TO: **Director, Occupational Health Surveillance Program, Massachusetts Department of Public Health**

FROM: **Massachusetts Fatality Assessment and Control Evaluation (MA FACE) Program Field Investigator**

SUBJECT: **Massachusetts Lead Chemical Technician Dies in Explosion During Chemical Synthesis Process - MA-92-09**

DATE: **July 19, 1993**

SUMMARY

A 41 year-old male lead chemical technician (victim) died of injuries resulting from a flash explosion of volatile toluene inside a centrifuge. The victim was monitoring the production of sodium phenate. Just prior to the incident, he was peering through a sight glass centered in the steel centrifuge lid when the explosion blew the lid back, striking the victim in the face. The victim was thrown backward into the air and landed on a concrete floor. He was working unobserved at the time of the incident, but employees working one floor below heard the blast and immediately went to investigate. The employees called for help and the victim was transported to the local medical center where he was officially pronounced dead one hour later.

The Massachusetts FACE Investigator concluded that to prevent similar occurrences in the future, employers should:

1. install a device to inform centrifuge operators when the flow of inerting gas is inhibited.

2. develop, implement, and enforce procedures to ensure that gas lines shut off during repair are operational after repairs are completed.

3. equip centrifuges with pre-set and/or automatic shut-off mechanisms to stop the flow of slurry once attaining the "fill line" of the centrifuge.

4. install a lid that is interlocked with the centrifuge drum forming an airtight seal and preventing the drum from spinning if the lid is not locked down.

5. train employees to ensure environmental safety prior to entry onto an incident site.

INTRODUCTION

On March 13, 1992, a municipal police department official notified the Massachusetts FACE Investigator that a worker had just been seriously injured in a chemical explosion at a local plastics manufacturing plant. The official stated that the victim's medical prognosis was grave. The MA FACE Investigator arrived at the scene of the incident within 15 minutes of its occurrence. Even though the victim had not yet died, the investigation took place immediately, before the incident scene could be disturbed.

The MA FACE Investigator conducted interviews with the company division shift leader, municipal police department officials, the municipal fire chief, a representative of the state fire marshall's office, and company haz-mat personnel. Subsequently, the investigator interviewed a company environmental technician, the manager of the Specialty Materials Products Department, in-house company safety investigators, and U.S. Department of Labor OSHA representatives. Multiple photographs, company chemical synthesis directives, the police report, and the OSHA Investigation Summary were obtained during the course of the investigation.

The employer was an international and multi-divisional manufacturing corporation with tens of thousands of employees worldwide, in business for over 100 years. The victim worked for the Specialty Materials Products Department of the Plastics Division (also with tens of thousands employees worldwide). The company employed safety officers and maintained written safety rules and procedures, as well as a written safety program. There were also monthly safety meetings, and written procedures that specifically addressed the production of sodium phenate.

The victim was 41 years old and had been an employee of the company for 22 years. He had worked in the Specialty Materials Products Department of the Plastics Division for the last 18 years and had been a lead chemical technician for 12.5 years.

INVESTIGATION

On the day of the fatality, March 13, 1992, the company's specialty materials operation (SMO) was producing sodium phenate for use as a catalyst in the manufacture of phosphites. The sodium phenate synthesis operation was in its 19th batch run. The production run had begun on February 11th, 1992.

Prior to the incident, the victim was actively engaged in the production of sodium phenate. This involved opening and closing valves that permitted the chemicals to move through various stages of production. The investigation indicated that the victim was following standard operating procedures in preparing the centrifuge to receive the transfer of sodium phenate slurry. Specifically, he opened a valve to purge the centrifuge with nitrogen to create an inert environment. Next, the victim set the centrifuge speed and then opened a recirculating line to begin the flow of slurry. The victim then peered through the sight glass at the top of centrifuge lid to ensure that the vessel was filled to the

proper level.

While the technician was peering through the sight glass in the centrifuge lid, an explosion bent back the lid lock-down mechanisms, forcing the steel lid into the victim's face/head region. The lid knocked the victim upward and backward onto the concrete floor of the laboratory.
The victim sustained fatal facial and cervical injuries. The victim was alone at the time of the incident. The closest workers were one floor below. Employees working on the floor below went to the scene as soon as they heard the explosion. The first respondent, a shift supervisor, manually closed the hand-operated fill valve to stop the overflow of slurry from the centrifuge. The first people to respond to the incident scene smelled pungent smoke yet witnessed no fire nor sprinkler system activation. This is consistent with the effects of a flash explosion, which does not involve a fire or widespread material damage.

Respondents called the company's emergency hazardous materials (haz-mat) services and municipal police, fire, and emergency medical services units. The haz-mat personnel and emergency medical services tended to the victim until he could be transported to an area medical center. The victim was pronounced dead one hour after reaching the medical center. According to the Medical Examiner, it was the force with which the lid struck the victim's face/head region that caused the fatality. Neither the flash explosion nor the fall to the floor were the cause of death.

Immediate and subsequent investigation of the site yielded the following information: Manually operated nitrogen valves on top of the centrifuges were in the "open" position, as was a valve further down the line. However, the nitrogen valve at a manifold, not within the technician's sight, was closed. Maintenance and work order records did not explain why this valve was in the off position. Operators suggested that the valve may have been closed (and never reopened) several weeks earlier when company representatives surveyed the nitrogen conveyance system for a leak. This indicates that the hazardous conditions may have existed for weeks but were never detected.

The closed valve inhibited the flow of nitrogen to the system causing the build-up of toluene vapors. The material conveyance system was not equipped to measure or gauge the proper flow of nitrogen to the equipment, thus the victim would have assumed that the nitrogen was flowing because he had opened the manual nitrogen valves. Investigation suggests that the lack of nitrogen needed to render the centrifuge atmosphere inert, combined with the static electricity generated by the filling and spinning action of the centrifuge, led to the ignition of the toluene vapors, resulting in the explosion. Although it is not possible to be completely certain that static electricity was the ignition source, it is clear that the lack of nitrogen contributed to the explosive environment.

CAUSE OF DEATH

The Medical Examiner listed the cause of death as asphyxiation, facial and cervical injuries, blunt trauma secondary to explosion, fractured second cervical vertebra and transection of cord.

RECOMMENDATIONS/DISCUSSION

Recommendation 1: Install a device to inform centrifuge operators when the flow of inerting gas is inhibited.

Discussion: In this incident, the flow of nitrogen was inadvertently shut off at a location beyond site of the centrifuge technician who had no way of determining whether or not nitrogen was flowing into the centrifuge. Since nitrogen was needed to render the potentially explosive environment inert, a gauge, meter, rotometer, or some other visible or audible device to inform the operator when nitrogen is not flowing may have prevented this incident. OSHA Standard 29 CFR 1910.106 (h)(4)(iv)(b) details protective measures, including inerting, to be taken where the vapor space of equipment is usually within the flammable range.

Recommendation 2: Develop, implement, and enforce procedures to ensure that gas lines shut off during repair are operational after repairs are completed.

Discussion: In this incident, operators recalled plant personnel surveying the nitrogen conveyance line for a leak. It is possible that the valve was not opened after this work was completed. A lock out procedure may have prevented this incident. Such a procedure would lock the valves in the "on" position during normal operation, and require the conscious unlocking and relocking of valves before and after repairs. OSHA Standard 29 CFR 1910.147 (c) (4) (ii) details how energy control procedures (lockout/tagout) must clearly and specifically outline the scope, purpose, authorization, rules, and techniques to be utilized for the control of hazardous energy.

Recommendation 3: Equip centrifuges with pre-set and/or automatic shut- off mechanisms to top the flow of slurry once it reaches the "fill line" of the centrifuge.

An automated filling system would have eliminated the need for the operator to check on the slurry through a sight glass. A redesigned system could potentially eliminate the need for the operator to be in such close proximity to the equipment during operation. Such a system would also have prevented the slurry from continuing to flow after the explosion. There was a potential risk of fire from this flow, endangering the lives of those who came to the aid of the victim. OSHA Standard 29 CFR 1910.106 (h)(4)(iv)(a) details how equipment must be designed and arranged to prevent the unintentional escape of liquids and vapors and to minimize the quantity escaping in the event of accidental release.

Recommendation 4: Install a lid that is interlocked with the centrifuge drum forming an airtight seal and preventing the drum from spinning if the lid is not locked down.

Discussion: In this incident, the centrifuge lid was held in place only by thumb screws and washers. The lack of an air tight seal increased the risk of explosion by allowing air into the centrifuge, potentially fueling the explosion. (An interlocked lid has the added advantage of preventing the door from being opened while the drum is spinning.) Also, consideration should be given to the installation of a sensor to detect the presence of oxygen and the installation of a rupture plug that would direct the event to a safe venting area away from the operator. The weak link in the system should not be the cover. OSHA Standard 29 CFR 1910.106 (h)(4)(iv)(b) details hazardous equipment safeguarding requirements and Standard 29 CFR 1910.212 (a)(4) enclosure requirements on equipment with revolving drums, barrels, or containers.

Recommendation 5: Train employees to ensure environmental safety prior to entry onto an incident site.

In the event of an explosion, the possibility of subsequent blasts or the presence of toxic exposures should be taken into account prior to entry onto the incident site. All employees working in or near potentially explosive environments should be trained in the steps to be taken in explosion emergencies.

REFERENCES

1. *Office of the Federal Register: Code of Federal Regulations,*
   Labor 29, July 01, 1991, Parts: 1910.106 (h) (4) (iv) (a)
   1910.106 (h) (4) (iv) (b)
   1910.147 (c) (4) (ii)
   1910.212 (a) (4)
   1910.212 (a) (4)

2. U.S. Department of Labor - Occupational Safety and Health Administration Springfield Massachusetts Regional Office - Incident Investigation Summary