

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

- CO₂ 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 CO₂ Systems Discharges
 - Most plants with CO₂ systems have experienced inadvertent discharges
 - Some have resulted in personnel exposure to CO₂
 - 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ Systems

NEI CO₂ 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 CO₂ 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 CO₂ White Paper

- CO₂ Change Options
 - Install another type of fire suppression system
 - Convert the automatic system to manual
 - Completely eliminate the CO₂ system (No Suppression)

NEI CO₂ 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 CO₂ 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 CO₂ White Paper

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

NEI CO₂ 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 CO₂ 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 CO₂ White Paper

- Role of Risk Considerations
 - Any change to the method of CO₂ 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 CO₂ system actuation method.

NEI CO₂ 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 CO₂ White Paper

- Regulatory Considerations
 - Considerations:
 - Is the automatic CO₂ system needed for Appendix R compliance?
 - Was the automatic CO₂ system used to support and exemption/deviation or G.L. 86-10 evaluation?
 - Are there specific commitments for an automatic CO₂ system in the Fire Protection Safety Evaluation Report?

NEI CO₂ 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 CO₂ 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 CO₂ 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