Moving From Automatic To Manual Carbon Dioxide Fire Suppression Systems

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Background

- CO_2 Fire Suppression Systems Found At Many Plants
  - Logical Fit at a Nuclear Power Plant
    - CO_2 already available for generator purge
    - The original "clean" agent
    - Familiar technology
    - Inexpensive agent
  - Both Low Pressure and High Pressure Systems
    - Low Pressure systems most common

Background

- CO_2 Systems Found in Many Types of Plant Areas Including:
  - Cable Spreading Rooms
  - Diesel Generator Rooms
  - Switchgear Rooms
  - Safety Related Pump Rooms
  - Motor/Generator Set Rooms
  - Turbine/Generator Bearings
  - Fuel Oil Transfer Pump Rooms
  - Cable Vaults

Background

- Many Systems Have Automatic Actuation
  - Heat detection
  - Smoke detection (often cross zoned)
- Backup Manual Actuation Typically Provided By:
  - Pushbuttons
  - Electro-Mechanical Pneumatic Control Valves

SAFETY

- Awareness that CO_2 will create a hazardous environment in the room
  - Systems typically designed with:
    - Pre-discharge Delay Timer
    - Pre-discharge Alarms (horn and lights)
    - Signs on doors and within room
    - Tagout procedure while working in room
    - General Employee Training included locations of CO_2 protected rooms and proper precautions
    - Wintergreen or other olfactory warning

SAFETY

- Inadvertent CO_2 Systems Discharges
  - Most plants with CO_2 systems have experienced inadvertent discharges
    - Some have resulted in personnel exposure to CO_2
    - A few have come close to resulting in fatalities
    - Experience outside the commercial nuclear industry have resulted in fatalities
  - Some inadvertent discharges have resulted in equipment issues
    - TMI Unit 1 1975 discharge

SAFETY

- IN 99-05 Inadvertent Discharge of CO_2 FP System and Gas Migration
  - Documents several Inadvertent CO_2 system discharges including a fatality at a Government Nuclear Lab.
  - Identifies the concern of CO_2 gas migration to other plant areas and impact on plant safety.

Peach Bottom Experience

- Following IN 99-05 Developed Conceptual Design to Eliminate CO2
  - Cable Spreading Room
  - HPCI Pump Room (safety related pump)
  - Emergency Diesel Generator Rooms (4)
- Cost exceeded $1 million
  - Exelon merger put design on hold

Peach Bottom Experience

- June 2002 – Inadvertent CO_2 trip in EDG room
  - Caused by spare light bulb in panel contacting two circuit board traces creating a "manual discharge."
  - Two operators in room at time of discharge only warning was smell of wintergreen.
  - With EDG running, horn was not heard and beacon light was on other side of engine.

Peach Bottom Experience

- All CO_2 systems had tank valves closed and declared inoperable.
- Pre-fire plans modified to allow for manual discharge.
- Training provided quarterly to fire brigade.
- Brigade drill scenarios included these rooms to address CO_2 condition.

Peach Bottom Experience

- Decision to Make All PB CO_2 Systems Manual Permanently
  - Requested License Amendment Request (LAR) Submitted in September 2003
  - Received Request for Additional Information, (November 2004)
  - Received Approved SER (June 2005)
  - Informed NEIL and Requested Penalty Quote

Peach Bottom Experience

- Redesigned Manual Systems
  - Discharge requires manual movement of valve (similar to EMPC). Micro switch make up initiates discharge logic
  - Cannot have an electrically initiated inadvertent discharge
  - Improved internal room warning,
    - Multiple strobe lights
    - Multiple horns

NEI CO_2 White Paper

- Request by NEI to Prepare Some Guidance for Making the Automatic to Manual Decision
- Provides Considerations Used at Peach Bottom
- Identifies Personnel Safety As Primary Drawback Of CO_2 Systems

NEI CO_2 White Paper

- Identifies Plant Areas/Rooms That Would Be Potential Candidates:
  - Rooms that are frequently occupied.
  - Rooms containing equipment that could be affected by a CO_2 discharge.
  - Rooms containing primarily fire retardant cables with no floor based combustibles for exposure.
  - Rooms that contain a single piece of equipment that would likely be rendered inoperable by the fire at the start of the fire event.

NEI CO_2 White Paper

- CO_2 Change Options
  - Install another type of fire suppression system
  - Convert the automatic system to manual
  - Completely eliminate the CO_2 system (No Suppression)

NEI CO_2 White Paper

- Install another type of fire suppression system:
  - Sprinkler systems (wet pipe or pre-action)
    - Consider drainage
    - Effect on equipment
    - Piping and head placement issues
  - Gaseous systems (Clean Agents)
    - Piping and nozzle location issues
    - Safety issues associated with specific clean agent
  - Water Mist
    - Considerations similar to sprinkler systems

NEI CO_2 White Paper

- Convert the automatic system to manual:
  - Modification must improve personnel safety
  - Must address potential delay in actuation
  - Equipment impacts and agent migration remain

NEI CO_2 White Paper

- No Suppression
  - Limited Applications
    - Improved Smoke Detection
    - Little or no combustible materials
    - Supported by Risk Analysis

NEI CO_2 White Paper

- Compensatory Measures to Consider:
  - Instructions for Manual Discharge in Pre-fire Plans
  - Addition fire detection
  - Additional backup suppression
    - Additional hose for stations
    - Nozzles (e.g. Coast Guard Applicators)
    - Ladders for access to cable trays
    - Thermal imaging cameras

NEI CO_2 White Paper

- Compensatory Measures to Consider
  - Restriction of activities within the room
    - Limits on Hot Work
    - Limits on Transient Combustibles
  - Refer to RIS 2005-07, "Compensatory Measures to Satisfy Fire Protection Program Requirements" and IN 97-48, "Inadequate or Inappropriate Interim Fire Protection Compensatory Measures."
  - In selecting Compensatory Measures remember the objectives of Defense-in-Depth.

NEI CO_2 White Paper

- Role of Risk Considerations
  - Any change to the method of CO_2 actuation (or change in type of system) should be considered within the Fire PRA.
  - Risk Analysis can form the basis for justification of the change.
  - NFPA 805 approach would permit the consideration of a change of CO_2 system actuation method.

NEI CO_2 White Paper

- Regulatory Considerations
  - Differences in each plant's licensing basis makes specific guidance difficult
  - Ultimately must demonstrate that the change "will not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire," (from G.L. 86-10 Standard License Condition)
  - Consult with other licensee's that are making similar changes
  - Develop a strategy with your licensing engineers
  - Get senior management acceptance

NEI CO_2 White Paper

- Regulatory Considerations
  - Considerations:
    - Is the automatic CO_2 system needed for Appendix R compliance?
    - Was the automatic CO_2 system used to support and exemption/deviation or G.L. 86-10 evaluation?
    - Are there specific commitments for an automatic CO_2 system in the Fire Protection Safety Evaluation Report?

NEI CO_2 White Paper

- Vehicle for NRC Notification/ Approval
  - Peach Bottom chose License Amendment Request
  - Review against NEI 96-07
  - Engineering Evaluation kept on file for inspection review

NEI CO_2 White Paper

- Interaction with NRC Staff
  - Peach Bottom maintained a dialogue with the NRR reviewer via phone calls
  - Invited NRR fire protection staff to the site to see configuration first hand
  - Resident Inspector kept informed of the process throughout

NEI CO_2 White Paper

- Summary
  - Change in actuation from automatic to manual can improve both personnel and plant safety
  - May required some plant modifications for improved safety and system performance as well as regulatory compliance
  - Be prepared to be challenged on the adequacy of a manual system in terms of fire damage and plant impact