Case Study: How to Maintain Adequate Fire Protection During Site Demolition

Bruce Campbell, FSFPE
Vice President, DOE Services

HUGHES ASSOCIATES, INC.
FIRE SCIENCE & ENGINEERING

Outline

- Purpose
- Background
- Case Study - Location
- Fire Protection During Demolition
- Life Safety During Demolition
- Lessons Learned
- Fires (with pictures)
- Summary
- Conclusions
- Acknowledgements

Purpose

- Provide information via a case study on ways to maintain an appropriate level of fire and life safety during demolition of an industrial site.

Background

- Involved with a large demolition project of the former Rocky Flats Site
- Site was owned by Department of Energy with Kaiser-Hill, LLC as the contractor
  - Incentive based contract
- Overall project split into distinct projects (by large facilities, functions and site infrastructure)
- Each project had a Chief Engineer, Safety Manager, Fire Protection Engineer(s), etc.
- Each project managed by a Vice President
- Budget of over $600M per year
- As subcontractor, I was the Fire Protection Program Manager

Background, continued

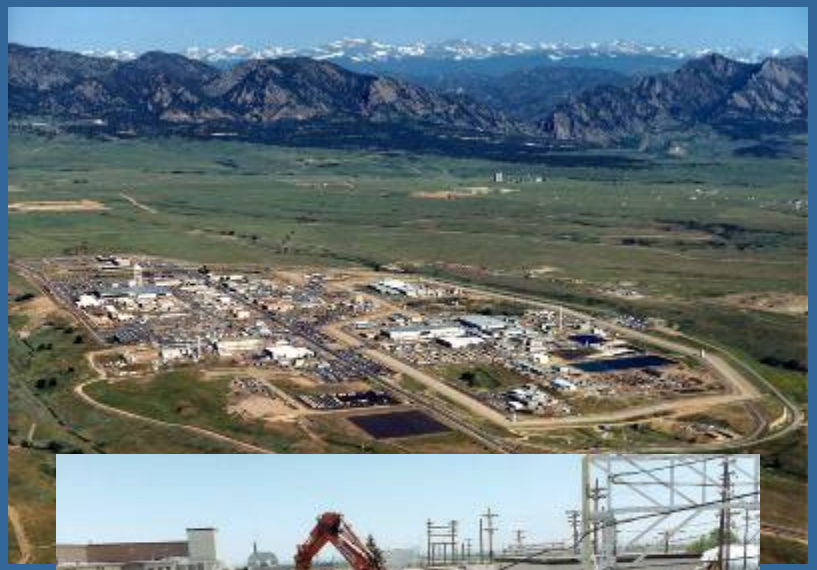
- Fire Protection was one of the top five safety areas (which also included electrical safety, fall protection, etc.) of focus during demolition to:
  - Protect the risk to the public
  - Protect the risk to the workers
  - Meet and exceed the contractual requirements
  - Meet the legal requirements, (i.e. Price-Anderson)
- Lessons learned at this project can be utilized for other industrial sites or individual buildings.

Case Study - Location

- The Rocky Flats Environmental Technology Site, near Golden, Colorado
- Previously manufactured various nuclear weapon components, including nuclear triggers
- Demolished over 800 buildings
- This DOE site was transferred to the Fish and Wildlife agency
- Employment down to several from over 8000

Rocky Flats Environmental Technology Site

- 6,000 acres
- All facilities were demolished in late 2005
- Largest D&D project in the nation, several billion $
- Contract completed one year early

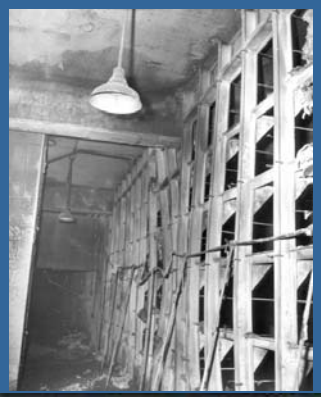


All Courtesy RFETS/DOE

Closure Project

- The Rocky Flats Closure Project was an enormous undertaking. To complete the mission:
  - More than 21 tons of weapons-useable nuclear materials were removed
  - Decontaminated and demolished 800 structures, comprising more than 3 million square feet
  - Drained 30,000 liters of plutonium solutions
  - Size reduced and removed more than 1,450 contaminated production glove boxes and 700 tanks
  - Stabilized and packaged 100 tons of high-content plutonium residue
  - Performed environmental cleanup actions at 130 sites
  - Dispositioned millions of classified items and excess property
  - Safely shipped more than 600,000 cubic meters of radioactive waste -- enough to fill a string of railcars 90 miles long

RFETS (cont'd)



All Courtesy RFETS/DOE

- Site of two large nuclear fires, one in 1957 and the other in 1969
  - The 1969 fire in its day was one of the nations highest dollar loss industrial fires
- Strong fire protection program
- Primary goals were protection of workers, the public, and the environment

RFETS (cont'd)

All Courtesy RFETS/DOE

Rocky Flats pre 2002

Rocky Flats February 2005

Courtesy RFETS/DOE

Rocky Flats September 2005

Courtesy RFETS/DOE

Fire Protection During Demolition

Goals

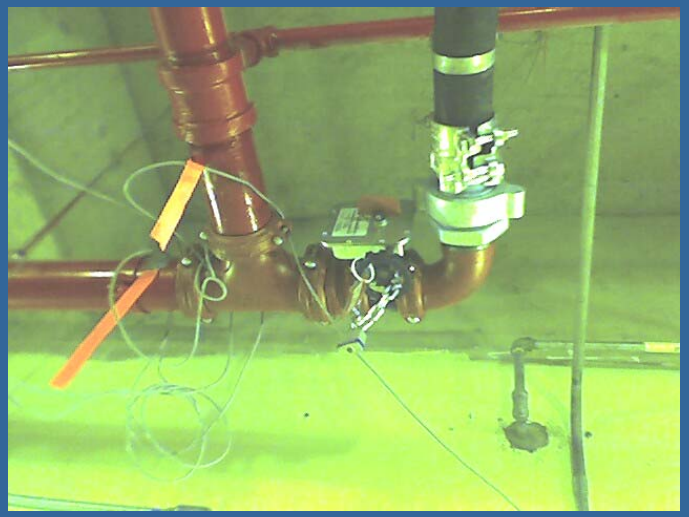
- The following goals were established early on in the project
  - Serious injury or fatality was unacceptable under any condition
  - A Maximum Possible Fire Loss (MPFL) was unacceptable under any condition (Loss exceeding $100M)
  - A fire impacting the closure mission was unacceptable
  - Impairments to fire protection systems had to be controlled to an acceptable level (contractual requirement)

Tools

- The fire protection program with support from senior management developed tools to ensure adequate fire protection while permitting as much flexibility in the project as possible
  - Alternatives to literal code compliance
  - A formal documentation process
  - Utilization of a wireless fire alarm system
  - Constant communication
  - Full Authority to the Fire Protection Program Manager

Alternatives to Literal Code Compliance

- It was not always possible or feasible to enforce full code compliance during demolition. Examples include:
  - Alternatives to life safety code compliance
    - Emergency lighting (flashlights, controlled access)
    - Exit signs (photoluminescent)
  - Automatic sprinklers
    - Dry pipe valve systems exceeding NFPA 13 volume capacity
    - Deactivation based on rigorous documented combustible controls
    - Deactivate portions of systems in lieu of total system isolations
    - Temporary feeds via high pressure hose



Automatic Suppression Systems

- Used a graded approach, the need for systems predicated on
  - Life Safety
  - Clean-up costs
  - Level of combustibles
  - Impact to environment and public
  - Nuclear Safety requirements

Courtesy RFETS/DOE

Formal Documentation

- To ensure control and consistency, a formal process was utilized to document all fire protection de-activations
  - "DES-210" Engineering Calculation
    - Required for ALL deactivations
    - Multiple DES-210 revisions to a single calculation for like systems to address additional areas isolated
    - Fire Protection Program Manager and Fire Chief required as final approvals
      - Initially a difficult sell

Wireless Fire Alarm System

- For employee safety, buildings were placed into a “cold and dark” configuration as soon as possible. This resulted in issues with maintaining the fire alarm systems and sprinklers due to the loss of heat.
- All electrical was isolated and then only temporary wiring was utilized that was well identified and defined.

Wireless Fire Alarm

- Consisted of a UL Listed wireless system that included
  - Wireless devices; waterflow, pull stations, alarm bells, etc.
  - Repeaters (internal to the building, electrically fed from temporary electrical wiring system)

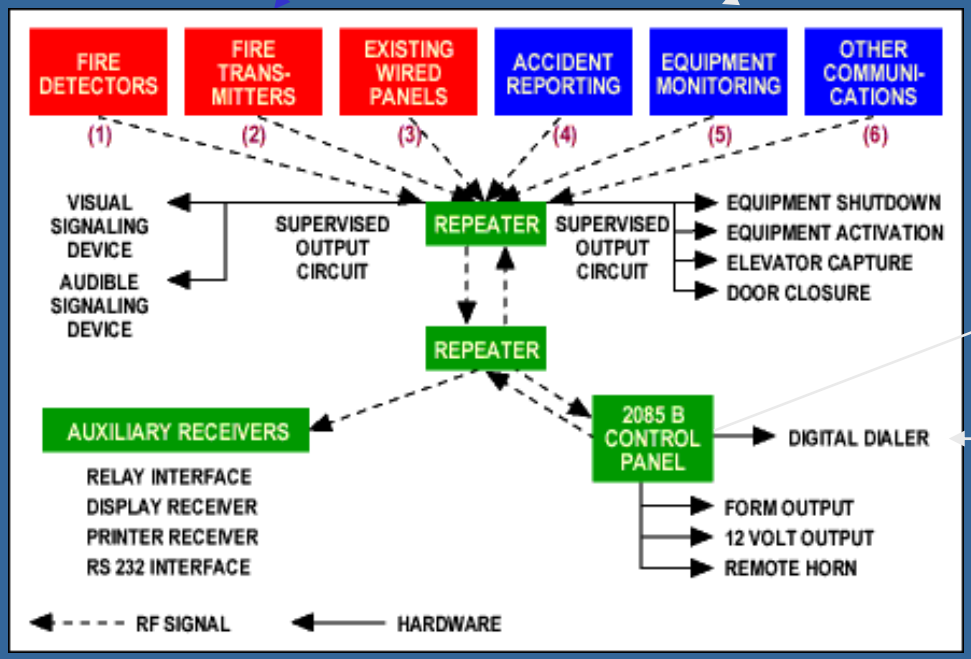
Wireless Fire Alarm System

- External repeaters
  - Pole mounted utilizing solar panels as the power source
    - Six days of battery supply, plus 24 hours of back-up power
    - Worked well, even in high winds
- Tied-in to the existing Simplex system at the central fire alarm station
- Most devices had individual identifiers
- Cost was around $300K to $400K
- Senior Management satisfied with the system and the relative low cost
- Realized significant savings

Wireless Fire Alarm System

Sprinkler flow, manual pulls, etc

Valve vaults



To Simplex System

Signals could go off site

TECHNOLOGY @ ROCKY FLATS

Demonstration & Deployment Summary

Radio frequency alarms support "cold & dark" deactivation at Rocky Flats

Summary
DOE's Office of Science and Technology provided partial funding for the deployment of new UL 864 Listed wireless alarm system technology to transmit fire alarms over radio frequency at Rocky Flats. Solar power technology was integrated into the system and used instead of hard-wired power for exterior repeaters, greatly reducing costs now and during future D&D activities.

At the Rocky Flats Closure Project, this new system, operable in all areas of the site, has resulted in estimated savings of more than $600,000 by eliminating the need to rewire the site alarm system as buildings are decontaminated and decommissioned. Resources important to the Closure Project mission can be better used for closure instead of reroutes. The equipment is reusable. When a building is demolished, equipment can be moved to the next building. When the site is closed, the equipment can be re-deployed at other DOE sites or sold if uncontaminated. From a safety perspective, this wireless alarm system allows D&D facilities to operate only on temporary power, thereby reducing the potential of cutting energized wires.

Integrating solar power into the design of the Rocky Flats wireless fire alarm system was a key innovation that resulted in significant cost savings and eliminates alarm issues during future D&D of the site electrical infrastructure.

The Need
The safest way to decommission the buildings at Rocky Flats is to turn them "cold and dark" by separating them from the site's infrastructure system. Disconnecting electrical, steam, gas and pressurized water lines before workers begin dismantling and removing equipment, conduit and pipes protect workers from many electrical, stored energy and contamination hazards.

But turning a building cold and dark also eliminates some necessary safety systems, including fire alarms, which are essential to worker safety. Alarm systems operating on temporary power must be installed for each cold and dark building undergoing decommissioning.

In addition, the fire alarm system on site is a closed loop system that must provide two reporting pathways for code-compliant operation. If you disconnect a building from the system, one reporting pathway is cut. This means that the system has to be rewired around each building that is taken out of the loop for D&D.

The Technology
The Rocky Flats Fire Protection Program determined that the best solution to this dilemma was to adapt currently available wireless radio frequency alarm technology to the site's requirements.

Fire protection personnel identified an existing wireless system manufactured by World Electronics. The system is currently used on the Statue of Liberty, Smithsonian Museum, Virginia State Capitol and other locations. It was determined to be the most applicable technology to replace the hard-wire system in D&D buildings and provide fire alarm coverage in relocatable structures.

The system consists of individual wireless transmitters reporting to repeaters that report to head-end equipment that integrates with Rocky Flats' existing Simplex fire alarm system. The system operates within the 290-305 MHz band. No commercial radio signals are allowed in this frequency range. Radio Frequency signals consist of words comprised of binary-coded audio tones. Groups of multiple words are transmitted on multiple frequencies to provide

A wireless transmitter installed at Rocky Flats

Head-end receiving equipment is located at the site's Emergency Operations Center in Building 115 and integrates into the existing Simplex system. Individual transmitter alarms are received on the Simplex system at Fire Dispatch with no additional screens to monitor.

assurance of reception in varying physical and noisy environments.

The wireless transmitting devices can include photoelectric smoke detectors, pull stations, heat detectors, maintenance transmitters for connection to any device with contacts, plus a host of security devices. At Rocky Flats, wireless transmitters were installed for automatic sprinkler water flow, smoke detection, fire phone and manual pull station replacement, and flow and level for waste valve vaults. All transmitters are surface-mount and microprocessor-based to provide special and selectable performance parameters. All devices are supervised for power source, device removal and transmission reliability.

Following installation and testing of a sitewide reporting loop consisting of approximately 30 repeaters, alarm transmitting devices were installed in Building 881. Repeater locations were chosen based on facility input and vendor specifications and verification. Most importantly, locations were chosen to be at safe distances from D&D activities to ensure that alarm functions do not impede closure progress.

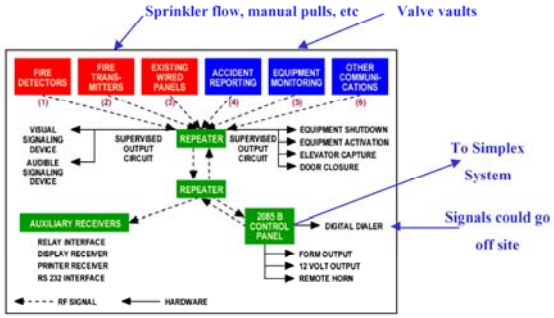
Integrating solar power in lieu of hard wiring for exterior repeaters proved to be a significant innovation as the project was implemented. Solar panel use on external repeaters eliminated reliance on site electrical power, resulting in no impact to future D&D of the site's infrastructure. It also greatly reduced cost to the project. Interior repeaters are powered from temporary power sources.

The Results and Benefits

Use of wireless fire alarm systems has proven to be extremely successful at Rocky Flats. Its benefits include:

- Class A signaling
- Rapid installation
- Addressable sensor ID
- Ease of expansion
- Multiple alarm reporting
- Ease of maintenance
- Alarm verification
- Substantial cost savings
- Alarm archiving and recall
- Fully supervised
- Trenching eliminated
- Reduces alarm resource requirements
- Improves safety of workers during D&D activities

Cost savings for initial deployment are estimated at approximately $600,000. Further savings will be realized when the system is expanded to additional major facilities.



Technology Supporting the Path to Closure

For more information about Technology at Rocky Flats, contact David Maloney, Kaiser-Hill Company, (303) 966-7566, or Gary Huffman, DOE, Rocky Flats Field Office, (303) 966-7490

KAISER•HILL COMPANY

07-02-03 Dodey K-H Communications REV1

Communication

- Good communication was established throughout the project
  - Fire Protection Program Manager (FPPM) → DOE Fire Protection Engineer
  - Senior Management → DOE Fire Protection Engineer
  - FPPM → Senior Kaiser-Hill Management
  - FPPM → Senior DOE Management

Water Tower Demolition

Courtesy RFETS/DOE

Communication, continued

- Fire Protection Center of Excellence
  - Effective method to keep the fire protection staff up-to-date and share ideas across projects
- Fire Protection Performance Indicators

Courtesy Jeff Conyers

Full Authority

- The Fire Protection Program Manager was designated the "Authority Having Jurisdiction" for Kaiser-Hill and their subcontractors
- The FPPM had easy access to all levels of management and was recognized as a tool to get the job done

Courtesy RFETS/DOE

Life Safety During Demolition

- Life Safety was paramount to the goals of the program
  - $1M contract penalty for any fatalities
- Retention of exits was given close scrutiny
  - Additional exits were added when possible
- As buildings were under going demolition, the interiors tended to be opened-up
  - Double edged sword; easier egress, but new configuration unfamiliar to occupants

Life Safety

- Maintenance of exit components were a constant struggle
  - Exit signs
    - Photoluminescent signs
  - Emergency lighting
    - Flashlights
    - Controlled entry
  - Horizontal exit paths
  - Door hardware

Fires

Glovebox Fire

- Trash fire at the bottom of a glovebox where the combustibles were “hidden” by internal obstructions
- Basically a trash fire, but the impact to the project was significant
- Initial investigation weak
- Oversight organizations required a much more in-depth investigation
  - Investigation easily exceed $200K
  - Performed experiments on a material (cerium nitrate) utilized in the clean-up of the glovebox

Glovebox Fire

All Courtesy RFETS/DOE

Fire Involving Foam

- A two-part polyurethane foam was utilized to "plug" existing sub-grade corridors in a facility where the corridors were to remain and the plugs were needed to prevent groundwater migration
- Foam applied too quickly (against the procedure) it then over heated (heat of reaction) causing a foam fire in the building, just prior to demolition
- Initial investigation was quick, rigorous and well handled. Thus oversight organizations had no concerns

Fire Involving Foam

All Courtesy RFETS/DOE

Cutting and Welding Fire

- Combustible insulation hidden behind a building component ignited during cutting of a structural beam
- Beam being notched to allow the building to be pulled away from another building and then would collapse without damaging the other building
- Initial investigation quick and rigorous, minimal effect to the project schedule

Cutting and Welding Fire

All Courtesy RFETS/DOE

Fires Lessons Learned

- Launch a comprehensive investigation immediately
- Use experts as you need them
- Document everything
- Maintain all evidence
- Share the lessons learned (obtain release authorization)

Lessons Learned

Lessons Learned

- Think out of the box
  - Don’t think in black/white terms
  - Don’t be afraid to “bend” the code criteria
- Fight the big battles
  - Let the smaller battles go
  - Use finite time and resources to win the high impact issues
  - Accept more compromise on lesser important issues
  - Management will respect your opinion and subsequent requirements and will go to bat for you
- Center of Excellence
  - Excellent way to maintain consistency in a large project having several sub projects
  - Good way to share new ideas
  - A great sounding board

Lessons Learned

- Utilization of a Performance Indicator
  - A simple way to communicate the health of the program to senior management
- Accessibility to buildings
  - Fire Department access can become quite difficult and requires constant monitoring
  - Perform daily drive arounds
- Combustible control
  - Demand total compliance
  - If done right can be a good tool

Lessons Learned

- Asbestos abatement
  - Use fire Retardant Plastic if at all possible
  - A lot of plastic is used for containment
  - Leave sprinklers in-service until abatement is complete
- Cold weather
  - Number one reason for project personnel to want to isolate sprinklers
  - Consider temporary electric heat
  - Consider isolation of sprinklers in perimeter areas that are subject to cold, then leave internal areas protected
  - Consider spot protection
    - Combustible storage areas
    - Life safety egress routes
  - Convert wet to dry systems/anti-freeze systems

Lessons Learned

- Wireless fire alarm system
  - Great tool
  - Easy way to maintain the fire alarm system well into the demolition process
  - Solar powered repeaters were very successful
- Teamwork
  - Respect each other's position
  - Be professional
  - Work and live in the "Gray" areas
  - Pick your battles
  - Empower the other members of your fire protection team

Conclusions

- This presentation has been geared towards a large nuclear site, but it could easily be adapted to an industrial site or building
- Teamwork pays off
- Remember, there is no black and white

Courtesy of Michael Bedard

Acknowledgements

- Ed Budnick, P.E.,Vice President *Hughes Associates, Inc.*
- Robert Williams, Fire Protection Engineer, retired, *Department of Energy*