

Fire Protection Carbon Dioxide System Instructor Notes

ACADs (08-006) Covered

5.1.1.2.1.12c4 5.4.3.3

Keywords

Liquid state hazards, gas state hazards, Idaho accident, areas protected, valves, timer.

Description

This document provides instructor notes and references to materials which can be used to develop a lesson in fire protection in relation to the carbon dioxide system.

Supporting Material

"Fire Detection and Alarm System", System Training Manual, Article AS-20A

SPEER 88-01-012 "CO2 Isolation To Both ESF Switchgear Rooms"

VTM-C285-00001 "Instruction Manual for Low Pressure Carbon Dioxide Fire Extinguishing and Generator Purge System"

IN 85-87 "Hazards of Inerting Atmospheres"

QIR 85-11 "Inadvertant Actuation of CO2 System"

IIR 3-1-89-098 "Inadvertant Actuation of the "A" Train E.S.F. Switchgear Room CO2 System"

TCS 92-1541 "SER 11-92 Consequences of Disabled Dampers"

TCSAI 2874660, SEN188 - Actuation of Carbon Dioxide Fire Suppression System Causes One Fatality and Multiple Personnel Injuries.

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This material is based upon work supported by the National Science Foundation under Grant No. 1104238. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

PALO VERDE NUCLEAR GENERATING STATION

Instrumentation & Controls Training

Classroom Lesson



I&C Program	Date:
LP Number: NID08C000402	Rev Author: Thomas E. Blank
Title: Fire Protection System, Carbon Dioxide	Technical Review:
Duration : 10 Hours	
	Teaching Approval:

INITIATING DOCUMENTS:

Site Maintenance Training Program Description

REQUIRED TOPICS

NONE

CONTENT REFERENCES

"Fire Detection and Alarm System", System Training Manual, Article AS-20A

SPEER 88-01-012 "CO2 Isolation To Both ESF Switchgear Rooms"

VTM-C285-00001 "Instruction Manual for Low Pressure Carbon Dioxide Fire Extinguishing and Generator Purge System"

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Lesson Plan Revision Data

Mar 10, 2006 Ed Blank

Record created

Added SEN188, expanded IIR #3-1-89-98

Tasks and Topics Covered

The following tasks are covered in Fire Protection System, Carbon Dioxide:

Task or Topic Number*	Task Statement
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Lesson: [Fire Protection System, Carbon Dioxide](#)

FP01	Troubleshoot and rework the Fire Protection Detection System
FP03	Perform Fire Protection/Detection Supervisory Test
FP02	Perform Fire Protection/Detection Functional Test

Total tasks or topics: 3

TERMINAL OBJECTIVE:

- 1.1 Given the necessary resource and reference materials, describe the operation and system interfaces of the Fire Protection Carbon Dioxide System. Mastery will be demonstrated by obtaining an overall average of 80% on a multiple choice exam.
 - 1.1.1 Explain the considerations for working around or with carbon dioxide.
 - 1.1.2 Identify the areas protected by the Carbon Dioxide system
 - 1.1.3 List the major components of the Carbon Dioxide system
 - 1.1.4 Describe the operation of the Carbon Dioxide system to include the function and interaction of the components and the interface with other systems
 - 1.1.5 Explain the operation of the Cardox and Pyrotronics control panels

Lesson Introduction: Fire Protection System, Carbon Dioxide

The following items are things to consider in your Lesson Introduction. They are not mandatory. You should develop your own introduction and place that material in the Program Hierarchy in the Lesson Introduction Tab or appropriate Training Unit.

CLASSROOM GUIDELINES

- If applicable, remind students of class guidelines as posted in the classroom.
- Pass the attendance sheet around and have it signed in Dark ink.
- Ensure that student materials needed for the class are available for each student.
- Emphasize student participation and remind them of your philosophy on asking and answering questions, if applicable.

ATTENTION STEP

- Give a brief statement or story to get student concentration focused on the lesson subject matter.

LESSON INTRODUCTION

- Give a brief statement that introduces the specific lesson topic. Should be limited to a single statement.

MOTIVATION

- Focus student's attention on the benefits they derive from the training. At Instructor's discretion. The need for motivation in each succeeding lesson must be analyzed by the Instructor and presented as necessary.
- Instructor should include how the STAR process can be used to improve or enhance Operator Performance, if applicable.
- Read and discuss lesson terminal objective and review lesson enabling objectives, if desired.
- If applicable, briefly preview the lesson topic outline and introduce the major points to be covered. The objective review may have been sufficient.
- REINFORCE the following PVNGS management expectations as opportunities become available:

- Nuclear Safety
- Industrial Safety Practices
- STAR and Self-Checking
- Procedure Compliance
- Communication Standards
- ALARA
- Prevent Events

[\[Introduction\]](#)

T.Obj 1.1	Given the necessary resource and reference materials, describe the operation and system interfaces of the Fire Protection Carbon Dioxide System. Mastery will be demonstrated by obtaining an overall average of 80% on a multiple choice exam.
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EO 1.1.1	Explain the considerations for working around or with carbon dioxide.
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1.1.1.1 Main Idea

In view of the gas's characteristics, explain the considerations for working around or with carbon dioxide as well as any applicable industry events.

Conduct Two Minute Drill
Conduct Hazard Assessment

Precautions

1) Extinguishes fire by displacing oxygen and by formation of heat-removal "snow"

2) Carbon dioxide can cause suffocation

B) Cover IN 85-87 Personnel Injury due to inadvertant carbon dioxide discharge at Hope Creek.

a)CO₂ is lethal for humans at concentrations >17 percent.

b)Do not enter areas flooded with CO₂.

c)Use SCBA if entry is required.

d)Persons overcome by CO₂ should be treated the same as drowning victims.

e) Increase of respiration causing more toxic gases to enter the body.

3) Liquid State Hazards:

a)CO₂ discharge temperature may be as low as -110 degrees F and can cause severe skin damage

b)When CO₂ is first discharged, it will greatly reduce visibility, creating 'white out' conditions in immediate vicinity.

4) Gas state Hazards: Colorless, odorless,

a)electrically non-conductive inert gas

Show simplified dwgs of control bldg areas where CO₂ gas could collect.

- b) CO₂ migrates to other locales
- c) 1.5 times heavier than air
- d) Palo Verde CO₂ system adds wintergreen to CO₂ discharge. Wintergreen smell indicates presence of CO₂ after discharge.

Cover SEN188: *Actuation of Carbon Dioxide Fire Suppression System causes one fatality and multiple personnel injuries in Idaho.*

TCSAI 2874660

Describe the differences between the CO₂ system at the Idaho plant and at PVNGS

- 1) High pressure CO₂ system is 70°F and 850 psi. (Idaho IENNL)
- 2) Low pressure CO₂ system is 0°F and 300 psi. (PVNGS)
- 3) CO₂ in Units are low pressure systems.
- 4) Idaho IENNL CO₂ system did not meet OSHA regulations requiring a positive isolation device.
 - a) (They believed that electronic impairment using software commands would prevent actuation per their FP specialist.)

What happened?

- 1) A high pressure CO₂ fire suppression system discharged without warning during maintenance at the DOE engineering test reactor facility of the Idaho National Engineering and Environmental Laboratory (INEEL).
 - a) The CO₂ released created a lethal atmosphere with near zero visibility (white out) conditions.
 - b) Thirteen workers and two rescuers inhaled potentially lethal concentrations of carbon dioxide, some suffered additional injuries.
 - c) Five of the workers were unable to escape from the building and had to be rescued.
 - d) One of the workers later died of asphyxiation.

Why did it happen?

- 2) Idaho IENNL CO2 system did not meet OSHA regulations requiring a positive isolation device.
- a) They believed that electronic impairment using software commands would prevent actuation per their FP specialist.
- 3) A backup predischage alarm was not installed. No discharge alarm sounded prior to CO2 release.
- 4) Supervisor changed usual work plan by deenergizing entire distribution system. He thought it would enhance personnel safety. A voltage spike occurred when main breakers were opened causing valves to open and release CO2.
- Procedure Use & Adherence:***
Supervisor
- a) Manufacturer was aware AC power loss could cause actuation but this information was not passed on when CO2 system was upgraded in 1997.
- 5) Workers believed that an actuation could not happen and were completely taken by surprise
- Inadequate Pre-job Brief***
Inadequate Hazard Assessment
Inadequate Two minute drill
- a) Workers allowed test equipment, tools, cables, and breakers to clutter the work area and obstruct the entrance door to the building.
 - b) CO₂ system actuated, CO₂ liquid/gas flooded the building, lowering the oxygen level and creating a dense fog that reduced visibility to zero.
 - c) Workers immediately experienced debilitating effects of 50 percent CO₂ atmosphere. They became nauseous, disoriented, and had difficulty finding their way out of the building.
 - i) Eight workers escaped; five others became lost and soon passed out from lack of oxygen.
 - ii) One worker lost consciousness just a few feet

from an open exit door when he became entangled in equipment and cables in front of the exit.

- 6) The eight workers who escaped the building formed an initial search and rescue party.
 - a) .In an effort to save their fellow workers, these employees exposed themselves to injury by reentering the building.
 - b) They did not have self-contained breathing apparatus. (SCBA). (They held their breath).

- 7) Emergency responders experienced delays in getting to accident site.
 - a) The emergency vehicle with rescue equipment (SCBA) was behind an electric garage door opener at the emergency control center.
 - b) Door had no electrical power because of the maintenance outage, and the manual chain opener did not work.
 - c) Door was finally opened by using emergency generator to supply power.

Can it happen here?

- 8) 38FT-9QK14 (Supervisory & Functional test for CO2 panels):
 - a) Requires that supply isolation valves are closed (blocks operating supply) for the Selector Valves of Battery & ESF rooms being tested.
 - b) Solenoid circuit is also opened to affected Master Valve, (blocks operating supply).

- 9) What if a discharge occurs? (***Whats the worse thing that could happen?***)

Procedure Use & Adherence

Procedure 38FT-9QK14 Fire Detection/Protection System Supervised Circuits Test and Functional Test - Carbon Dioxide Panels.

Hazard assessment

- a) Can a discharge occur?
 - i) It can if Techs get on wrong equipment.
 - ii) It can if isolation valves are not properly closed.

Self check, Peer check

Procedural Use & Adherence

- b) Escape route covered in pre-job brief?

Pre-Job brief

Show Control bldg simplified dwgs.

- c) Are there obstacles? Could exit be accomplished in zero visibility conditions? Is housekeeping in area a concern?

Two minute drill

10)What if you are in control bldg and smell winter green?
(What else could go wrong?)

- a) Inform others in area, leave immediately and call 4444.

11)When performing corrective/abnormal maintenance on CO2 system make sure system isolation is acceptable prior to beginning work.

- a) Mechanical isolation of system using valves (preferred).
- b) In addition opening circuits to actuation solenoids.

Use 01M-FPP-004 to cover various options.

EO 1.1.2 Identify the areas protected by the Carbon Dioxide system
1.1.2.1 Main Idea
Identify the areas protected by the Carbon Dioxide system.

Areas protected:

A) Battery rooms

- 1) A, B, C, and D "flooded", (application of CO₂ in confined space)

A) Refer to drawings 01-M-FPP-004, & simplified control bldg layout dwgs.

B) ESF switchgear rooms

1) Train A

- a) Flooding system

- b) Extended discharge using pneumatic discharge timer

B) Refer to drawings 01-M-FPP-004

1) Discharge times

30 sec evac(elec)

2 min flood(pneu)

20 min stop(elec)

2) Train B

- a) Flooding system

- b) Extended discharge using pneumatic discharge timer

C) Non-Essential Switchgear Rooms

1) Hose stations

- a) Manual discharge

- b) Fed directly from tank, no timers

C) DANGER!! Use of these stations requires SCBA!!

***Hazard Assessment:
Suffocation - CO₂
displaces O₂ causing an
IDLH environment.***

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EO 1.1.3 List the major components of the Carbon Dioxide system
1.1.3.1 Main Idea
List the major components of the Carbon Dioxide system.
Components
A) Storage tank

- 1) Use of thin walled vessel possible by maintaining liquid CO₂ at low temperature and pressure
- 2) Maintained by refrigeration at approx. 0 degrees F/300 psi (At 100 degrees F pressure would reach 1465 psi)

Refer to P&ID 01-M-FPP-004 to identify the following major components. Specifics on their operation will be provided as needed.

B) Electric vaporizer

- 1) Flow through electric heaters
- 2) Thermostat controlled
- 3) Provide CO₂ to generator purge system only
- 4) Approx. 288 PSI at 70 degrees F.

C) Pilot valves

- 1) Electro Manual Pilot Valve (NDE)
 - i) Provides CO₂ control pressure to the Selector valve
 - b) Actually 2 valves in 1
 - i)Electrical

1) NDE = normally energized

b) Draw attention to the 01-M-FPP-004 P&ID for the Pilot valve "vendor panel".

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- | | |
|--|---|
| ii) Pneumatic/manual | Draw unit on board & explain flowpath. Pass photo around. |
| 2) Electro Manual Pilot Valve (NE) | 2) NE = Normally energized |
| a) Provides CO ₂ control pressure to the Master valve | |
| b) Referring to the P&ID, describe the pilot operation | |
| D) Cardox valves | D) Refer to T002, (CARDOX valve cutaway) |
| 1) Controls flow and discharge of CO ₂ | |
| 2) Description | |
| a) Piston operated globe valve, spring held closed | |
| b) Four openings | |
| i) Inlet flow | |
| ii) Outlet flow | |
| iii) Pilot supply | |
| iv) Operating pressure | |
| c) Operation | |
| i) CO ₂ pressure in the upper chamber opposes spring to open valve | |
| ii) Operating pressure externally controlled | |
| d) Application determines <u>master</u> , <u>selector</u> , or <u>master/selector</u> type | d) Display T003, (System schematic - Carbon Dioxide) Discuss difference in valve functions; Highlight that, |

though covered in the tech manual, the Master/Selector valve arrangement is not used at PVNGS

i) Master valve

- (a) Used to control flow to one or more selector valves
- (b) Generally located at the storage tank
- (c) Valve is constantly under pressure

ii) Selector valve

- (a) Controls flow into hazard
- (b) Located near the hazard
- (c) Pressurized only when the master is open

iii) Master-selector valve

- (a) Use when only one hazard is served
- (b) Valve under constant pressure

iii) Analogous to valve of deluge system; this system NOT USED at PVNGS!

E) Odorizer

- 1) Glass container inside steel housing, fractures on CO₂ flow
- 2) Causes the CO₂ being discharged to have a very distinctive "wintergreen" odor as a warning to personnel in the area (since gas is odorless)

E) Manual hosereels in Non-Essential Switchgear Room and extended discharge headers in ESF Switchgear Room have no odorizer. Beware!

HAZARD ASSESSMENT:
SUFFOCATION- CO₂ displaces O₂ causing an

IDLH environment.

F) Pneumatic discharge timers

1) Timer valve

a) Adjustable needle valve

b) Time from 15 seconds to 8 minutes

2) Check valve

3) Accumulator

4) Piston globe valve

a) Spring opposed

b) CO₂ pressure to close

c) Backpressure vented when closed

5) In operation, pilot pressure applied to selector valve operator through the globe valve

6) Needle valve also ports CO₂ from the discharge of the globe valve to:

a) The accumulator

7) Needle valve opening allows a pressure build up in the accumulator chamber

a) Length of delay determined by the amount of restriction at the needle valve

b) When pressure in accumulator exceeds the spring pressure the globe valve closes

c) Pilot pressure to selector valve is vented through globe valve

F) Refer to T004 & T005 as required, (Pneumatic Timer charge/discharge)

b) Set at 2 minutes

- d) Selector valve closes and discharge is stopped
- e) System is reset
 - i) When EMPC electrically times out from CARDOX panel and closes, pilot pressure in EMPC is vented to atmosphere via spring loaded valve
 - ii) Check valve vents pressure from
 - (a) Accumulator
 - (b) Globe valve operator
 - iii) Globe valve returns to open position

G) Discharge nozzles

- 1) Open discharge
- 2) Wide angle
- 2) Directs CO₂ discharge

H) Local alarm bell

- 1) Polarized
- 1) Description
- 2) Parallel string
- 2) Operation
- 3) EOL resistor
- 4) 24VDC
- 5) Supervised circuit

I) HVAC dampers

Prevent Events: Operating

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1) Description

2) Operation

Experience

I) Cover INPO significant event report 92-11; CONSEQUENCES OF DISABLED DAMPERS. TCS-92-1541

Identify the detectors used by the Carbon Dioxide system.

J) Detectors

- 1) Pyrotronics Model EL-30198-6, Ionization Detector; contacts close on actuation
- 2) Pyr-A-Larm DT-135CPS, Thermal Detector; rate compensated, contacts close on actuation
- 3) Fenwal Detect-A-Fire Model 27121-0, Thermal Detector; bimetallic thermostat, contacts close on actuation

J) Battery Room has 2 Ionization detectors and 2 Thermal detectors, ionizations in one zone and thermals in the other.

ESF SG Room has 5 Ionization detectors and 5 Thermal detectors, ionizations in one zone and thermals in the other.

K) Control panels

- 1) Pyrotronics System 3, control panel
- 2) Cardox Electrical Control Panel

1) Refer to Drawings 01-M-FPP-004 and highlight that any "Interlock Diamond" (i.e. panel) that receives detector inputs is a Pyrotronics panel

2) Refer to Drawings 01-M-FPP-004 and highlight that any "Interlock Diamond" (i.e. panel) that receives input from a Pyrotronics panel and outputs to control valves/HVAC is a Cardox panel.

EO 1.1.4	Describe the operation of the Carbon Dioxide system to include the function and interaction of the components and the interface with other systems
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1.1.4.1 Main Idea

Describe the operation of the Carbon Dioxide system to include the function and interaction of the components and the interface with other systems as well as any applicable industry events.

System Operation

- A) Provided to normally unoccupied rooms, where electrical equipment vulnerable to water spray is housed
- B) CO₂ provides its own pressure from holding tank for discharge for fire protection
- C) Vaporizer's function is solely to ensure that CO₂ provided to the generator is in gas form only
- D) CO₂ storage tank is located near the Radwaste Building, is refilled by truck, and has a capacity of 7.5 tons (enough to permit two separate discharges in the largest single protected area immediately after two complete purgings of the main generator)
- E) System accomodates Class "B" circuits only
- F) Interfaces
 - 1) Pyrotronics panel monitors detector inputs, when logic is satisfied, outputs

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contact to CARDOX panel for release into zone

- 2) Pyrotronics panel contacts are also output to PSS via multiplexers, providing alarms in event of zone alarms or circuit trouble
- 3) CARDOX panel causes HVAC damper closings to allow CO₂ to reach effective concentration
- 4) CARDOX panel outputs contacts to indicate CO₂ discharge

G) Operation

1) Battery rooms

a) Automatic

- i) Detector activated
- ii) Picked up by central control panel (Pyrotronics System 3)
- iii) Zone alarm is activated
 - (a) Computer
 - (b) Local bell

1) Display T006 (Physical Layout of Battery Room CO₂) and describe physical layout of equipment.

- iv) Detector from second zone in same area activated
- v) Fire signal sent to area electrical control panel (Cardox)
- vi) Discharge signal sent to EMPC for selector and master valves
- vii) System activated alarm generated

iv) Logic requires both a thermal and an ionization detector

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- (a) Computer
- (b) Local horn
- (c) Actuation signals sent to necessary HVAC and process equipment

viii) CO₂ is discharged

ix) Odorizer is activated

x) Discharge times out

xi) Automatic function bypassed until manually reset

b) Manual operation

i) Push button station electrically actuates sequence previously listed, starting at basically the point where the detector coincidence logic from the Pyrotronics to the CARDOX has been received

ii) EMPC can be manually tripped bypassing the functions up to that point

ii) Only if header from Master valve is charged. If not, plaque instructs opening of Master Valve.

Prevent Events: Operating Experience & Self Check/Peer Check

vi) Cover ICQIR 85-11

2) ESF Switchgear rooms (except hose stations)

2) Cover SPEER 88-01-012
"CO₂ Isolation to Both ESF

Switchgear Rooms"

- a) General operation the same as battery rooms

Prevent Events: Self Check/Peer Check

Emphasize how attention to detail and caution must be exercised in performance of work.

- b) Exception is the pneumatic discharge timer used to regulate the high flood rate time. Purpose is to provide sustained CO₂ concentration in area by using two separate discharge arrangements, each having its own selector valve. One discharges at a high rate for a relatively short period of time, then closing; while the other provides a sustained release through few headers until an electrical timeout is provided.

3) Non-Essential Switchgear Rooms

- a) CO₂ can be supplied manually to the switchgear room though either of two "playpipes" or wands
- b) When either wand is removed from its bracket:
 - i) Microswitch actuated
 - ii) Opens the Master Valve
 - iii) Starts a purge timer
 - (a) Setting 143 sec
- c) Purge provided to prevent "fanning flames" of fire with air in lines
- d) Purge nozzle located outside

HAZARD ASSESSMENT:
SUFFOCATION-: CO₂
 displaces O₂ causing an

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- Switchgear room rollup door *IDLH environment*
- e) After purge time, CO2 delivered to wand
 - f) Only safety system is "deadman" switch, i.e. springloaded trigger
 - i) No odorizer!!
 - ii) No timers!!
 - iii) No warning signs!!
 - iv) SCBA required!! **Only to be used by trained Fire Personnel**
- 4) CO2 Storage Tank Controls
- a) Cautions
 - i) 110 VAC control voltage
 - ii) Exposed fan blades in housing
 - iii) Prolonged compressor downtime can cause pressure relief valve to lift causing IDLH atmosphere
 - b) Compressor controls consist of:
 - i) Transformer secondary
 - ii) Fuse
 - iii) Pressure Control Switch
 - (a) Opens at 295 psi
 - (b) Closes at 305 psi
 - iv) Compressor Head Pressure Switches
- 4) Refer to M652-51 and guide student through identification of components and operation
- iii) PSHL116A

- (a) Low opens at 0 psi
 - (b) High opens at 175 psi
 - v) Three thermal overload contacts in series
 - (a) Heated by the three associated thermal heaters in series with the 440 VAC compressor motor leads
 - vi) Contactor control coil
 - vii) If all of these devices are closed the compressor will run, cooling the CO₂, lowering its pressure
- c) Additional CO₂ tank controls
- i) Alarm Pressure Switch
 - 1) PSHL 116

CAUTION!! Isolating this instrument can cause a loss of compressor since PSHL116A is isolated with the same valve.

 - (a) Barton PT
 - (b) Closes on High Pressure of 325 psi
 - (c) Opens on Low Pressure of 275 psi
 - (d) Provides 110 VAC to alarm bell locally and energizes a control relay for a 3 Kilohm PSS alarm loop output

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ii) Level Switch

2) LISL119

- (a) Opens on less than half tank of CO2 remaining to indicate that the Generator Purge reserve is depleted
- (b) Provides remote annunciation via PSS

iii) Tank Safety Valves

- (a) One lifts at 341 psi
- (b) One lifts at 357 psi

1) While performing CO2 Fire Suppression Panel testing, a lifted lead was accidentally dropped and brushed against adjacent terminals, causing an actuation of fire panels for both "A" and "B" trains ESF Switchgear rooms and a release of CO2 into Switchgear Room "A".

Prevent Events: Operating Experience

Cover IIR 3-1-89-098
"Inadvertent Actuation of the 'A' ESF Switchgear Room CO2 System"

- a) Both "A" and "B" train suppression systems received their actuation commands from one common panel with adjacent terminals.
- b) Both trains should have been isolated via the ball valves VX05 and VX06 prior to performing any work in the panel.
- c) Leads being lifted were not terminated with lugs, but were bare stripped ends and were frayed.
- d) No pre-job briefing performed by the I&C WGS

- e) The FP tech had to identify the leads to be lifted and landed to the I&C tech.
- f) .There was no discussion on the potential consequences of accidental contact of leads with other surfaces.

Corrective Actions taken

- 1) Issued letter recommending isolation of both "A" and "B" train ESF Switchgear Room CO₂ systems when performing work, testing, or lifting/landing leads on either system.
 - a) Submitted PCR to install test switches to eliminate lead lifting for the purpose of functional testing.
 - b) Recommended lugging leads with ring tongue connectors per 13-EN-306.
 - c) Subsequent modifications to system have eliminated most lead lifting for testing using installed switches. Rooms.
 - d) Have separated the "A" and "B" Switchgear Rooms and "A", "B", "C", and "D" Battery Rooms into train-related divisions; i.e., "A" Switchgear with "A" and "C" Battery Rooms; and "B" Switchgear with "B" and "D" Battery

EO 1.1.5	Explain the operation of the Cardox and Pyrotronics control panels
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1.1.5.1 Main Idea**Explain the operation of the Pyrotronics and the Cardox control panels.**

See M652-52 and 53

1) CP-30 Module

3)CP-30 module no longer available, replaced by CP-35 module, This will require modification as CP-35 has no internal power supply.

- a) Basic panel control unit
- b) One supervised initiating device circuit, Class "B"
- c) EOL device is a 50 uf capacitor, supervised by supplying a DC pedestal with an AC ripple applied; normally the ripple is detected by the sensing circuit via EOL capacitor while the DC pedestal is blocked; if initiating device contacts close, the DC pedestal is detected
- d) Two indicating device circuits
- e) Lamps
 - i)White; Power On
 - ii) Red; Alarm (short)
 - iii) Yellow; Trouble (open, power loss, ground)
- f) Switches
 - i)Reset / Lamptest
 - ii) Trouble silence

- g) System reset switch
 - i) Resets detector local alarm (if applicable)
 - ii) Resets panel alarm
 - h) Power for 200 detectors
 - i) Supervision of the other modules in cabinet and battery cabinet
 - j) Power to other modules
- 2) **BC-30 Battery Charger/Transfer Module**
- a) Automatically supplies 24 VDC to the system during normal power outage
 - b) Yellow LED "On Battery" indication flashes when system is on battery power
 - c) On restoration of main power, yellow LED extinguishes, charges battery
 - d) Battery fuse protects against battery overcurrent or polarity reversal
 - e) Initiates System Trouble alarm when battery circuit is opened
- 3) MM-30 Module (external)
- a) Located in battery cabinet, associated with BC-30 module
 - b) Voltmeter / Ammeter
 - c) Manually operated "Fast Charge" selector switch

- 4) BM-30 Module (external)
 - a) Storage location for emergency batteries
 - b) Two sealed lead acid, 12 VDC, series connected units
 - 5) ZN-30 Dual Ion Zone, Input Module
 - a) Two separate input circuits
 - i) One ionization detector string
 - ii) One thermal detector string
 - b) Operation of any detector in either zone
 - i) Latches red LED on ZN-30 for the Zone alarmed zone
 - ii) Latches alarm in CP-30
 - iii) Provides current limited output for the zone in alarm to the SR30 module
 - c) Trouble Condition (Open regulator transistor, open detector line, excessive line leakage)
 - i) Local yellow trouble LED
 - (a) One for each zone
 - (b) Remote trouble annunciation
 - d) SR-30, Supplementary Relay Module
 - i) Activate or deactivate external devices
 - ii) 2 Relays
 - (a) 24 VDC
- ii) Emphasize the difference in the alarm light on the CP module versus the ZN module

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- (b) Independently operated

- (c) SPDT contacts

- iii) Relay actuation

- (a) High resistance transistor input circuit

- (b) High going DC signal, 12-24 VDC

- (c) Can be made to "seal in"

- iv) Placement supervised (Removal of module causes system trouble alarm)

B) Cardox Electrical Control Panel

- a) Pyrotronics contact picks up THR relay

- b) THR relay

- i) Locks out Reset

- ii) Opens detector actuated contact

- iii) Picks up RH1

- c) RH1 relay,

- i) Drops out THR relay

- ii) Drops out green light and monitor circuit power

- iii) Picks up and latches LR

- iv) Picks up and latches PE

- v) Seals itself in through TR2 contact

- vi) Picks up TR1

- d) LR relay

B) DRAWINGS M652-49, 50, 51; Refer student to writeup in Student Handout. Go over sheet 69 of handout.

- i) Locks out the green light and the monitor circuit power
 - ii) Locks out THR pickup of RH1
 - iii) Picks up Red System Actuated Light
- e) PE relay
- i) Locks out PE latch coil in latch position
 - ii) Actuates local alarm horn
 - iii) Permissive to unlatch coil closed
 - iv) Actuation contacts to equipment such as exhaust fans
 - v) Picks up TR3
- iv) Customer use contacts to immediately shut down dampers
- f) TR1 relay
- i) Drops Push button circuit power
 - ii) Picks up RH2
- g) RH2 relay
- i) Picks up TR2
 - ii) Picks up EMPC(NDE)
 - iii) Picks up Master Valve relay (MVR)
- h) MVR drops out EMPC (NE)
- i) EMPC (NE) opens master valve
 - j) EMPC (NDE) opens selector valve, CO₂ discharge starts

- k) TR3 relay times out and picks up time delay damper control
- l) TR2 times out and drops out RH1
- m) RH1 out
 - i) Puts THR relay Back in circuit with detector, pick up depends on current status of detector
 - ii) Drops power to LR latch coil
 - iii) Drops out TR1
- n) TR1 out
 - i) Reapply power to push button circuit
 - ii) Drop out RH2
- o) RH2 out
 - i) Drops out TR2
 - ii) Drops out EMPC (NDE) which stops CO₂ discharge
 - iii) Drops out MVR which closes master valve
- p) At this time
 - i) Automatic operation remains locked out by the PE and LR latch coils
 - ii) Reset to normal operation if detectors are clear by unlatching PE and LR relays
 - iii) Manual operation can be initiated by push button
- q) Manual operation;
 - i) By the push button occurs at any time it is initiated by picking up RH1 and following the same sequence as automatic operation

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ii) By EMPC (NDE) manual operation only if the master valve is open!!!

ii) Following this explanation, use T007 to review "big picture" operation

C) CO2 Panel Interconnection Drawings

C) See 01-E-FPB-003, 004

SUMMARY OF MAIN PRINCIPLES

The following items are things to consider in your lesson summary. They are not mandatory. You should develop your own summary.,

Objectives Review

Review the Lesson Objectives

Topic Review

Restate the main principles or ideas covered in the lesson. Relate key points to the objectives. Use a question and answer session with the objectives.

Questions and Answers

Oral questioning

Ask questions that implement the objectives. Discuss students answers as needed to ensure the objectives are being met.

Problem Areas

Review any problem areas discovered during the oral questioning, quiz, or previous tests, if applicable. Use this opportunity to solicit final questions from the students (last chance).

Concluding Statement

If not done in the previous step, review the motivational points that apply this lesson to students needs. If applicable, end with a statement leading to the next lesson.

You may also use this opportunity to address an impending exam or practical exercise.

Should be used as a transitional function to tie the relationship of this lesson to the next lesson. Should provide a note of finality.