likely to require one of the following costs:

- Larger pumps
- Large pressure tanks
- Gravity tanks with booster pumps

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Private water supply

- Storage for 10 minutes supply
- Typically ~ 300 gallons
- Booster pump or pressure tank

Storage tank with booster pump

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Other design considerations…

- Unconditioned space and freezing
  - –Cathedral ceilings
  - –Exterior walls
  - –Seasonal use
  - –Power outage

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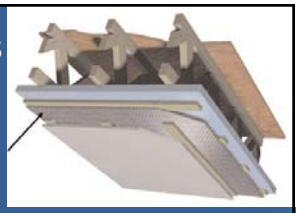
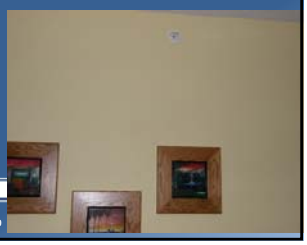
Cathedral ceilings

- Sidewall sprinkler or insulate in ceiling?





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4. Cost

- Capital: design, permitting, fees and construction
- On-going: operation and maintenance

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Cost estimates of sprinkler systems

- We did not find a standard cost per square foot, but a wide range due to different estimates of associated costs and unique design elements

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Costs increase due to …

- Water supply (tanks, pumps, service lines, meters)
- Pressure (tanks and pumps, pressure reducers)
- Backflow prevention devices
- Installation in unconditioned spaces
- Differing assumptions of unit costs
- Maintenance and inspection.

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Some capital cost estimates:

- NFPA's Fire Protection Research Foundation study done of costs in 30 houses found a range of total system costs from $2,386 to $16,060; and in $ / sprinklered SF from $0.38 to $3.66.
- Other estimates reviewed ranged from under a dollar / square foot to $11.20 / square foot.

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Sample homes in NYS:

- 2 modular home styles: Andover and Cambridge
- Estimates ranged from $6,210 to $23,065
- The estimated sales price of the Andover home is $402K ($175k without land).
- That of the Cambridge is $469K (204K without land).

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Costs increase due to…

- More complex houses, such as with cathedral ceiling and unconditioned space (Insulation, antifreeze issues)
- Water supply issues – low water pressure or no municipal supply
- Local requirements for water meters and backflow prevention

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5. Potential impact on housing market

- Survey of impact in 'high end' communities mandating sprinklers did not identify impact
- Based on the ability to obtain a mortgage, in twelve metro areas of NYS the number of households priced out of the market for a median priced new home by a $1,000 price increase in selling price averaged 0.17%, with a median of 0.19% (study by NYSBA)

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Building Statistics for NY State December 2007 v. December 2008

Type of Housing	Year to Date Units 2007	Year to Date Units 2008
Single Family	10,665	8,225
Two Family	3,384	1,668
Total of 1-&2- Family	**14,049**	**9,893**
Three & Four Family	3,864	1,278
Five or More Family	28,464	34,223
Total	**46,377**	**45,394**

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Households priced out of market

Based on info from HousingEconomics.org and US Census in NYS metropolitan statistical areas - excludes NYC area

- **Median new home price: $222K to $340K, average of $262K**
- **Income needed to qualify: $65K to $100K, average of $77K**
- **% of household priced out per $1000 price increase, average of 0.19%**

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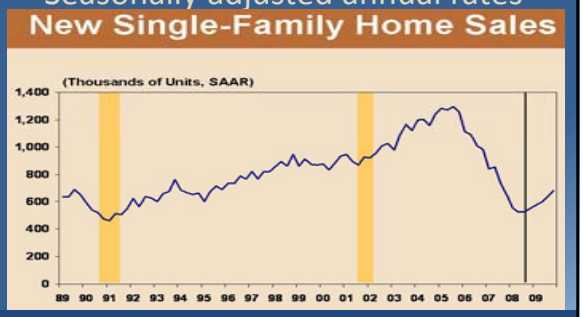
U. S. New home sales '89 – '09 Seasonally adjusted annual rates



From www.NAHB.org accessed April 24, 2009

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New Manufactured Homes in NYS

Source: US Census 2007

Average sales price: $58,900

Number of new homes placed in 2007 :
2,163 manufactured homes
17,090 total single family building permits

Income needed to qualify at 6% interest rate: $33K

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6. Insurance and sprinklers

- Premium deductions or penalties
- Water damage coverage

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Premium deductions for sprinklers

- Generally offered from 5 - 10%.
- Usually less for a NFPA 13D residential system than for a NFPA 13 total system.
- A rough upper bound of annual savings is generally under $100/ year.
- No increase in premiums found due to sprinklers

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Potential discounts limitations

- Most insurance companies discount premiums due to fire sprinklers, as well as to conditions like burglar alarms, new construction, etc.
- Total of all discounts has an upper limit, so that fire sprinklers may not provide a discount.
- Actual applied deductions range from 0 to 10%.

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Insurance and water damage?

- No increased premiums due to potential for water damage.
- Water damage by sprinklers is generally covered with limitations. The NY Insurance Association says building and contents should be covered if the insured complies with conditions (eg., heat to keep from freezing.)
- Damage due to freezing is generally covered if the occupant takes "reasonable care" to maintain water supply and maintain heat in the building. If no heat, the occupant should drain the system.

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Insurance & water damage example

"Like most insurance companies, we have filed a homeowners credit for having a sprinkler system installed (no mention of credit for partial systems): 3% Credit. Most people who install a sprinkler also install a smoke detector and get a total 5% credit (3% for sprinkler and 2% for the smoke detectors).

Why is the sprinkler credit so small: only 1% more than the smoke detectors? The answer is that wet sprinkler systems can be more destructive than fires. Water from prolonged sprinkler releases usually do a lot of collateral damage all by themselves. In addition, wet sprinkler systems are expensive, need routine maintenance and are vulnerable to accidental releases and freezing."

Survey of New York Insurance Association, Inc., Albany, NY

Contacts: Ellen Melchionni, CAE, President and Stacey Orlando, Director of Technology

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7. Jurisdictions mandating fire suppression in 1- & 2-family residences

- Survey of 8 NYS municipalities that have have More Restrictive Local Standards (MRLS), approved by the NYS Code Council, that mandate installing fire sprinklers in new construction of 1 & / or 2 family dwelling.
- Other jurisdiction in US

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NYS Jurisdictions mandating fire sprinklers in 1&2-family residences

- Survey of 8 NYS municipalities.
  - 7 in Westchester County: 3 are towns (Harrison Town & Village, includes a village) and 4 are villages
  - 1 in Onondaga County, when surveyed does not mandate sprinklers in 1- & 2- family residences
- Both water based & water / anti-freeze are used
- Installed with both private & public water supplies

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NYS Jurisdictions mandating fire sprinklers in 1&2-family residences

- 3 communities reported fires in sprinklered residences; the remainder have none
- Sprinklers contained the fires, except 1 case - fire started on the roof
- When asked about problems:
  - freezing pipes
  - insufficient pressure

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Other case studies

- Mandatory residential sprinklers: City Scottsdale, Arizona since 1985 & Prince George, Maryland since 1992
- There were no reported fire deaths in home protected with residential sprinklers.

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Arizona case study

10-year study of City of Scottsdale, AZ, 1985 - 1995

	# homes	%	# fires	Sprinkler activations
Sprinklered	19,649	34%	?	44
Nonsprinklered	37,652	66%	?	
Total	57,301		598	

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Maryland case study since 1992

- Fires in Sprinklered Structures, 1989 to 1999: 121 incidents, 0 deaths, 7 burn injuries.
- Fires in Unsprinklered Structures, 1990 to 1993: 50 incidents, 22 deaths and 46 injuries. # of deaths and injuries / fire is very high, possible due to small database.
- Rate of deaths and injuries for residential structure fires per Fire Incident Reporting Systems in NYS (excluding NYC) and US
  - NYS averages 0.005 deaths & 0.023 injuries per fire, 2002-2007
  - '96-'05 US average is 0.008 deaths, 0.04 injuries & $15K loss per fire

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8. Additional impacts

- Maintenance
- Licensure & staffing
- Inspection

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Summary of maintenance **required** in NFPA 13D Section 4.2

4.2.1 Installer to provide owner instructions for inspecting, testing, & maintaining the system.

4.2.2 Replace operated or damaged sprinklers with one with characteristics of originals

4.2.3 Replace sprinklers painted outside of factory.

4.2.4 Antifreeze Systems. Requires specific annual maintenance (empty, adjust antifreeze, refill)

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Maintenance **recommended** in NFPA 13D Section 4.2 annex

"The responsibility [...] is that of the owner or manager, who should understand the sprinkler system operation."

Maintenance should include a monthly inspection.

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Maintenance **recommended** in NFPA 13D Section 4.2 annex

A minimum monthly maintenance program should include:

(1) Visual inspect sprinklers for obstructions.
(2) Ensure valves are open.
(3) Test water flow devices.
(4) Test alarm system.
(5) Operate pumps.
(6) Check air pressure of dry systems.
(7) Check water level in tanks.
(8) Verify sprinklers not painted post factory

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Licensure and staffing

- Municipalities may require NYS design professional or locally licensed installer
- No NYS licensure required for installer; it can be required at a local level.
- Designers and contractor will need "ramp-up" time to develop expertise and staffing
- Additional designers and installers would be needed if more systems are required

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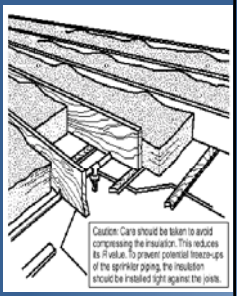
Inspection

- Current legislation, standards & guidelines are in place for inspection of sprinkler systems
- NYS codes require inspection
- NFPA 13D (part of code) require hydrostatic testing & installation to prevent freezing



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Rough in

- Inspection of installation before testing

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Inspection

- In practice, rough inspection before installing gypsum board
- When system is complete, final flow test witnessed by Code Enforcement Official (CEO)
- NFPA 13D installation in NYS infrequent at this time. Training of CEO in NFPA 13D would smooth any transition

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Appendix A – Sample Home cost estimates: Andover

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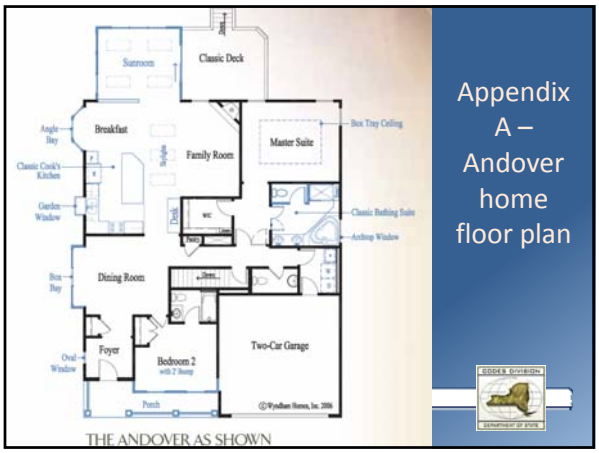
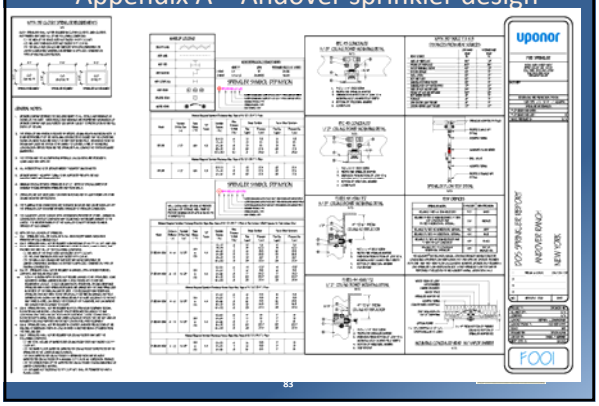
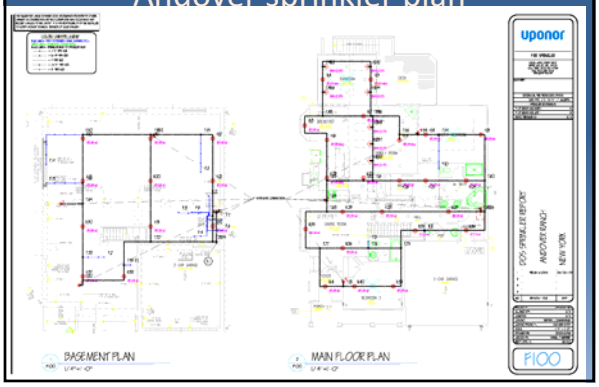


Appendix A – Andover home floor plan

Appendix A – Andover sprinkler design



Andover sprinkler plan



Appendix B – Survey

- Contains survey forms to jurisdictions with more restrictive local standards.
- Survey results are discussed in section 7

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Appendix C –

- by Dan Nichols, fire protection engineer.
- After installation inspection, testing and maintenance of sprinkler systems using NFPA 13D

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Thank you

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