Turnaround Disaster

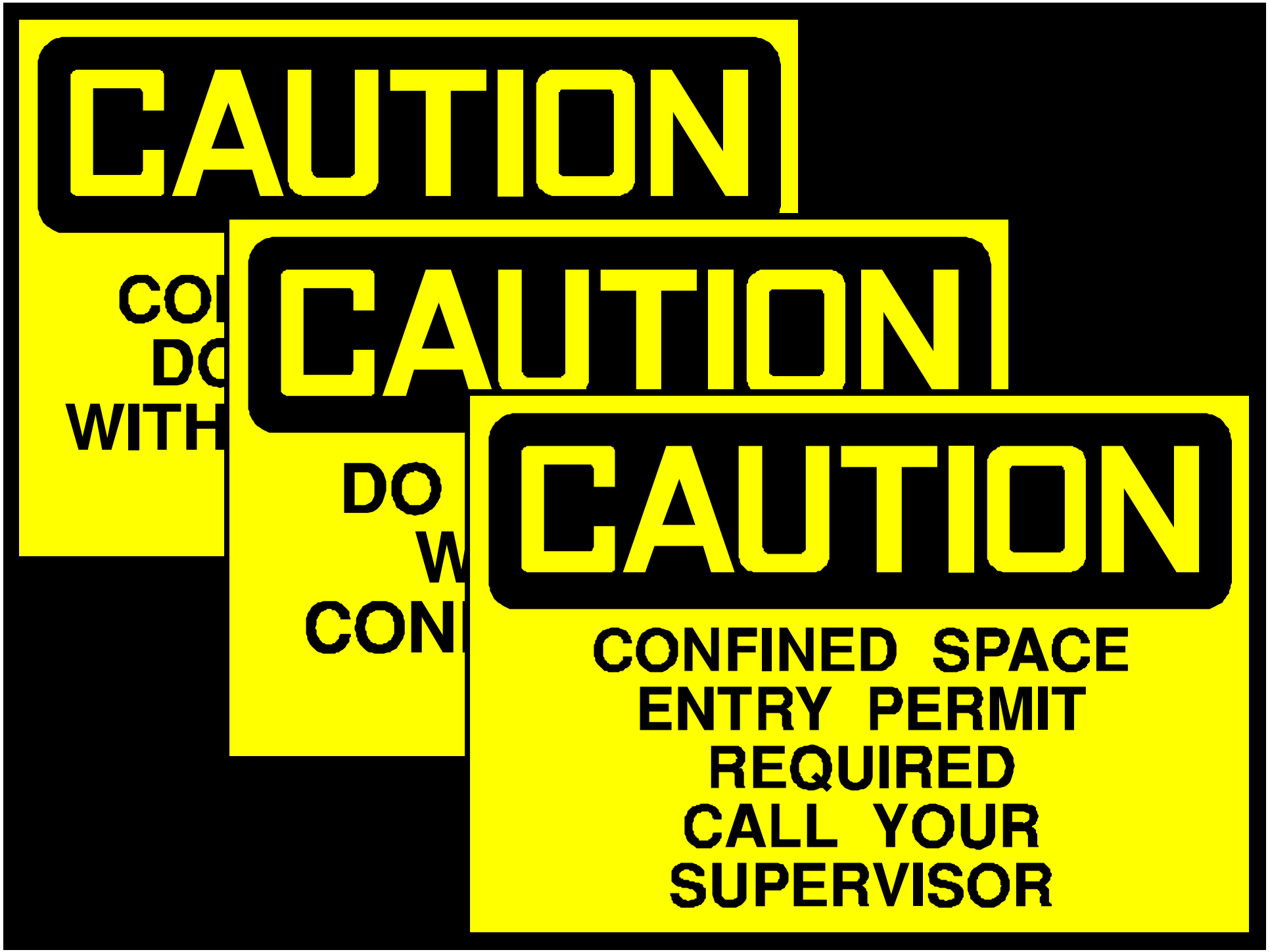
Confined Space

Prepared in Beaumont by Training Group
4/99

One Person Dead

Incident

- On March 27, 1998, at approximately 12:15 PM, two workers at a chemical plant, were overcome by nitrogen gas while performing a black light inspection at an open end of a 48-inch-wide horizontal pipe.


CAUTION
CO
DO
WITH
CAUTION
DO
W
CON
CAUTION
CONFINED SPACE
ENTRY PERMIT
REQUIRED
CALL YOUR
SUPERVISOR

Incident *continued*

The 48-inch pipe was open because chemical-processing equipment had been shut down and opened for major maintenance. Nitrogen was being injected into the process equipment primarily to protect new catalyst in reactors from exposure to moisture.


DANGER
TEST ATMOSPHERE
BEFORE ENTRY

Incident *continued*

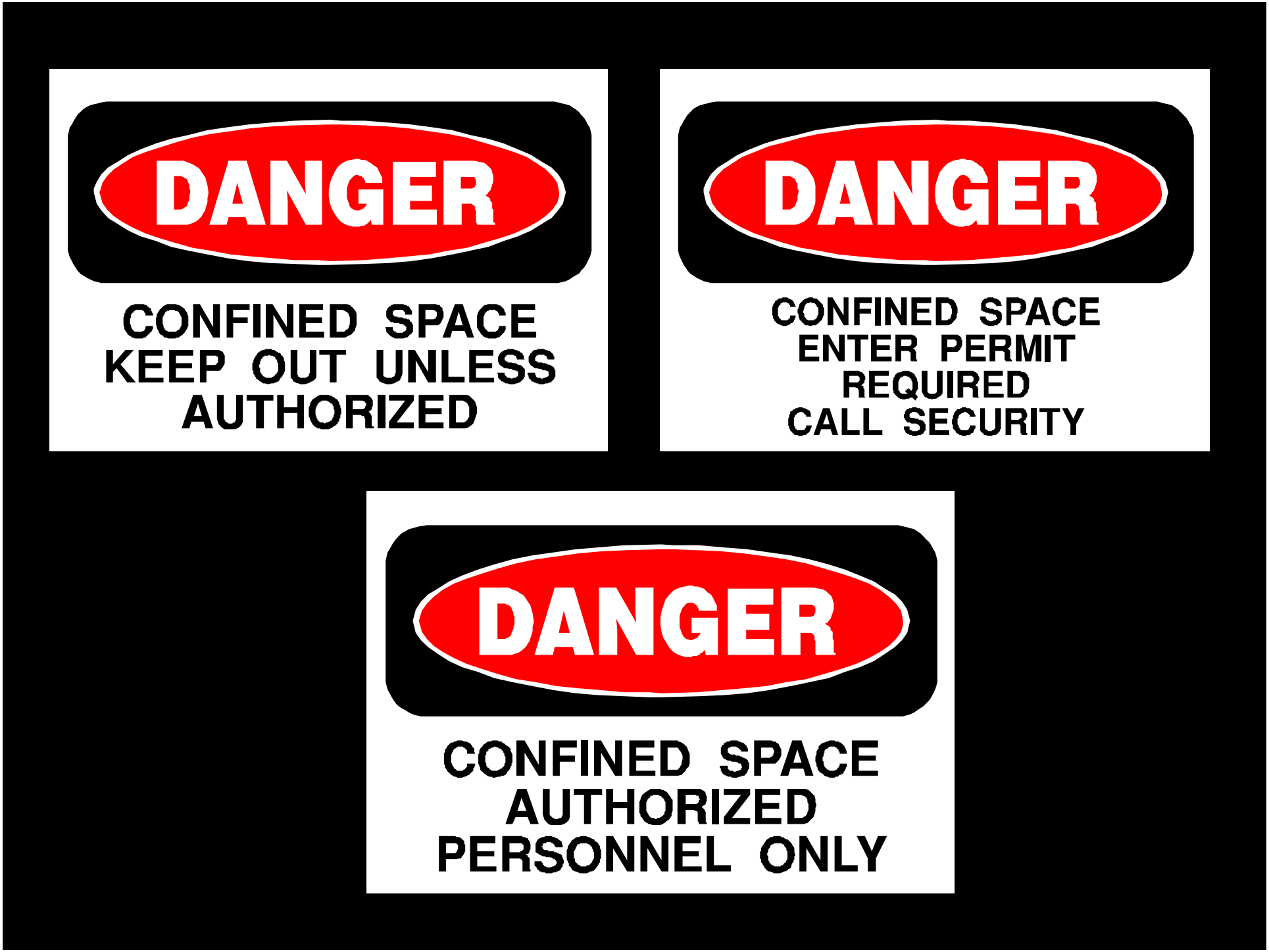
The nitrogen was also flowing through some of the piping systems connected to the reactors. The nitrogen was venting from one

side of the open pipe where it had formerly been connected to an oxygen feed mixer.


DANGER
CONFINED SPACE
ENTER BY
PERMIT ONLY

Incident *continued*

- No warning sign was posted on the pipe opening identifying it as a confined space or warning that the pipe contained potentially hazardous nitrogen.


DANGER
CONFINED SPACE
KEEP OUT UNLESS
AUTHORIZED
DANGER
CONFINED SPACE
ENTER PERMIT
REQUIRED
CALL SECURITY
DANGER
CONFINED SPACE
AUTHORIZED
PERSONNEL ONLY

Incident *continued*

- The two workers had placed a sheet of black plastic over the end of the pipe to provide shade to make it easier to conduct the black light test during daylight.


DANGER
FOLLOW CONFINED SPACE ENTRY PROCEDURE BEFORE ENTERING

Incident *continued*

Note;

A black light was used to see any residue of organic material, such as grease or oil, on the pipe. Organic residue shines when viewed under a black light.

WARNING

Keep Out

Signed By _____

Date _____

Incident *continued*

- While working just outside the pipe opening and inside of the black plastic sheet, the two workers were overcome by nitrogen. One worker died from asphyxiation. The other worker survived but was severely injured.

Incident *continued*

- Nitrogen is an odorless, tasteless, and invisible gas that can cause asphyxiation at high concentrations..

Incident *continued*

- When used in confined spaces, nitrogen is especially hazardous because it cannot be detected by human senses but can cause injury or death within minutes by displacing the oxygen that is required to sustain life

Incident *continued*

- The worker injured (B) in the incident was retained as an independent contractor and was in charge of daily operations in the reaction area during the turnaround.

Incident *continued*

- He had retired from Union Carbide after 32 years of service, primarily at the plant. His last position prior to retirement was Reaction Area Specialist for the same Unit.

Incident *continued*

- The worker (A) who died was a Union Carbide employee who had 23 years of service at the plant.

Incident *continued*

- He was a Maintenance Skilled Operations Team Technician in the Unit. Worker B was under the general direction of Worker A at the time of the incident.

Incident *continued*

- Two primary maintenance activities were scheduled during the turnaround of the Unit: Replacement of the old catalyst in the reactors with new catalyst and cleaning the oxygen feed mixer.

Incident *continued*

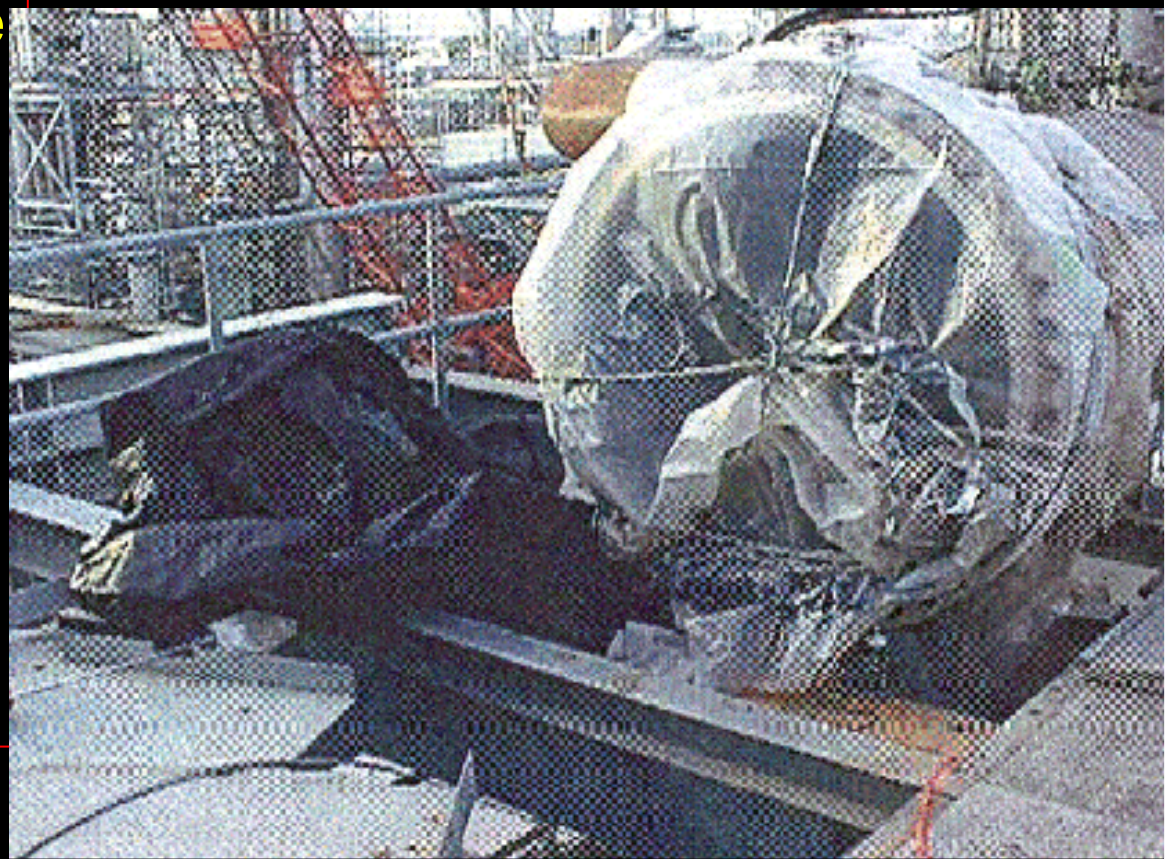
- The oxygen feed mixer had been removed from the piping system for cleaning. Removing the oxygen feed mixer exposed two open ends on 48-inch piping that had been connected to the oxygen feed mixer.

Incident *continued*

- The two open pipe ends were wrapped with a clear plastic sheet in order to keep the pipe free of debris until the oxygen feed mixer was reinstalled.

Incident *continued*

- This picture shows the clear plastic sheet over one of the 48-inch pipe openings and the black plastic sheet lying near the opening.



Incident *continued*

- The parts of the pipe that the workers examined with the black light were the two flange surfaces, which were located at the ends of the pipe that connected to the oxygen feed mixer.

Incident *continued*

- This picture shows the north end of the pipe and the flange surface.

Incident *continued*

- Although a black light inspection was a typical part of oxygen feed mixer cleaning,

  it was not needed on the 48-inch pipe flange surfaces. For these flanges, a visual inspection was all that was required.

Incident *continued*

The CSB investigation did not discover any conclusive reason that explained why Workers A and B decided to perform black light inspections on the pipe flanges.

Incident *continued*

- The catalyst used in the ethylene oxide reactors was sensitive to moisture.

Incident *continued*

- Therefore, following replacement of the old catalyst, the new catalyst was protected from exposure to moisture-containing

  air by injecting nitrogen gas into the area around the catalyst. The nitrogen displaced the air in the reactors and blanketed the catalyst.

Incident *continued*

- The evening before the incident, Worker A directed Operations Technicians to add the nitrogen to the piping because the catalyst had been changed.

Incident *continued*

- Because nitrogen would retard rust formation in the piping connected to the reactors, two valves were opened to allow the flow of nitrogen into the process piping.

Incident *continued*

- The nitrogen vented from the open end of the 48-inch pipe on the north side of where the pipe formerly connected to the oxygen feed mixer.

Incident *continued*

- On the day of the incident, Workers A and B performed a black light inspection and cleaning of the two flange surfaces on the open 48-inch pipe, beginning with the south flange.

Incident *continued*

- Because the midday sun made it difficult to see any grease or oil residues with the black light, Workers A and B used a sheet of black plastic to provide a darker working area.

Incident *continued*

- The black plastic sheet was fastened over the pipe flange because there was a strong breeze that day. The plastic sheet was held in place by Workers A and B sitting on one edge of the sheet with the remainder of the sheet held over them and against the exterior of the pipe flange by two contractor workers.

Incident *continued*

- The contractor workers were in the area because they were waiting for the oxygen feed mixer to be lifted back into place.

Incident *continued*

- Though unintended, the plastic sheet created a temporary enclosure around Workers A and B. The inspection and cleaning of the south pipe flange began at

  approximately 10:45 am and was completed at about 11:35 am.

Incident *continued*

There was no incident because the nitrogen was not venting through the south pipe opening. The south pipe was also connected to the reactors, but a closed valve blocked this piping, thus preventing the flow of nitrogen to the south pipe.

Incident *continued*

- Next, the workers and the contractors placed a plastic sheet in the same fashion on the north pipe flange while Workers A and B conducted an inspection and cleaning. Because this part of the pipe was being purged with nitrogen, it contained a high level of nitrogen.

Incident *continued*

- The temporary plastic enclosure trapped a high concentration of the nitrogen, which continued to vent out of the north pipe. Worker A probably did not realize that nitrogen was venting from the pipe even though the evening before he had directed that nitrogen be injected into the piping system.

Incident *continued*

- He may have not remembered that nitrogen was in the pipe because the nitrogen was injected at a distant location, 150 feet and several stories in elevation away from the site of the incident.

Incident *continued*

- Contractors, who were on the other side of the black plastic sheet, reported talking with Workers A and B. The last communication with Workers A and B took place just after noon.

Incident *continued*

- At approximately 12:20 pm, a contractor noticed blood on one of the worker's hands when he looked through a gap in the plastic sheet.

Incident *continued*

- He alerted his foreman. The foreman called to the two workers behind the sheet and, getting no reply, removed the sheet.

Incident *continued*

- Worker B was found in front of the pipe, unconscious and slumped over with his head lying inside the open pipe. Witnesses said that his skin color was purple.

Incident *continued*

- Worker A was found seated beside the pipe opening, dazed and leaning against the side of the pipe. His color was described as white.

Incident *continued*

- Emergency assistance was requested. The plant emergency response team arrived and removed the two men from the Unit while administering cardiopulmonary resuscitation to Worker B. The two workers were transported by ambulance to the hospital.

Incident *continued*

Worker B was dead on arrival.

Worker A was admitted to the hospital in critical condition and given oxygen therapy over the next several days. He was released after five days in the hospital.

Incident *continued*

- OSHA defines a confined space as a space that is large enough to enter, has limited or restricted means for entry or exit, and has not been designed for continuous human occupancy.

Incident *continued*

- OSHA defines a permit-required confined space as one that meets all of the above criteria and also contains or has the potential to contain a hazardous atmosphere.

Incident *continued*

- In order to enter a permit-required confined space, OSHA requires that personnel monitor the atmosphere in the space and that the company issue a written permit that identifies the hazards present and the precautions that must be taken before entry.

Incident *continued*

- One factor that makes entering a confined space hazardous is that the space may contain a hazardous atmosphere. A confined space may contain a dangerous vapor, such as Ethylene Oxide, in concentrations hazardous to health.

Incident *continued*

- Other confined spaces may contain a nontoxic gas, such as nitrogen, in concentrations that displace the oxygen in the air in the space. One factor that makes entering a confined space hazardous is that the space may contain a hazardous atmosphere.

Incident *continued*

- A confined space may contain a toxic gas, such as hydrogen sulfide, in concentrations hazardous to health. Other confined spaces may contain a nontoxic gas, such as nitrogen, in concentrations that displace the oxygen in the air in the space.

Incident *continued*

- The air we normally breathe contains about 21% oxygen, 78% nitrogen, and trace amounts of other gases. In this incident, the nitrogen acted as an asphyxiant,

Incident *continued*

- It is not necessary for nitrogen to displace all of the 21% of oxygen normally found in the air in order to cause harm to people. OSHA requires that oxygen levels be maintained at or above 19.5% in order to prevent injury to workers.

Incident *continued*

- According to the Compressed Gas Association, “exposure to atmospheres containing 8-10 percent or less oxygen will bring about unconsciousness without warning and so quickly that the individuals cannot help or protect themselves.”

Incident *continued*

- Exposure to an atmosphere containing 6-8 percent oxygen can be fatal in as little as 6 minutes. Exposure to an atmosphere containing 4-6 percent oxygen can result in a coma in 40 seconds and subsequent death.

Incident *continued*

- In this incident, no signs were posted at the pipe opening to warn workers and contractors that it was a confined space or that it contained nitrogen. Even if the temporary enclosure had not been erected around the north pipe opening,

Incident *continued*

an employee or a contractor could have been overcome by nitrogen if he or she merely had inserted his or her head into the pipe for a short time. A worker or a contractor could have put his head into the north pipe opening as part of cleaning or inspecting the pipe flange.

Incident *continued*

- OSHA has investigated confined space injuries and fatalities at other facilities in

  which a worker only entered a confined space with his head.

Incident *continued*

- Although management did not expect the specific job of a black light inspection to be performed, there were other workers in the area who needed to be protected from the potential nitrogen hazard. Earlier during the day of the incident,

Incident *continued*

contractor employees used wire brushes and cleaning solution to clean the same 48-inch pipe flanges that were later inspected with the black light. In order to perform this job, contractors removed the clear plastic sheets covering the pipe openings,

Incident *continued*

thereby exposing themselves to the nitrogen hazard. Because there was a strong breeze that day, the nitrogen venting from the north end of the pipe was quickly dissipated and did not harm the contractors.

Incident *continued*

- In this incident, the plant had a confined space entry program and a chemical safety-training program. Nonetheless, one very experienced worker died and another was seriously injured because these workers were not aware that they were being exposed to dangerous levels of nitrogen.

Incident *continued*

- This potentially dangerous substance cannot be detected by the human senses. In addition, high concentrations of nitrogen are dangerous because personnel may not recognize physical or mental symptoms resulting from over-exposure.

Incident *continued*

- The two workers involved in the incident were unable to recognize that they were in trouble.

Incident *continued*

- They did not try to leave the hazardous work area even though there was an easy means of escape. Also, contractors were located nearby, but the two workers did not ask for help.