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EXPLOSIVES ACCIDENT / INCIDENT ABSTRACTS

SEPT. 1961 THRU JUNE 1967

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DISSEMINATED BY-

ARMED SERVICES EXPLOSIVES SAFETY BOARD

WASHINGTON D.C. 20315

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FOREWORD

These explosives accident/incident abstracts have been disseminated between 1 September 1961 and July 1967 as a result of a voluntary program instituted by the Armed Services Explosives Safety Board. The purpose of this program is to effect expeditious dissemination of accident/incident information to all concerned with a view toward forestalling, where possible, similar occurrences.

Constributions to this program have been made by Government organizations and industry.

R. E. JOHNSON
Captain, USN
Chairman, ASESB

GENERAL

N O T I C E

There has been a REPRINT of the publication entitled "Study of Missiles Resulting From Accidental Explosions, A Manual for Investigators" by Crosby Field. This publication may be obtained at $ .50 a copy from the Superintendent of Documents, Government Printing Office, Washington, D. C. under the title of "AEC Safety and Fire Protection Bulletin No. 10."

1 June 1966

NOTICE

The Ad Hoc Committee on Sensitivity of New Materials was formed under the Solid Propulsion Sub-Group of the Interagency Chemical Rocket Propulsion Group (ICRPG) in January 1965. The purpose of this Committee is to render guidance to the ICRPG in solving problems on the sensitivity of new propellant materials. Initial attention was devoted to N-F compounds.

To evaluate the problems of sensitivity of these new materials, the Committee decided that it is important that all incidents involving rapid spontaneous decomposition, pressure explosion, or detonation be recorded, reported and compiled.

The first compilation of these incident reports is contained in CPIA Publication No. 99 entitled "Incidents Reflecting the Sensitivity of New Materials (U)", dated December 1965. The report is classified CONFIDENTIAL and is available to qualified users thru the Defense Documentation Center, Cameron Station, Virginia under call number AD 368 665.

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The following article was submitted by one of the participants in the program for exchange of incident information, and has been reproduced for further distribution.

"Influence of Nitroglycerin on the Human Body"

"To the question of what is the possible influence of nitroglycerin (without nitroglycol) on the human body, the following contribution by a Swiss factory is of interest:

'At the beginning of 1959, at the request of the workers medical service, 75 workers and employees, who come in contact with nitroglycerin underwent medical examination. In the examination were 14 men and women who jointly worked in a laboratory with different poisonous substances. The questioning of workers revealed a mearingful dependence of the frequency of subjective complaints (headaches, dizziness, nervousness, loss of sleep, etc.) and disturbance of the vegetative nervous systems (trembling, sweating, etc.) and abnormal blood and heart functioning on the degree of exposure. The frequency of complaint is - bearing in mind age groups - in the group of most heavily exposed two to three times higher than in the more lightly exposed group. The complainants undergo exposure meanwhile only a short time. Bad effects on the inner organs could have been produced exclusively or chiefly from the influence of the nitroglycerin. With the above-mentioned 14 men and women, we found in the same manner no sign of poison or consequences of poisoning. The reports on the diseased are for the most part accidental observations. The relatively large number of reported sick, namely in the older age category, speak for the utilization of periodic rotation.'"

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The following article appeared in the November 1964 issue of Aerospace Maintenance Safety magazine, and has been reproduced for further distribution.

"WHIPLASH"

Helium was being transferred from a rail tube car through off-loading header Nr 1 into the helium storage system. The high-pressure hose was secured at both ends with safety chains. The hose had been pressurized to header Nr 1 with approximately 1400 psi originating from the Nr 1 tube bank of the rail car. During the bleed sequence, the quick disconnect allowed the hose to disconnect while under pressure.

The safety chain momentarily secured this disconnected line to the header. The operator was standing adjacent to the header. In an attempt to divert the flow of gas away from his body, he grabbed the disconnected end of the line. At this time the buttons on his coveralls were severed from the uniform, and his undershirt was torn by the escaping high-velocity gas. The chain securing the hose to the header broke, allowing the hose to entwine, snarl, whiplash, and break free from under the 130-pound sandbag weights that had been placed on the hose at five-foot intervals. This hose freedom allowed whiplashing in all directions, restricting access to the source shutoff valve.

The operator boarded the rail car from the opposite end and cautiously approached the manifold from the top. He maneuvered himself into a position that enabled him to close the source valve from above. Then he was immediately taken to the hospital for examination and observation; no injuries were incurred.

Investigation of the incident revealed the following facts:

a. The quick disconnect (QD) coupling was unreliable for high pressure transfer in this application. Inspection revealed that the design of this type of QD coupling allows the hose fitting to remain loose at the point of insertion into the QD receptacle after the snap ring has been engaged.

b. The egg-sized gravel allowed some movement of the hose under the sandbags. This movement quickly removed enough stones from under the sandbags to free the hose. This condition progressed from bag to bag.

c. The heavy steel chain used as a safety tiedown proved to be inadequate.

The following corrective action was taken:

a. Quick disconnects were removed from all headers and hoses and replaced by Nr 8 AN stainless steel fittings. Positive thread-type connections were judged to be more safe than QDs in this application.

b. Two-inch by ten-inch boards, 10 feet long, and equipped with 2 x 4 rails spaced a hose-width apart, will be used for support of the hose. The hose placed between the 2 x 4 and on top of the 2 x 10 boards, and sandbagged every five feet will afford more adequate security in the event of a rupture or inadvertent disconnect. Additional action has been taken to blacktop the area between the railroad ties and the offloading headers.

c. The chains were removed and replaced with $\frac{1}{4}$-inch steel cable secured with loops and steel U-bolt cable clamps.

EXPLOSIVE INCIDENTS

ARMED SERVICES EXPLOSIVES SAFETY BOARD
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ASESB Explosive Incident Report No. 1

Modified Double Base Slurry Explosion

At approximately 6:00 PM on August 25, 1961, an explosion occurred at a Naval facility involving a classified formulation of modified double base propellant slurry, which resulted in instant death of five civilian workers.

The building in which the explosion occurred was approximately 50 feet in length, divided into two sections by a 10' corridor extending the length of the building. On either side of this corridor were cubicles approximately 10'x10' with 1' thick reinforced concrete walls. The open sides of the cubicles faced outward from the corridor walls. The explosion occurred in the second cubicle from the front of the building, on the right-hand side. The first cubicle on this side was used for weighing and separation of ingredients contained in the propellant mix. This second cubicle (in which the explosion occurred) contained a 50-gallon Baker-Perkins type mixer located approximately 3' from the walls, in one corner of the cubicle. The controls for this mixer were located on the wall of a transverse corridor separating this pair of cubicles from a similar pair of cubicles which contained no explosive at the time of the incident. A similar type concrete structure used for the same purpose is located approximately 300' from the open ends of these cubicles. These two buildings were separated by an intervening earth barricade.

The water-jacketed type mixer contained modified double base propellant. No desensitizers were used in this special formulation as it was being mixed in slurry form. The cooling water in the jacket was maintained at 60-65 degrees Fahrenheit. At the end of the mix, the water was to hold this temperature until the mixer was emptied in order to prevent the material from "setting up". Following the mixing operation, the mixer was stopped, the mix lid removed, and the material removed by vacuum from the mixer to a casting container alongside the mixer. Approximately 200 pounds had been removed, leaving an approximate 15-25 pounds for manual removal. Manual removal is by scrapedown with non-sparking type spatulas and transfer to the casting container. The explosion occurred during removal of the remaining 15-25 pounds from the mixer. It appears that, in the scrapedown operation, a considerable amount of propellant was adjacent to the power shaft end of the mixer. A portion of this shaft, with flange minus sigma blades weighing approximately 40-50 pounds, was propelled almost vertically from the cubicle and penetrated the roof of a building 700' away. The escape of this fragment, and its trajectory, indicate the likelihood that the original explosion occurred within the mixer and in all probability, adjacent to the flanged portion of the shaft and then communicated to the casting can alongside the mixer. The casting can contained approximately 200 pounds of propellant.

Four of the operators were within the mixing cubicle, or its doorway, and the fifth operator was in the control cubicle adjacent to the mix cubicle.

The roof of the building in which the explosion occurred was transite, as well as a building located approximately 300' distant. These transite roofs were a complete loss and were practically removed from both buildings. Likewise, the closure to the open ends of the cubicles in both buildings were transite and had wooden doors. The transite was blown apart, and in many instances, the doors were split and pulled from their hinges. The only major structural damage was to the cubicles on the right side of the building in which the explosion occurred. Two sides of the mixing cubicle walls were completely blown apart and other walls were blown down or left standing at an angle. There was no major structural damage to the left corridor wall or any of the cubicles on the left side of this building.

The Navy is suspending the process development stage of the slurry casting process for a close reexamination. It is anticipated that this reexamination will involve a restudy in the laboratory (particularly as concerning high-energy propellants) for better characterization of the safety aspects of the various processing steps.

Reference Number of this Incident: 991

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
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ASESB Explosive Incident Report No. 2

Laboratory Explosion of Difluoramine

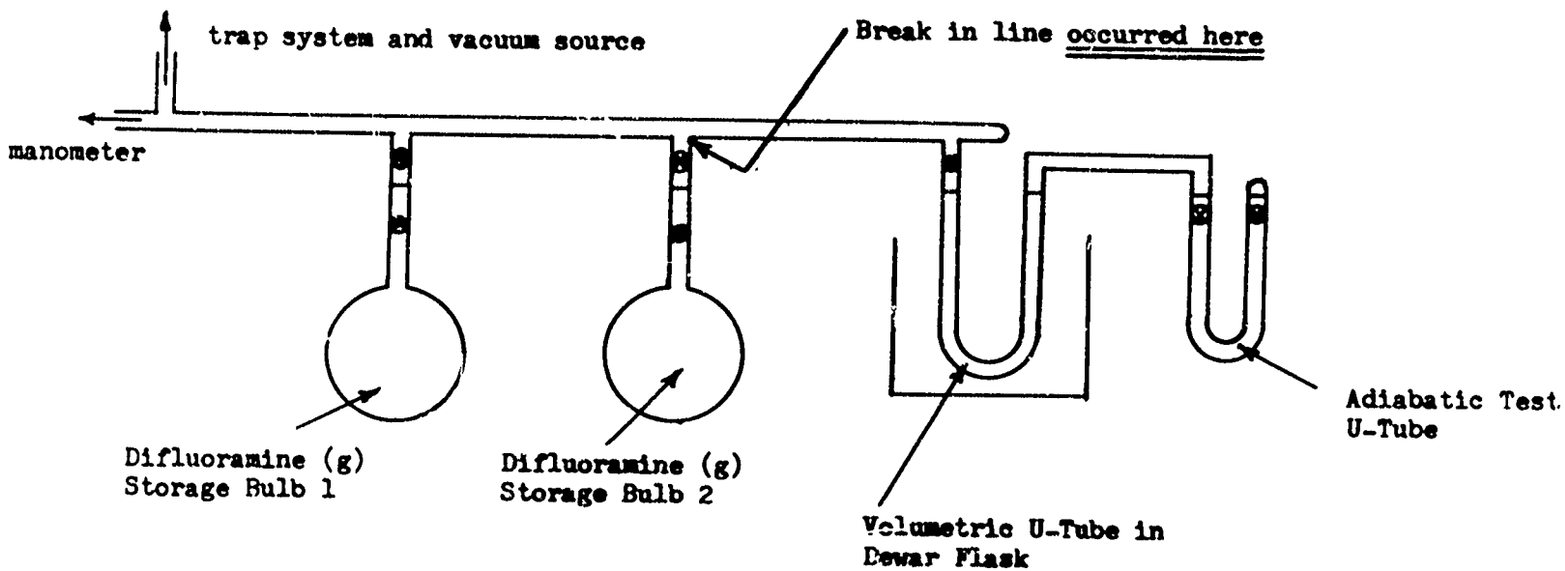
On August 8, 1961, at approximately 3:15 PM, a small explosion occurred in a test bay. The accident occurred during an adiabatic compression sensitivity test on difluoramine. A schematic diagram of the test apparatus is shown in Enclosure (1). The first step in the operation requires that difluoramine gas be condensed under reduced pressure in the volumetric U-tube which is maintained at -80°C, utilizing a methylene chloride-dry ice bath. At the time of the accident, the difluoramine gas which was in Bulb 1 had been transferred to the volumetric U-tube (1.5 ml liquid) and the bulb was closed off from the system. The chemist, while standing behind a portable safety shield but reaching around its side, was turning the stopcock with a 4' reach-rod to open Bulb 2 to the system. The glass line broke at the manifold (the point indicated in Enclosure (1)) while the stopcock was being turned. The bulb fell to the concrete deck and exploded on impact. Immediately the volumetric U-tube exploded. This may have been caused by the shock of the first explosion or by air rushing into the broken vacuum line.

The incident did not result in damage to the building. It did, however, completely destroy the expendable glass portion of the laboratory test apparatus. The chemist conducting the experiment received minor cuts on the arms and face and a chemical burn on one arm. The facial cuts were apparently caused by glass traveling upward from the floor and were suffered even though the chemist was wearing safety glasses and a full face shield.

Reference Number of this Incident: L-1

Duplication of this report is authorized.

Enclosure (1)



LOADING APPARATUS FOR ADIABATIC
COMPRESSION TEST OF DIFLUORAMINE

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ASESB Explosive Incident Report No. 3

Explosion in Nitrobenzene Recovery Kettle

Description: Nitrobenzene was being recovered in a cast iron jacketed distillation kettle by heating with steam at 90 pounds pressure and operating under vacuum. After distillation was complete, kettle contents were inspected for viscosity of the tarry residue. A small amount of the nitrobenzene was added to make the mass more liquid prior to blowing contents with inert gas through a bottom outlet valve into drums. Due to other more urgent work, the operator interrupted the above sequence after the kettle had been sealed just prior to the blowing operation. The kettle was held at 150°C for about 1½ hours. Just before the operator was planning to blow the residue out of the kettle, hissing noises of escaping gases were heard. Personnel took cover as best they could and reported that they saw vapors issuing from the main gasket of the kettle. About 4-5 seconds later, the kettle ruptured violently and was torn from the steel I-beam floor supports, dropping to the floor below. The cover was ruptured into many parts; some pieces were found 40' from the scene. All windows except those directly behind the kettle opened automatically at the spring-loaded latches, thus relieving a great deal of the pressure and greatly minimizing glass breakage. There were no injuries, and damage to adjacent equipment was of a minor nature.

Cause: Detailed investigation by manufacturing and research laboratory personnel revealed the following:

1. Shortly after the accident, a similar condition was in the making in an adjacent nitrobenzene recovery kettle. This could be kept from getting out of complete control.

2. Residues from the kettle which exploded showed an acid analysis of 5-30% determined as sulfate.

3. The receiver which contained the distilled nitrobenzene contained large amounts of sulfur dioxide.

4. The contents of the second-mentioned kettle showed large amounts of acid present.

It has always been the practice to wash with 5% sulfuric acid all nitrobenzene known to be contaminated with amines before carrying out the vacuum distillation. Later it was determined that when the nitrobenzene is charged into the washing kettle first, followed by sulfuric acid and then water, that an emulsion layer frequently results and that

sulfric acid settles to the bottom of the kettle in spite of vigorous agitation. IF THE WATER IS CHARGED FIRST, FOLLOWED BY THE SULFURIC ACID AND THEN THE NITROBENZENE, EMULSIONS ARE NOT FORMED AND THE ACID LAYER IS ON TOP OF THE NITROBENZENE. It is apparent that acid-containing nitrobenzene got into the cast iron distillation kettle. Under these conditions, hydrogen was generated. The explosion was caused by either hydrogen alone or unstable intermediate reduction products of nitrobensene or a combination of the two.

Preventive Measures: To prevent a recurrence in the future, the method of washing with dilute acid will be changed as indicated above and as an extra precaution, a dilute soda ash wash will be given prior to the vacuum distillation. Strict instructions have been given that no time should elapse from the time a distillation is complete until the tar is blown out. To avoid opening the kettle after the distillation is complete, an ammeter will be installed on the kettle to show the proper end point.

Reference Number of This Incident: L-2

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 4

Explosion in Vent Stack - Static Generation

Description: An employee was repairing a blower on an exhaust vent system for a 1200-gallon dissolver. After lubricating the fan shaft of the blower, he turned on the switch. As he returned to the vent stack, he observed that the blower was not operating. When he leaned over the open vent stack and reached down into the stack to give the fan a turn, a flash fire and explosion occurred. The employee received moderate to severe burns to the head, face and hand.

Cause: The employee was wearing street clothing underneath coveralls of synthetic fibers which probably built up a static electrical charge. The electricity probably discharged when the employee reached into the vent stack. The vent stack contained an explosive mixture of methyl alcohol and benzene.

Preventive Measures:

1. Use of an inert gas blanket on the dissolver when maintenance work is being performed.

2. Study the process to eliminate the oxygen from the system.

3. Reinstruct all employees on the potential hazards of static electricity relative to types of clothing, static potential of workmen, etc.

4. Emphasize to all employees the hazards of reaching into electrically-energized equipment.

Reference Number of this Incident: L-3

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 5 (Fire)

Accidental Ignition of Flammable Liquid in Laboratory

Description: A chemist was working at a laboratory hood preparing a reduction reaction using lithium aluminum hydride. A companion chemist had just left the laboratory when he heard a cry for help. Returning, he found the laboratory in flames and the injured man trying to get out through the door which opened inwards. When the door was opened, the injured man was squeezed between it and the hood. In his fright, the injured man might have run but fortunately, someone had already pulled a safety shower under which he was led to extinguish the flames and wash the solvent and chemicals from his body. A first-aid fire blanket from the laboratory was used to wrap the burned man to try and keep him warm until the ambulance arrived. He received first degree burns on his face, and more severe burns on his hands and legs.

Cause: It is believed that the injured chemist was pouring ether (which had been dried over calcium hydride) into a flask containing lithium aluminum hydride. Something caused the ether to flash -- a static spark, moisture on the lithium aluminum hydride, or something else. He jumped back from the fire because his face was seared and may have been temporarily blinded. Perhaps there was some ether on his hands which also flashed causing him to drop the bottle containing the ether and calcium hydride. This ether also flashed causing burns to his legs. The laboratory contained nearly 100 gallons of flammable solvents in glass bottles and safety cans on shelves. It appeared to be cluttered and overcrowded and hoods were located behind doors. The laboratory door opens inward, forming a trap in an emergency.

Preventive Measures:

1. Despite the apparent inconvenience of drawing solvents and chemicals from a general stockroom, all unnecessary flammable solvents and chemicals should be removed from laboratories and drawn as needed. Supervision should enforce this rule.

2. Chemical laboratory doors should be arranged to swing outward.

3. While everything feasible should be done to avoid accidents in laboratories, also anticipate the unforeseen by advance emergency planning. Laboratories should be arranged for convenient working conditions and for easy exit in an emergency. Cabinets, files, etc. often clutter a

laboratory and should not be placed in a position where they obstruct passageways.

4. Emergency first-aid blankets should be provided in convenient locations in laboratory buildings.

Reference Number of This Incident: L-4

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 6 (Fire)

Ignition of Toluene Vapor by Electrostatic Spark

Description: An employee was transferring toluene by vacuum from a 55-gallon drum to a kettle through a ¼-inch plastic tube. The tubing at the drum end was fitted with a flannel filter (held in place by two turns of copper wire) in order to prevent contamination of the kettle with scale from the drum. When the desired amount of toluene had been transferred, the employee pulled the tube from the drum. At this time, vapors ignited and enveloped the area around the bung opening of the drum. The employee received moderate burns on the left wrist and hand.

Cause: A thorough investigation after the fire revealed the following:

1. The toluene drum was not grounded.

2. The copper wire holding the flannel in place had two antenna-like projections.

3. Both ends of the drum were bulged after the fire.

4. Plastic tubing is a nonconductor of static charges.

5. The toluene drum was ¼ full after transfer was made.

From the above facts, the following conclusions were made:

1. As the toluene passed through the plastic tube, a static charge was built up on the tube.

2. The static charge collected on the antenna-like projections of the copper wire.

3. The toluene vapors around the bung opening of the drum were within their explosive limits.

4. As the tube was pulled from the drum, there was a static discharge, with a spark, from the copper wire to the edge of the bung opening of the drum, causing ignition of the toluene vapors. This, in turn, was followed by a flash fire outside the drum and an explosion inside the drum.

5. Had the drum ruptured, the accident would have resulted in a much more serious fire and injury.

Preventive Measures: Transfer tubes will be made of stainless steel and grounded. Operators will be reinstructed to make sure the grounds on the kettle and drums are secure.

Reference Number of This Incident: L-5

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 7 (Fire)

Toluene - Static Fire

Description: Static sparks caused a solvent fire with an unusual sequence of events. While toluene was being transferred by a hand pump from a drum to an ungrounded pail, a static spark jumped from the nozzle to the pail, igniting the toluene. The nozzle was dropped and toluene syphoned from the drum to the floor of the main work area. This pump was the only one of 14 in the plant that did not have a syphon breaker. While employees attacked the fire with extinguishers, the fire door in the opening to an adjacent flammable liquid mixing room was closed, but due to the absence of a curb, burning liquid flowed under the door. After the fire in the main work area was put out with extinguishers, the door to the mixing room was momentarily opened. Flames burst out and re-ignited spilled toluene. Fire in the main work area was put out for the second and last time by 13 sprinklers and a carbon dioxide hand hose line. The fire in the mixing room was extinguished by a carbon dioxide flooding system and three sprinklers.

Reference Number of This Incident: L-6

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 8 (Fire)

Polyethylene Liner - Static Fire

Description: Static fire from a polyethylene liner at a production plant caused essentially no damage. The operation involved charging the chlorothiazide intermediate (DSA - Chlorodisulfanyl aniline) to tetrahydrofuran in an agitated still. The dry DSA is scooped with a stainless steel scoop from a polyethylene-lined fiber drum into the vessel through a 13"x15" manhole. A slight vacuum is maintained in the vessel to minimize escape of fumes and dust. One drum was scooped into the vessel and when the drum was nearly empty, the operator removed the liner from the drum and shook the remainder into the vessel. When the operator shook the second bag over the manhole, a sudden flash occurred and flame billowed out of the manhole. The operator's hair was singed but he and two others extinguished the flames quickly with extingushers before sprinklers operated. Relative humidity was found to be 50%.

Preventive Measures: This incident reaffirms need for strict adherence to the policy of not shaking plastic liners over manholes. Ventilation of vessel manholes should be provided outside the manhole. Vacuum should not be cracked into the vessel since it sweeps in sufficient air to give a flammable mixture. Wherever possible, eliminate use of polyethylene liners in flammable areas.

Reference Number of This Incident: L-7

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 9

Explosion - Ethylene-Air Mixture in Pipe

Description: Two pipefitters were engaged in running a 1" pipeline from the ethylene surge tank to the ethylene distribution header. This job was being done prior to a scheduled shutdown so that the ethylene system could be depressured and the ethylene recovered. The line from the ethylene header was started by connecting into two ½" connections on the ethylene header and laying 75' of 1" pipe along the south wall of the compressor house. After this temporary line was completed up to the surge tank, a closed valve was installed on the end of the new line. Later, it was decided by the pipefitters that a union should be installed ahead of the valve, and so they proceeded to remove the closed valve. As this valve was unscrewed from the pipe, and at the moment it cleared the last few threads, a small explosion occurred and the gas from the pipe ignited. Both the pipefitters were singed about the head. A fire extinguisher was used by an operator to put out the fire.

Cause: Probably ethylene pressure built up within the 1" line against the closed valve as a result of a leak through the ethylene header connections. It is believed that the mixture of air and ethylene in the line was ignited by a frictional spark resulting from the unscrewing of the valve from the pipe.

Preventive Measures:

1. All maintenance personnel would be informed not to remove a closed valve from a line once it has been tied in to a process source without first depressuring the line safely.

2. Production also consider all valve connections into process as potential leakers, and provide a bleed valve on the open end on a new line until that line can be finally tied in. Wherever possible, all tie-ins to valves that are connected to processes will be made last.

3. In other situations similar to this, production will have pipe connections checked for possible leaks prior to tieing in, and maintenance personnel will be informed if "operations" is unable to stop the leak.

Reference Number of This Incident: L-8

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 10

Explosion Involving Tollen's Reagent

Description: After following the course of a reaction by periodic testing of samples from the mixture of Tollen's reagent, a research chemist allowed the unemptied test tubes from the testing to sit over the weekend. Monday morning, upon picking up the test tubes to dispose of the contents, an explosion occurred, splattering the contents into the face and on the upper body of the chemist, and onto the laboratory ceiling. Fortunately, the chemist was wearing safety glasses. No serious injury resulted.

Cause: The docket of cases involving violent explosions incurred while working with ammoniacal silver ion solutions is a very long one. In using such solutions, it is difficult NOT to form fulminating silver. Although the exact structure of the latter is not yet known, it is thought to be either Ag_3N or Ag_2NH. Dry fulminating silver is extremely sensitive and is instantly and violently decomposed by the slightest disturbance. Even still moist fulminating silver can be detonated by allowing a drop of water to fall on it from a sufficient height.

Preventive Measures: Consequently, great care should be taken in the preparation and use of Tollen's or similar ammoniacal silver reagents. The procedure given in Vogel's "Elementary Practical Organic Chemistry", Volume II, page 406, is recommended. The reagent must not be heated. It should not be prepared in large amounts and stored; only a small volume should be made up just before use. Any residue (both before and after use) should be washed down the sink immediately with copious amounts of water and the container rinsed with dilute nitric acid. Above all, do not allow the reagent solution or any test mixture containing the reagent to evaporate to dryness.

Reference Number of This Incident: L-9

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 11

Propellant Explosion

Description: An employee was working with an experimental mixture for a propellant in a dry box (controlled argon atmosphere cabinet). While working in the dry box, he had completed mixing two chemicals in a polyethylene beaker and set the beaker to one side. He thought he noticed a discoloration taking place in the beaker. He tilted the beaker with his left hand, and an explosion occurred. The safety glass front of the box was blown out. The employee received a severely lacerated left hand with loss of the tip of the little finger. He also sustained moderate cuts about the face.

Cause: The exact cause for the explosion is not known.

1. The employee was working with experimental propellants which entails the use of many kinds of high-energy chemicals.

2. The employee mixed too much of the material in the dry box at one time.

3. The employee handled the beaker when discoloration had occurred.

4. Improperly designed equipment.

Preventive Measures:

1. More careful control of chemicals being worked with or stored in the dry boxes is to be re-emphasized with all employees.

2. Reinstruction to all employees on keeping experimental mixtures to a minimum size and the use of tongs and shielding whenever possible for manipulating materials and equipment.

3. The feasibility of remote tongs being used through a ball joint is being considered.

4. A dry box is being investigated which will relieve pressure through the back in case of an explosion.

Reference Number of This Incident: L-10

Duplication of this report is authorized

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ASESB Explosive Incident Report No. 12

Explosion in Oxygen-Nitrogen Manifold

Description: An explosion occurred in the oxygen-nitrogen manifold which feeds an experimental unit. The laboratory technician opening the oxygen valve received lacerations to his left hand when the explosion ruptured a stainless steel tee. The experimental unit was being started up by normal procedures during which a nitrogen purge was required to be followed by oxygen introduced through a manifold into a hydrocarbon stream. However, there was a delay involved and a nitrogen purge was used for some 3½ hours before the unit was ready for oxygen addition. As soon as the oxygen was introduced, the explosion occurred.

Cause: Sometime during the 3½ hour period in which the nitrogen purge was used, the hydrocarbon process pressure must have exceeded the nitrogen cylinder pressure, allowing hydrocarbon to flow back through the manifold and into the nitrogen bottle. This is substantiated by a subsequent analysis of the contents of the nitrogen cylinder which showed a 2 mole % of hydrocarbon in the nitrogen. When oxygen was then introduced, it is assumed that this line was still contaminated with hydrocarbon which exploded.

Preventive Measures:

1. The complete system, including the nitrogen-oxygen manifold, will be enclosed within a steel barricade, and all block valves will be replaced by remote operators.

2. Extensive revision will be made to the instrumentation and control system so that flow reversals or other upsets will automatically shut down the system.

Reference Number of This Incident: L-11

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 13

Explosion During Handling Sensitive Explosive Material

Description: A research chemist was uncertain as to the present purity of a substance prepared 8 months earlier and attempted to recover what material he could from the sample. He placed the sample in a solvent and started to filter the solution using a sintered glass filter and a vacuum filter flask. As the filtration was in progress, the material exploded. The employee received puncture wounds and lacerations of hands and puncture wounds to his cheek and chest from the flying glass.

Cause: The chemical which exploded is relatively safe to handle when damp, but is shock sensitive when dry. It is believed that a portion of the material became completely dry on the filter and detonated when the employee touched it.

Preventive Measures: Future operations of this nature will be performed in a laboratory hood with additional personnel protective equipment provided the employee.

Reference Number of This Incident: L-12

Duplication of this report is authorized.

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ASESB Explosive Incident Report No. 14

Laboratory Explosion

Description: An employee had removed an explosive mix from a drying oven for testing. He was in the act of removing the mix from the crystal by holding the crystal in his left hand and scraping the mix with a spatula held in his right hand. The mix (approximately 2.5 grams) detonated. He received severe damage to his left hand including amputations to index and middle fingers, laceration and tendon damage to ring finger and fracture contusions and lacerations to little finger, with minor lacerations and burns to thumb. On his right hand, he received a laceration to the web of the thumb and powder burns to his hand. He also received powder burns and minor lacerations to his face.

Preventive Measures:

1. In the future, wet mix will be added to the ignition chamber of the calorimeter unit and then it will be dried prior to testing.

2. Employees will be instructed to refrain from holding sample mixes on watch crystals with bare hands. Forceps or tongs will be used.

3. Similar operations of this type will be conducted behind a suitable barricade.

Reference Number of This Incident: L-13

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
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ASESB Explosive Incident Report No. 15

Fatal Accident Involving Fluoride Mixture in Steel Cylinder

Description: Several hundred grams of crude reaction mixture involving nitrogen trifluoride and tetrafluorohydrazine had been collected three days prior to the incident in a small stainless steel cylinder. During the opening of valves to measure the cylinder's pressure by means of an attached pressure gauge, the cylinder ruptured with considerable force and was torn into three pieces. The exact cause has not yet been completely established. A fireball of exploding gas filled a one-story room, blowing out windows and loosening some cinder blocks in the walls. A technical trainee who was opening the valves received the full force of the blast and died from multiple internal injuries. An engineer who was in the same room was knocked down and sustained a fractured leg and perforated eardrum.

Cause: Not yet completely determined.

Preventive Measures: The operation will be barricaded and operated by remote control.

Reference Number of This Incident: L-14

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 16

Laboratory Explosion

Description: A laboratory employee was working with an organo lithium compound in a dry box. He was holding a small glass flask, containing about 0.1 gram of material, by the neck in his left hand. As he approached the flask with a spatula in his right hand, there was an explosion. The employee received moderate to severe lacerations in the palm of his left hand as well as the little and ring finger.

Cause: It is believed that the explosion was due to a static discharge between the spatula and the glass flask or the small amount of material in the flask.

Preventive Measures:

1. This incident resulted in short, shielded tongs being made up for use inside of a dry box. Also a shielded spatula has been made up for use in this type of work.

2. The need to limit the quantities of unknown potentially hazardous materials in dry box work has been reviewed with all concerned.

3. Additional flexible transparent plastic (Ethyl Cellulose) shielding is being considered for use inside of the dry box, including a piece on the inside of the dry box cover glass in the area through which the operator looks to do his work.

4. All employees have been encouraged to use polyethylene equipment to reduce potential tissue damage when parts of the body are exposed to an explosion.

Reference Number of This Incident: L-15

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 17

Laboratory Explosion

Description: On December 6, 1960, an explosion occurred while Difluoramine was being condensed down with liquid nitrogen. The safety shield contained most of the glass fragments, although personnel received a few superficial cuts.

Cause: The explosion was probably due to the sensitivity of solid HNF_2 although there was some evidence for the presence of non-condensible gases.

Reference Number of This Incident: L-16

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 18

Propellant Explosion

Description: On December 30, 1960 at 11:15, an explosion occurred in B-Range Laboratory, due to the cook-off of 6 grams of plastisol propellant which was being heated to obtain gas samples of the decomposition products. The sample was contained in a small test tube in an oven in the hood, and extent of damage was confined to the breakage of that test tube and the associated manometer used for measuring the pressure. Safety glasses were being worn at the time of the explosion; however, it is pointed out that the pressure burst was well contained by the hood which had the safety glass front down and hence, there was no flying glass.

Preventive Measures: As a result of the explosion, the following operating procedures will be changed in this laboratory:

1. Times to deflagration will be determined on all samples before they are decomposed in the laboratory to obtain decomposition product.

2. The front of the hood will be double-checked at all times before the start of a run to make sure that it is down.

3. Gloves and armlets will be worn when manipulations are required by the operator in the hood.

4. Soft-side goggles will replace the safety glasses being worn by the operator at the time of the explosion.

Reference Number of This Incident: L-17

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 19 (Fire)

Grass Fire Behind Chemistry Laboratories

Description: On January 30, 1961, shortly before noon, a grass fire was observed around the boron hydride disposal pit in the rear of Gorgas Laboratory. The fire inside the fence was put out by use of fire extinguishers and the broom. The Fire Department arrived about 10 minutes after the fire was observed, and put out the fire which had spread beyond the fence.

Cause: During the morning, two samples of boron hydride waste had been put in the pit. Presumably one of these underwent spontaneous combustion and dry vegetation around the pit was ignited.

Preventive Measures: Prevention of such fires can be accomplished by eliminating vegetation around the pit. This may possibly be done by use of salt, vegetation killer, or some sort of paving around the pit.

Reference Number of This Incident: L-18

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 20

Spontaneous Ignition of Motor

Description: On January 30, 1961, about 9:40 AM, a 2C1.5-2 motor ignited spontaneously while it was being prepared for loading. The round was one of two submitted for evaluation by Chemistry which contained encapsulated hydride pellets cast in a plastisol propellant. The rounds had been received on January 26th and had been stored in a dessicator during the interim period. The actual operation being performed was simply cleaning the ends and threads of the motor body with acetone to assure safety in applying the head and nozzle fixtures. This cleaning was being done after discussion as to the procedure to use. The ends of the first motor were cleaned successfully. The second motor ignited spontaneously when the top end (casting wise) was being cleaned. The motor was clamped in the trimming table and was held securely while burning. The operator observed the point source ignition and backed away quickly, preventing injury to himself. The only damage done was the burning of a hole in the bottom of the scrap bucket below the trimming table, although this bucket contained no scrap at the time. The showers in the bay would not turn on when the cord in the hall was pulled, indicating that these need checking more often. Otherwise, safety precautions in effect worked as planned.

Cause: The cause of ignition is presumed to be due to the presence of water in the acetone, and that the acetone came in contact with a hydride pellet which was not completely encapsulated, causing it to ignite spontaneously.

Preventive Measures: This operation will not be carried out again on motors containing this material.

Reference Number of This Incident: L-19

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 21

Incident in Chemical Processing

Description: On February 1, 1961, a thin wall oxygen bomb (400 psi rating) was filled with isobutylene by chilling the bomb in a dry ice-acetone bath and permitting isobutylene vapor to condense in it. The bomb, with valve closed, was then allowed to warm to room temperature. At some unknown temperature the bomb ruptured and was propelled across the room, striking and bruising the elbow of a nearby operator. The vapor pressure of isobutylene at 25°C is about 30 psig (b.p., -7°C), so that the system was of adequate strength as long as the bomb was not filled completely with liquid. Hydrostatic rupture from improper filling could, and did, produce only a mild propulsive force. It is considered, however, that a serious hazard lay in the rapid release of flammable vapor in an occupied area as the isobutylene boiled on escaping into the air. We were fortunate that a static spark or one from the bomb striking the concrete floor did not ignite the vapor.

Preventive Measures: A mechanical means, if possible, will be devised to prevent overfilling of this bomb; failing this, other safeguards to the same end will be included in the operating procedure.

Reference Number of This Incident: L-20

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 22

Ignition of Gas Mixture

Description: On February 8, 1961, at approximately 3:00 PM, spontaneous ignition of the hydrogen-oxygen mixture in the 10,000 psi pressure tested-gas-mixing cylinder of the C-Range detonation tube occurred. The gas mixture was originally comprised of 300 psi H_2, 200 psi A and 200 psi O_2 and at a total pressure of 700 psig. At the time of the ignition, the cylinder pressure was approximately 400 psig. No personnel injury occurred and damage to the gas mixing system was less than $50.00.

This ignition differed from those reported earlier in that no burn-through occurred (heavier walled tubing was installed in manifold system after the last spontaneous ignition) and the ignition occurred when the operator began closing the cylinder valve. This valve had been degreased and all inner surfaces coated with Kel-F grease. Later examination of the valve and similar valves showed that component parts are well grounded with exception of brass packing gland. As this gland is behind the seal and does not see the explosive gas mixture, spark ignition from a static charge resulting from gas flow would seem unlikely. One of the previous ignitions occurred only after the operator began to fully open the valve and before any gas flow took place (manifold lines were pre-pressurized with A). Catalytic action by a freshly exposed metal surface is the only likely explanation that can be offered at this time.

Reference Number of This Incident: L-21

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 23

Laboratory Fire and Explosion

Description: An accident involving a fire and an explosion occurred at approximately 2:00 PM on March 28, 1961 in the hood on the right hand side of the laboratory. The hood was used for storing toxic materials as well as for chemical operations. At the time of the accident, it contained 200 g. of BAND, 5 g. of decaborane, 300 ml. of dimethylsulfide, 100 g. of boron trichloride (b.p. 12°C) in a metal low pressure bottle, 30 g. of tetramethylammonium nonaborohydride (12) and 1 g. of vinylmethyltetrazole triborane (7). All of the materials except the last two were known to be stable in storage. Furthermore, no difficulty had been experienced in storing tetramethylammonium nonaborohydride (12) during the last 6 months. Very little information was available concerning the stability of the last material except that it was known to be very shock sensitive. A fire started, apparently due to the spontaneous decomposition of one of the last two compounds listed above. This, in turn, most likely ignited some of the other material in the hood. (The dimethylsulfide was recovered unharmed.) The heat from the fire caused the borontrichloride container to rupture. The shock wave thus created shattered the hood window, bent one of the metal sides of the hood and threw debris into a glass vacuum line. No chemical operations were being performed in the hood or the vacuum line at the time of the accident.

Reference Number of This Incident: L-22

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 24

Laboratory Explosion

Description: On August 2, 1961, during the isolation of 2,6-di-t-butyl-4-nitro-phenol according to an apparently well defined literature procedure, an explosion occurred resulting in broken glassware but fortunately no injuries to personnel. The procedure followed is outlined below. 2,6-di-t-butylphenol in cold acetic acid was treated with a nitric-acetic acid solution. The reaction mixture was made alkaline, filtered, acidified, and extracted with chloroform. The chloroform extract (ca. 500 ml. containing no more than two grams of material) was placed on a Rinco evaporator and warmed with a steam bath. After about 2-3 minutes, the explosion occurred with enough violence to completely destroy the flask and a few pieces of surrounding glassware and scatter the rings from the steam bath around the hood. The operator was observing the process when the explosion took place but BECAUSE OF THE HOOD DOOR AND SAFETY GLASSES, HE SUSTAINED NO INJURIES.

Cause: It is reasonable to assume that the violent decomposition was initiated by the heat from the steam bath, however, it is not known at this time whether the desired nitrophenol or a possible poly-nitro derivative was the actual explosive.

One point which should be emphasized regarding this incident is that other materials than NF compounds are sources of potential explosion. Preoccupation with the hazards of NF materials tends to overshadow the danger presented by other types of explosives, known as such or not. Therefore, compounds containing any high energy functional group or reactions which might inadvertently produce one should be treated with due respect.

Reference Number of This Incident: L-23

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 25

Laboratory Fire

Description: Ethyl ether solvent containing dissolved difluorourea (extracted crude fluorination product) was being poured from a 500-ml. flask into a separatory funnel mounted on a rack when the poured liquid ignited. The operator set down the flask on the bench top and retreated. The burning solvent spread over a small area of the bench top, engulfing a wooden test-tube rack, a piece of rubber hose and the electric cord attached to an electric motor, currently inactive. Two minor explosions, spats, which may be attributed to samples contained in NMR tubes resting in the test-tube rack, were heard during the fire. No injuries were sustained by any personnel. Damages consisted in loss of the flask, test-tube rack, rubber hose and electric cord, probably not exceeding $10.00 in total value.

Cause: The fire may have been initiated by chemical reaction involving products of decomposition of difluorurea and air, or by static discharge produced by pouring the ether.

The fire was extinguished by use of an extinguisher which had to be procured from another laboratory. BOTH FIRE EXTINGUISHERS WITH WHICH THIS LABORATORY (AND ALL OTHER LABORATORIES) IS EQUIPPED ARE MOUNTED INSIDE THE LABORATORY AND WERE INACCESSIBLE WITHOUT EXPOSURE HAZARD ONCE PERSONNEL HAD LEFT THE VICINITY.

Reference Number of This Incident: L-24

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 26

Explosion Igniter Composition During Mixing

Description: Explosion occurred in mechanical mix wing of pyrotechnic area on February 21, 1961, during mixing boron-potassium nitrate igniter composition of the following formula: 3257 grams boron, 9362 grams potassium nitrate, 989 grams laminac and 500 grams trichloroethylene. The igniter composition was being mixed in Simpson Intensive Mixer by remote control, utilizing mix-muller principle. The boron, laminac and trichloroethylene had been mixed through a mixing cycle of 10 minutes. The operator poured the potassium nitrate on top of the pre-mix, retired to the operator's station, and started the mixer for a 20-minute mixing cycle. After the mixer had been in operation for approximately 5 minutes, an explosion occurred. A supervisor received second degree burns on the left hand. Three light fixtures and interconnecting electric conduit, air control system of room and mechanical linkage of room door damaged. Ceiling and blow-off roof extensively damaged. All paint burned off room. Possible minor damage to mixer. Glass cracked on observation port. The present design and layout of the mechanical mix wing room is inadequate for mixing large batches of hot compositions. The flame from the explosion flashed around the edge of the door of the mixing room, which caused the injury involved in the incident. The flame flashed through a 12-inch reinforced concrete wall, around an electrical conduit, into an adjacent room, leaving burned residue on the ceiling and on glass blocks near floor level and next to the door of the room. The air-operated door of the room came open some time after the incident and prior to arrival of fire protection division personnel, and when the door opened, the interlock switch shut off the mixer. The flame flashed through a conduit port in the wall, bouncing off the back wall of the mechanical mix wing. The supervisor of the operation stated that he had checked operation of the mixer, via the vision port, just prior to the explosion and everything was normal.

Cause: Exact cause undetermined. Possible causes:

1. The mullers and scrapers of the mixer may have got out of adjustment allowing them to ride on the bottom of the mixer, which could cause friction, initiating the composition.

2. The laminac binder may have built up on the muller, and could rub the bottom of the mixer, causing enough friction to initiate the composition.

3. Composition may have built up at the edge of the dumping door, which could have been pinched by the scraper passing over it.

4. Composition may have been pinched between moving parts of the mix-muller assembly.

Preventive Measures:

1. The batch size for mixing in the mechanical mix wing should be limited to a maximum of 15 pounds.

2. The inner doors of the rooms should be modified to prevent flash arounds.

3. Light wood or transite blow-out doors should be installed on all rooms of the mechanical mix wing.

4. Door controls inside the mechanical mix rooms should be enclosed in boxes to prevent the possibility of pressure from explosions opening the room doors.

5. Mullers and scrapers of mixers should be gauged at the start of each shift to assure that adequate clearance is maintained.

6. The mixer should be modified to facilitate remote control dumping.

Reference Number of This Incident: 992

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 27

Explosion at Burn Oven During Disposal

Description: On April 12, 1961, an explosion occurred during disposal by burning of various explosive items. A considerable variety of explosive items were scheduled for disposal, either by open pit burning, or by means of a burn oven. A small quantity had been accumulated, with the balance to be delivered to the disposal grounds. The operation began at approximately 7:30 AM when a member of the EOD team drove to the site, stoked the burn oven and ignited the fire. He brought with him a small but varied lot of explosives which had been picked up from the various ranges and stored in magazines. The items were placed in a receptacle not far from the oven. Some days prior, the oven had been thoroughly cleaned out and a small quantity of unexploded items found in the ashes were removed and placed in this same receptacle. After satisfying himself that the fire was burning properly, the employee cleared the area and returned to his station. At approximately 8:45 AM this same individual returned, with a second EOD man, to the disposal grounds. At the locked entrance barricade they met an employee who had just arrived with a truckload of explosive items. The three employees proceeded to the burn site, parking the vehicles about 125' from the oven. The two EOD men disposed of all items contained in the receptacle, and then transferred operations to the explosives items on the truck. The material was handed down, examined, and those requiring open pit burning were removed and set aside. The items to be burned were placed in an aluminum wheelbarrow, wheeled to the oven, and as one man manipulated the controls of the gates in the oven feed chute, the other deposited the items into the mouth of the chute. This routine continued and appeared to be progressing normally when a violent explosion occurred, completely destroying the oven and blowing all three men off their feet. (The third man remained with the truck.) Two of the men were injured, one receiving severe contusion and abrasions on his back and the other, wounds and a lacerated scalp.

Cause: Probable causes:

1. The M8 burster tubes (containing one ounce tetryl explosive charge each) were placed in the oven "two at a time" and there is a strong probability that more than two were placed in the chute at one time. Since no M8 bursters were returned to the magazines, it is assumed the total quantity of 51 was placed in the oven prior to the explosion. It is also considered possible that a quantity of unburned burster tubes accumulated within the oven resulted in the detonation.

2. The materials being destroyed are part of a long range program to dispose of items which have accumulated in the magazines. Many items have been stored for 15 years.

Reference Number of This Incident: 998

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 28

Function of M91A5 Base Fuze During Drop Testing

Description: The incident occurred on May 1, 1961 during routine surveillance drop test on M91A5 base fuzes. The firing was performed by pulling a lanyard and dropping a weight on the fuze. When the employee picked up a fuze, the tray containing other fuzes tilted and fell 16", landing on a steel plate, and one of the fuzes fired. The employee received superficial laceration of right hand, arm and leg with hair line fracture of upper right tibia (right leg). No property damage.

Cause: Failure to follow established procedure. The procedure called for assembling the fuze just prior to the drop test firing. The M91A5 fuzes have a fuze head and fuze body, the explosive being in the body. As long as the two are separate, they are comparatively safe. A number of assembled fuzes were found laying about the room.

Preventive Measures:

1. To further eliminate the possibility of human error, the procedure is being revised to require the fuze head and body to be assembled in the drop test firing device just prior to the drop test.

2. Ensure that supervisory personnel exercise their responsibilities for the safe conduct of assigned tasks.

3. Re-instruct all employees on safe job performance, stressing individual responsibility for alertness to accident hazards and also stressing NEVER SACRIFICE SAFETY FOR TIME.

Reference Number of This Incident: 995

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 29

Rocket Motor Explosion

Description: Explosion occurred on September 6, 1961, involving a Wing 1 conventional solid propellant rocket motor, 12,000 pounds, scale model. During a cutback operation and pre-operation of the cutting device, sparks were noted which subsequently ignited the motor grain.

Cause: Undetermined. Probable causes:

1. Explosives dust in cutting tool.

2. The striking of metal against the jack device.

3. Foreign material in the powder.

Investigation of the incident in progress. This specific operation will be resumed in approximately 10 days.

Reference Number of This Incident: 999

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 30

Explosion of Propellant Components During Storage

Description: On September 15, 1961, explosion occurred during storage of 26 pounds of various R&D propellant components (20 items ranging from a few grams to 2 or 3 pounds). Items were stored in magazette (a small box constructed of 5 inches reinforced concrete, with dimensions 44" x 49" x 60"). Two adjacent magazettes were blown over, but undamaged. Minor property damage. No injuries.

Cause: Unknown, but dry HNF suspect. HNF normally kept wet with carbon tetrachloride. Investigation in progress.

Reference Number of this Incident: T-162

Duplication of this report is authorized.

(SEE ATTACHED SHEET FOR ADDITIONAL INFORMATION)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Additional Information on ASESB Explosive Incident Report No. 30

The magazette involved was located approximately 100 feet from a propellant and explosives laboratory building, and was used for temporary storage of small quantities of material used in the building laboratories. Contents of this magazette were: 3-5 pounds petrin, 100 grams TEGN, trace of TMETN, two 1-pound bottles desensitized TMPTN, five 1-pound bottles desensitized DPHN, 100 grams polyglycidyl nitrate, 50 grams TN-TACOT (did not explode), 5 pounds HMX(200μ) wet, 5 pounds coated NH_4ClO_4, 25 grams HMX, 2 pounds hydrazine nitrate, 100 grams TAG azide, 50 grams TAG perchlorate, 50 grams TAG nitrate, 3-5 grams TAG nitroform and 3 classified materials totalling less than 1 pound.

The explosion occurred after normal working hours and the area was clear.

One side of the magazette was a metal (aluminum) door and there was one metal shelf about half-way up. The magazette sat upon a solid unreinforced concrete pedestal, but was not attached to it. All features except the metal shelf were typical of the two adjacent magazet also.

The sides and top of the magazette involved were completely demolished, the concrete broken into fragments varying in size from around 8 inches in diameter to pea-gravel, and thrown as far as 1000 feet. Reinforcing rod found was completely clean, no concrete adhering to it. The floor of the magazette was shattered and cratered. Large chunks were broken from the edges of the concrete pedestal and it was deeply cracked. The door was shattered and pieces of it thrown forward up to 900 feet. The door frame was broken into its four constituent pieces of angle. The transite roof of the walkway immediately behind the magazette was shattered up to the ridge to a limited distance on either side. The pipe columns supporting this roof were unscathed.

The other two magazettes were blown off their pedestals but their contents did not detonate or burn.

No further information at this time as to cause of detonation or what detonated first.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 31

Pre-Ignition of Illuminating Powder

Description: On September 8, 1961, during demilitarization of Mk 27 Mod 0 flare involving the removal of illuminating powder, a pre-ignition occurred causing first and second degree burns on face and hands to three personnel. Pressures generated from the initiation disrupted corrugated roof covering the missile operating bay.

Cause: Unknown at present. Investigation in progress.

Reference Number of This Incident: T-158

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 32

Diborane Surge Tank Explosion

Description: At 12:30 PM on March 15, 1961, a diborane surge tank disintegrated with severe resultant loss. The tank in question had a capacity of 2000 cubic feet, 8 feet inside diameter x 30 feet long, and was constructed of 1-inch thick steel. It had a settling or sump tank of about 2 feet diameter of 3/4-inch thick steel. The tank served as storage for diborane and was operated between 175 and 225 psig. It was designed for a working pressure of 296 psi with a design safety factor of 4. At the time of the explosion, the pressure in the tank was 192 psig with a temperature of 12°C. From the pressure, temperature, and purity calculations, 1,775 pounds of diborane were present in the tank at the time of failure. The tank was located about 75 feet from the nearest piece of adjacent equipment and was barricaded on three sides by a 24-inch thick reinforced concrete wall. The tank, prior to installation, had been completely radiographed and stress-relieved. The tank failure which took place fragmented the tank and made rubble out of the three barricading walls around it. Pieces of the tank traveled more than 2200 feet. Other equipment in the area of the tank was not damaged but one piece of steel cut four process lines in a unit located 1800 feet away. The fire which resulted from the severing of these lines was minor and completely extinguished in less than 10 minutes after occurrence.

Cause: Since there was some concern that a detonation may have occurred in the tank due to some trace impurities, and in order to fully evaluate what occurred, expert consultants from outside the company were obtained. An explosion consultant examined the locale of the explosion and the debris and debris pattern and then, based on the information available to him, drew the following conclusions in his report:

"The blast pattern and magnitude of the explosion of the diborane surge tank explosion of March 15 may be explained on the basis of one of the following two mechanisms:

1. Simple (probable defect) mechanical failure of the tank under its operating pressure.

2. A surge of pressure, which evidently could have been produced only by an explosion of relatively small amount of some unknown explosive condensate inside the surge tank localized at the point of initial failure of the tank."

toughness would have decreased the degree of fragmentation but it probably would not have prevented ultimate failure of the drum."

Based on the foregoing conclusions of these consultants plus a calculation which indicates that the same damage could have been done to the tank if only an inert gas had been in the tank, the conclusion reached is that the tank failure was precipitated by a complex stress system which had been set up by a defective welding procedure used in the installation of a platform support which had been attached directly to the tank by welding.

Comments Concerning the Explosion: On an unplanned basis, a spill test for diborane occurred. It is interesting to note that minor damage, if any, occurred as a result of the release of over 1700 pounds of diborane. Essentially, the material, as released, burned as an envelope without any evidence of detonation taking place. This is interesting since optimum mixtures of diborane in air have a flame speed of up to 2600 meters per second which is actually above detonation velocities. It is also significant that in spite of the large amount of material released and in spite of the toxicity of the material, the area was not contaminated and no personnel received over-exposures resulting in toxic symptoms and that the extent of the damage was definitely localized.

Preventive Measures:

1. There must be definite assurance backed up by Engineering inspection that vessels which are installed in critical service do not have their properties altered by additional field welding on them unless such welding or heating is done in accordance and to meet the conditions as originally prescribed and designed into the vessel.

2. A second and more important consideration involved here is to design a plant such that the inventory of hazardous material or the installation of large tanks under pressure be minimized as much as possible. In this particular case, it was possible to eliminate the intermediate storage or hold-up of diborane completely by minor modification in piping, instrumentation, and operating conditions of the system producing this material. The design safety engineer should examine inventories of all materials very critically to assure the safest and best design.

Reference Number of this Incident: L-25

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 33

Rotometer Guard Shattered

Description: While an operator was checking on the flow of material through a rotometer, it ruptured with sufficient force to break the lucite guard, spraying a dilute hydrofluoric acid solution over his face, chest, arms and legs. The operator's monogoggles prevented serious eye injury. The provided lucite guard shattered and proved inadequate under the 45-pound pressure. The glass rotometer which broke had a designed pressure of 185 pounds.

Cause: The exact cause of the rotometer's breaking has not been conclusively determined.

Preventive Measures: The glass tube rotometer has been replaced with a metal tube type rotometer and a check valve has been installed between the eductor and the rotometer.

Reference Number of This Incident: L-26

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 34

Nitroglycerin Stability Test

Description: A technologist was carrying out a stability test on nitroglycerin and on mixtures of nitroglycerin with various materials. Eight loosely-stoppered 6-inch test tubes were immersed in an oil bath at 82°C. The oil bath was contained in a stainless steel beaker heated by an electric mantle. After the test had been underway for some time, a small puff of smoke appeared in one of the tubes. A detonation occurred immediately involving all tubes, a total of 20 to 25 grams of nitroglycerin. The technologist sustained a fractured elbow and fractures and lacerations of several fingers.

Cause: Test equipment was not shielded.

Preventive Measures: The heating bath will be redesigned and adequate shielding will be provided before the test is run again.

Reference Number of This Incident: L-27

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 35

Explosion of Detonators

Description: On August 28, 1961, 33 detonators exploded en masse while operator was transferring detonators from tray at knockout station on loading machine to a cardboard packing carton. Each detonator contained - upper charge 40 mgs primer mix, 85 mgs lead azide intermediate charge, 32.5 mgs RDX lower charge. The detonator cup and closing disc were stainless steel. The operational shield at this station on the loading machine was constructed of ½ inch plexiglass. One operator received severe damage to both hands and a mechanic standing near this station received minor injury from fragments in both arms. The mechanic was given first aid and returned to work. There was no damage to equipment or building.

Cause: Investigation of the incident indicated that standing operating procedures were being followed. Direct cause of the incident has not been determined, but probabilities considered were:

1. Impact, caused by operator striking one detonator against another with contamination on the exterior.

2. Contamination in the packing tray caused by re-use of same packing materials. This has been discontinued.

3. Impact, as a result of striking the top of one detonator in the packing tray which had been loaded without a closing disc.

Preventive Measures:

1. Improve operational shields at the work station.

2. Install a rubber cup containing water to receive reject detonators. This eliminates handling reject detonators.

Reference Number of This Incident: 1000

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Additional Information on Operational Incident Report No. 35

The following preventive measure for the dangerous situation described in the first of the two incidents cited was offered by a valve manufacturer:

"As a modification of our valves we can supply the plug with a 1/8" drilled vent hole in the plug. This hole is drilled in the side of the plug through to the plug port. When the plug is in the closed position the liquid then entrapped in the plug port can drain or at least relieve the pressure of the liquid entrapped. This feature is most commonly utilized on liquid chlorine or other liquefied gas services. We have never had a request nor have we experienced problems such as described on HF service. In any case, this 'vented plug' could be utilized."

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington D. C. 20315

ASESB Explosive Incident Report No. 36

Explosion of Composite Rocket Propellant During Mixing Operation

Description: On July 13, 1961, explosion occurred involving 2882 pounds of polysulphide perchlorate solid rocket propellant during mixing in 200-gallon Baker-Perkins mixer equipped with sigma blades. Mixing was accomplished by the forward mixing method which requires the fuel to be introduced into the mixer first. The oxidizer container is then placed in position and the operators retire to the remote control building. The mixer is started and the oxidizer screw feed switch activated. Upon completion of each cycle, the mixer is stopped and the sides of the mixer bowl are scraped down to insure a homogeneous mix. The total time cycle for completion of this particular mix is 130 minutes. The mixer had operated satisfactorily through the oxidizer addition phase (40 minutes) and the mixer was stopped for removal of the oxidizer tote bin discharge chute and screen, and scraped down. After the first additive batch was introduced into the mixer, the operators retired to the remote control shelter and placed the mixer in operation. The mixer had been in operation for 64.2 minutes of the required 70-minute cycle (104.2 minutes total time), when the explosion occurred. The total amount of 2882 pounds of propellant in the mixer was consumed in the explosion. Static depth of propellant mix in mixer at time of explosion was approximately 30 inches and temperature of mix at time of explosion was approximately 134°F. Eleven operators working inside adjacent buildings suffered first-aid injuries from flying debris caused by the blast. All were released for return to duty (no lost time). Damage resulting from the explosion consisted of complete destruction of all equipment within the mixing bay, complete severance of concrete and earth dividing walls, destruction of the mixer building and structural damage to eleven adjacent buildings.

Cause: Exact cause unknown; probable causes:

1. Frictional heat build-up igniting the fuel-oxidizer mixture in the packing gland rings.

2. Friction as a result of metal-to-metal contact in the area where the mixer blade shaft passes through the sidewalls of the mixer (scoring of the mixer blade bearing surfaces was noted in these areas).

3. Pinching of propellant where metal separation was noted on the mixer blade shafts in the packing gland area. Metal separation or "grazing" was noted on the chrome-hardened surfaces of the front mixer blade shaft in the packing gland area.

Comments: Maintenance records indicated that repacking of all four packing glands was accomplished 15 days prior to the incident. The packing material utilized in the glands is jute, impregnated with liquid polymer. Clearances between mixer blade shafts and bowl ends were checked at the time the glands were repacked and found to be within acceptable tolerances. The mixer cover was constructed of $\frac{1}{4}$" x 2" x 3" angles welded to the sheet to provide rigidity. The weight of the mixer cover (75 pounds) and type of construction tended to confine the initial pressures and probably contributed to the severity of the explosion. Disassembly and inspection of mixer for worn parts and examination of blades was required annually or every 2000 operating hours, whichever occurred first. Records showed that mixer was put into operational status approximately 1 year and 2 months prior to the explosion. The required disassembly and inspection was not accomplished during this period.

Preventive Measures:

1. Blades and other moving parts of new mixers shall be carefully inspected (X-ray, magnaflux, etc.) for cracks, crevices and other imperfections before being placed in operation. Inspections will also be performed on a routine basis, not less frequent than once annually, and after each accident which results in damage to the mixer.

2. Mixer covers shall be designed to provide immediate venting in event of a fire in the mixer.

3. Standing operating procedures for maintenance of explosives operating equipment should be observed at all times.

4. Temperature recording devices should be provided for the packing gland and bearing areas of the mixer-blade shafts.

Reference Number of this Incident: 1003

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 37

Explosion of Ammunition During Demolition Operations

Description: On July 28, 1961, an explosion occurred at a demolition pit. The pit is prepared by arranging boxes of tetryl booster pellets to form an inclosure. The remainder of the pellets are emptied onto the ground within the inclosure. The mortar rounds (complete with fuze, primer, ignition cartridge and increments attached) are removed from wood boxes and fiber containers and stacked on top of the tetryl pellets inside the inclosure. Fuzes are then placed on top of the mortar rounds and the pit primed with five 500-pound GP bombs. The bombs are in turn primed with Composition B and Primacord. The pit is fired, utilizing an electric blasting cap. After charging the pit with approximately 471 rounds of 81mm mortar ammunition and other components, a discrepancy was noted in the count. Four personnel proceeded to the pit to take a recount. The mortar rounds were removed and recounted. Two of the employees left the pit and waited in a vehicle parked approximately 50 yards from the pit. While restacking the mortar rounds, one of the primers was accidentally initiated, which in turn ignited the exposed increments on the other rounds. The employees evacuated the area in the vehicle. After traveling approximately 200 yards, the explosives in the pit detonated. The demolition supervisor suffered burns and minute lacerations on face, chest, and neck from the burning ignition cartridge and increments.

Cause: Accidental ignition of mortar primer.

Preventive Measures:

1. Explosives or explosives-loaded items (tetryl pellets, fuzes and complete rounds) should not be destroyed concurrently.

2. Protection should be provided to prevent primers in components or complete rounds from being subjected to accidental impact or pressure.

3. Standing operating procedures should be developed, utilizing Typical Procedures as minimum guides, and approved prior to starting ammunition demilitarization operations.

4. All vehicles should be removed from the demolition area to a safe location prior to charging the pits or opening containers of explosives.

5. During disposal or destruction activities, the number of personnel exposed to hazardous conditions and/or operations should be kept to a minimum.

6. Supervisors, foremen, and operators employed at demolition areas should be thoroughly trained regarding the nature of the materials handled, the hazards involved, and the precautions necessary.

Reference Number of this Incident: 1009

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incidnet Report No. 38

Dope House Flash Fire

Description: On September 6, 1961, a flash occurred at the feeder hopper and weigh pan while mixing dopes. A Giant Gel 40% dope had been dumped to the feeder hopper and a small amount of ingredients, primarily sulfur, was still laying along a corner and one side of the sloping weigh pan. A flash occurred when the operator "punched" a lump through the grate to the feeder hopper and just when the screen unit was placed in operation. The flash carried up into the weigh pan along the ingredients still in the pan.

Cause: Investigation revealed that: the bars of the grate over the dope feeder are of mild steel. The tamp which is used to "punch" lumps through the grate is made entirely of aluminum. The blade is made of aluminum floor plate. Operators at Dope House, when questioned, stated the aluminum blade would spark when striking the steel grate at an angle. Sparking tests of the tamp blade against steel confirms that this aluminum floor plate will spark readily when it strikes steel with a glancing blow. The aluminum floor plate is believed to be of composition containing 0.25% copper, 0.60% silicon, 1.00% magnesium and 0.25% chromium. It is stated to be hardened and non-sparking and has a hardness of 95 Brimell. It is believed that a critical air-dust mixture existed in the dope feeder and that a dust flash was set off by a spark when the tamp struck the grate.

Preventive Measures: The tamp with the blade made of hard aluminum floor plate was removed from service and a tamp with a soft aluminum blade was placed back in service. (The punch with soft blade had recently been replaced by the harder aluminum to eliminate frequent replacements of the soft blade.) Recent data indicates that practically all combinations of metal couples can cause ignition of explosive atmospheres by impact. Alloys are particularly prone to cause ignitions. Sulphur is the most sensitive material in dope houses to accidental ignition. Only pure soft aluminum tips should be used on tamps in dope houses and all tools should be used with care. Steel tools are, of course, prohibited.

Reference Number of This Incident: 1011

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 39

Failure of Liquid Oxidizer Run System (Chlorine Tri Fluoride)

Description: On September 18, 1961, a series of explosions resulted when an oxidizer (ClF_3) run system failed in a barricaded enclosure. The incident occurred during a small scale rocket engine test. The barricade contained the spillage and subsequent explosive reactions. There were no personnel injuries and only minor physical damage to the oxidizer system. A "chugging" condition arose during a shift in oxidizer flow rate. The ensuing vibration pulled the oxidizer run line out of the "bee" nut located on the downstream side of the tank valve. The run tank is remotely located from the test stand by approximately 35 feet. Emergency shut down procedures were immediately initiated and oxidizer spillage stopped upon closure of the run tank valve. The oxidizer trapped in sections of the system was allowed to vaporize to atmosphere after the area and system were inspected and cleaned by responsible personnel. The contents of the tank were disposed of through a shunt to a scrubber. The system was at 980 psig at the time of the incident and approximately 70 pounds of oxidizer was involved in the spill. Standby fire and safety personnel were fully equipped with self-contained respiratory apparatus and propellant suits. The control block house is pressurized with filtered air from a separate source. The complete investigation reveals the importance of placing such a system in an enclosure to preclude secondary effects of such an occurrence and to arrest or confine flying objects.

Reference Number of this Incident: 1012

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVE SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 40

Fire During Pressing of Grain

Description: On September 12, 1961, a fire occurred in compaction area of building. At the time of the incident, a compacted grain consisting of 353 grams was being pressed out of dies assembled in a 400-ton compaction press. A small local detonation occurred and ignited the remaining portion of the grain. One employee received slight burns on head and face; however, injury was not serious enough to warrant hospitalization or release from work. Property damage consisted of 1 broken window, slight soiling of building walls, damage to 2.5-inch diameter die (repair cost $50), and spacer block of the tool was eroded by fire and will require replacement.

Cause: The cause of fire attributed to a loose retaining mandrel in the press-out tooling. This loose mandrel was misaligned with the die mandrel and consequently interfered with a portion of the compacted grain on press-out by the compaction press. The detonation occurred at the point of interference.

Preventive Measures: To ensure against possible recurrence of this type of incident, frequent alignment checks will be made during operation of the press. In addition, the attachment of the retaining mandrel has been removed.

As a point of interest, it should be noted that the 400-ton press has been operated for the past 10 years without an accident. During this period, approximately 1025 grains were successfully and safely compacted.

Reference Number of this Incident: 1013

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 41

Flash Fire at Dynamite Test Shooting Grounds

Description: On October 3, 1961, a flash fire occurred from a test shot. Two employees loaded a test shot to a post hole and stemmed it with packed earth. The detonation of the shot appeared to be incomplete from the fire point. Stemming and loose dirt were dug from the hole in order to examine the crater; but the hole was deep and, consequently, difficult to examine. One employee knelt beside the hole, reached down into the hole, and lit a cigarette lighter. A flash of flame poured from the hole, singeing eyebrows, hair, and reddening the face of the employee. The employee required first-aid application but did not lose time.

Cause: Failure to use good judgment and good sense, and failure to observe the rule of "no matches or lighters" on the test site.

Preventive Measures: The employees were reprimanded for failure to observe rules and their lack of good sound judgment. All employees at the facility were instructed on the match and lighter rule, and informed about the incident and the results possible from such action.

Reference Number of this Incident: 1014

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 42

Fire - Ammonium Nitrate in Oven

Description: On September 10, 1961, an oven fire occurred in small concrete oven building. Oil sensitized ammonium nitrate, being conditioned in an oven, ignited and caused minor fire damage to the oven.

Cause: Investigation revealed that a faulty thermostat was the most likely cause of the incident.

Preventive Measures: Existing rules call for double control on all laboratory type ovens. This oven did not have the limostat safety control. The oven was repaired and the limostat safety control installed. A thorough investigation of all existing ovens was carried on to see that limostat controls were properly installed and functioning.

Reference Number of this Incident: 1015

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Additional Information on ASESB Explosives Incident Report No. 43

Methyl Bromide Tank Explosion

This report contained two statements or implications which led to further inquiries. These were:

1. That recent work indicates that the explosive limits of methyl bromide in air are greater than those normally recognized.

2. That contact of all non-ferrous metals with methyl bromide should be avoided.

Regarding 1 above, the summary of a report prepared by the company which reported this accident includes the statement that a series of tests has been run to outline the range of explosive concentrations at pressures above one atmosphere. Lower explosive limits were determined at pressures from one to 20 atmospheres and upper explosive limits were determined to 8 atmospheres. Methods of ignition were found to be a critical variable. The explosive range at one atmosphere was found to be from 10% to 15.4% inclusive, a range which is much broader than the previously published limits of 13.5% to 14.5%.

Regarding 2 above, inquiry was answered as follows:

"The use of the broad terminology 'non-ferrous metals' was a misnomer because lead, copper and tin have shown no tendency to react with methyl bromide under storage conditions, and can be satisfactorily used in methyl bromide handling. Zinc, aluminum and magnesium are known to form pyrophoric grignard type reaction products. Any other metals readily capable of forming a grignard type of reaction should also be suspected."

Reference Number of this Incident: L-28

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 44

Unstable Nitroso Chloride Derivative

Description: The use of nitroso chloride as a reagent for the preparation of solid derivatives of olefins, has been known for a great many years and has been of especially great value in the characterization of certain members of the Terpene series. An accident occurred involving one of these nitroso chlorides which may serve as a warning to other workers in the field. The nitroso chloride of alphamethylstyrene was prepared by treating a mixture of the olefin and amyl nitrate with concentrated hydrochloric acid in the usual manner (Hicken-bottom, Reactions of Organic Compounds, pg. 28). The bluish white crystalline product was filtered off, washed with several portions of methyl alcohol and dried in air. The dry product was placed in an 8-ounce wide-mouthed screw-capped bottle. The following morning, while working in the laboratory, a hissing noise was heard coming from the direction of the bottle of nitroso chloride. Turning around, white smoke was observed escaping from the cap of the bottle. The employee immediately left the laboratory and closed the door. A few seconds later there was a loud report and the room became filled with white smoke. After the fume hood had cleared the room of smoke, it was reentered so that the damage might be surveyed. The bottle had remained upright and intact but the Bakelite cap had been broken into several fragments which were scattered about the room. The contents of the bottle which had been transformed to a black resinous material, had been thrown against the ceiling and over the desk. In addition to the black resinous material, there was some yellow granular substance which was probably only partially decomposed nitroso chloride.

Cause: From the nature of the report and the fact that the bottle was unbroken, it seemed unlikely that a detonation had occurred. Apparently, the nitroso chloride had been undergoing slow decomposition for some time and finally the heat evolved or decomposition products accumulated to the point that the reaction was accelerated and sufficient pressure was built up to force the cap from the bottle.

Preventive Measures: It is suggested that nitroso chloride be prepared only in small quantities and that they should be destroyed as soon as they have been used.

Reference Number of this Incident: L-29

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 45

Ignition of Xylene-Petroleum Naptha Vapors

Description: A crystalline intermediate is separated from a 50-50 mixture of xylene and petroleum naptha by dropping from an overhead crystallizer into a centrifuge via a stainless steel line. The centrifuge is a 32-inch suspended basket (overdriven) type. Exhaust ventilation is connected to the casing which effectively prevents escape of vapors to the surroundings. On this day, two of the seven centrifuge loads in the batch had been successfully processed. During the third drop, a flash fire occurred in the centrifuge basket. The flames forced the operator from the platform before he could close the valve on the drop line from the crystallizer. This permitted approximately 300 gallons of mixed solvents to flow into the burning basket. Sixty-seven sprinkler heads opened in this two-story building, effectively minimizing damage in the building. Flaming solvent was floated out of the building doors adjacent to the centrifuge and into a sewer pipe trench. Fire spread in the trench for approximately 300 yards and broke a 12-inch ceramic chemical waste pipe in the trench, adding fuel to the fire. Despite the intense flames, damage was minor and the fire in the building and in the trench was brought under control in a very short period. There were no injuries.

Cause: The operator stated that this batch was extremely grainy and that the cake had built up along the bottom of the centrifuge basket to a point where it was almost touching the nozzle on the petroleum naptha wash line. Since this particular mixture had given indications that high charges of static electricity do accumulate, it was felt that the cake had become charged and arced to the ground wash line, igniting solvent vapors.

Preventive Measures:

1. The process was changed to eliminate the use of petroleum naptha in the crystallizer and as a cake wash. Despite the fact that the equipment was bonded and grounded, it is difficult to prevent static accumulations in centrifuges and where this is a problem, the only safe solution is to change the process or use a different type of extractor.

2. Drop line valves to centrifuges, filter pots and similar pieces of equipment will be provided with either self-closing valves, heat-activated valves, or extension handles as the situation requires.

Reference Number of this Incident: 4-30

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 46

Static Charge Fire - Decaborane in Polyethylene Bag

Description: A fire occurred in a test area when a technician was working with decaborane. He had removed a scoop full of the material from a drum and had placed it in a polyethylene bag on a work table approximately 1½ feet away from the drum. He heard what he described as a "snap" or "crackling" noise as the material in the bag burst into flame. He evacuated the room immediately. Fire spread from the bag to the drum, then to another bag on the floor next to the drum. The fire was extinguished by an overhead automatic sprinkler system. Heat from the fire was intense enough to actuate three of the four sprinkler heads in the room. The technician was wearing prescribed protective equipment (conductive-sole shoes, flame-proof coveralls, canister-type respirator, and neoprene gloves). In addition, the drum of decaborane was an approved storage and transport container, and the floor was of concrete treated for conductivity. (The conductivity of the floor had passed satisfactory inspection only 3 days before the incident.) Nevertheless, the technician did receive burns on the hand from the heat of the fire and accumulation of decaborane dust on the glove before he could remove the glove. Due to the rapid actuation of the automatic sprinkler system, damage to the building and equipment was slight.

Cause: It is believed that a static charge built up on the scoop and discharged to the polyethylene bag, passed through the decaborane dust in the bag and ignited it.

Preventive Measures: It is recommended:

1. In operations with decaborane and similar hazardous materials, that the drum, scoop and bags be physically bonded by a metal band strap that terminates at a ground point common to the entire building.

2. That personnel wear face shields in addition to safety glasses.

3. That comprehensive SOP's be prepared to cover the entire operation.

Reference Number of this incident: L-31

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 47

Pentaborane Exposure

Description: Two men reacted with what appeared to be toxicosis from pentaborane after exposure during a disposal operation. The two employees were cleaning out a cylinder of pentaborane; they were men regularly assigned to disposal operations. A charcoal bed was not used in this instance; however, the men observed the disposal was progressing as expected, and they noted no unusual reaction. Total time of exposure to pentaborane was a 1½ minute maximum. Approximately an hour following the disposal operation, both men began to experience a "queasy" feeling. Other difficulties were experienced with psychomotor functions, in memory blocking, lack of coordination, feelings of detachment, and related quasi-psychotic reactions demonstrating the "classic" symptoms of borane toxicosis. The incident occurred on a Thursday; neither victim was rational until the following Sunday. However, recovery was complete, and there is no evidence of permanent physical or mental impairment.

Reference Number of this Incident: L-32

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 48

Explosion Inside Dry Box

Description: A laboratory employee was working with an organo lithium compound in a dry box. He was holding a small glass flask, containing about 0.1 gram of material, by the neck in his left hand. As he approached the flask with a spatula in his right hand, there was an explosion. The employee received moderate to severe lacerations in the palm of his left hand as well as on the little and ring fingers.

Cause: It is believed that the explosion was due to a static discharge between the spatula and the glass flask or the small amount of material in the flask.

Preventive Measures:

1. This incident resulted in short, shielded tongs being made up for use inside of a dry box. Also a shielded spatula has been made up for use in this type of work.

2. The need to limit the quantities of unknown potentially hazardous materials in dry box work has been reviewed with all concerned.

3. Additional flexible transparent plastic (ethyl cellulose) shielding is being considered for use inside of the dry box, including a piece on the inside of the dry box cover glass in the area through which the operator looks to do his work.

4. All employees have been encouraged to use polyethylene equipment to reduce potential tissue damage when parts of the body are exposed to an explosion.

Reference Number of this Incident: L-33

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 49

Flash Fire - Pyrotechnic Composition

Description: On October 17, 1961, at 9:20 AM, a flash fire occurred at pyrotechnic laboratory during loading flares with an experimental pyrotechnic composition. Specified amounts of fire clay, dry flare and igniter compositions were weighed into separate conductive rubber containers. The containers were then transferred one at a time to the press area for incremental consolidation in the item by means of a 50-ton press. Two items were loaded and removed from the room. The two increments (50 grams each) for the third item were prepared and placed on the worktable. The first increment was placed in the item and pressed by remote control. The operator opened the doors, entered the room and proceeded toward the worktable to obtain the second increment when a flash fire occurred which consumed all the material in the room (approximately 250 grams flare composition and 50 grams igniter composition). The weighing of pyrotechnic compositions was conducted in the same room with the pressing operation. Each operation was separated by a barricade and the operations were not being conducted concurrently. The press operator received first and second degree burns on neck, face, and both hands. A second operator, standing outside of room, was treated for shock. The injured employees were not wearing face shields with bib and fireproof gloves as required by standing operating procedure. In addition, the worktable and weighing balance were not grounded as required by the standing operating procedure.

Cause: Exact cause unknown. Probable causes:

1. Ignition of pyrotechnic composition from static spark.

2. Ignition of a new sensitive and experimental pyrotechnic composition by friction or impact during handling.

Preventive Measures:

1. Employees working with sensitive and experimental pyrotechnic compositions should be carefully instructed, trained and supervised in the specific operations to which they are assigned.

2. Work areas, selected equipment, and procedures involving the handling and processing of hazardous materials should be reviewed and frequently checked by safety and supervisory personnel.

3. Operating personnel should comply with standing operating procedures without deviation. Supervisors should ascertain that operators are familiar with and understand all aspects of the standing operating procedure.

4. Equipment used in processing or handling pyrotechnic mixtures should be adequately grounded to dissipate any static electrical charge.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 50

Ignition of Composite Rocket Propellant

Description: Ignition of composite rocket propellant occurred in clean-up bay of operating building while operator was engaged in cleaning remnant composite propellant from a 300-gallon stainless steel casting can by hand with a stainless steel spatula. Approximately 80-100 pounds of propellant had been removed from the can and placed in a waste container under water. The operator was inside the casting can removing the remaining 50-60 pounds of propellant with the hand spatula when the propellant ignited and hurled him approximately 20 feet. The operator received second degree burns on back, chest, and left arm; first degree burns on face and head. The operator was wearing safety glasses, flameproof coveralls and safety shoes. The coveralls and glasses prevented more serious burns. The fire was controlled by an automatic deluge system. Estimated damage to building and equipment $594. The operator had been on continuous duty 14 hours and 20 minutes prior to the accident. The size and depth of casting can (3½' x 6') required operator to enter can for the hand cleaning operation.

Cause: Exact cause unknown. Probable cause - impact or friction on thin film (skin) of propellant when stainless steel spatula was struck or scraped against stainless steel casting can.

Preventive Measures:

1. Personnel should be prohibited from entering casting cans during removal of scrap propellant.

2. Stainless steel tools should not be used for removing scrap propellant from casting cans.

3. Whenever operations are such that protective clothing will not provide adequate protection to the operators, consideration should be given to conducting the operation by remote control.

4. Whenever possible, all propellants removed from equipment and tools should be maintained wet during removal operation.

5. Employees working with hazardous materials should be carefully instructed, trained and supervised in the specific operation to which they are assigned.

6. Working hours of personnel assigned to hazardous operations should be regulated so as to eliminate fatigue as a factor.

Reference Number of this Incident: 1017

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 51

Explosion Igniter Composition in Pellet Press

Description: On December 14, 1961, at 2:30 PM, an explosion occurred in pelleting press used in manufacture of igniter pellets. The igniter composition contained aluminum, potassium chlorate and vegetable oil. The press was charged with composition and had run from 5 to 10 minutes when the explosion occurred. The operation was conducted by remote control, with the two press operators behind a barricade in the operating room. There were no injuries or death. This job was identical to the one being conducted last year when an explosion occurred, resulting in two deaths. Estimated machine damage $1000 and estimated building damage $2-3000. Production capability was unimpaired due to having anotner press operating and capability of going to two shifts.

Cause: Exact cause unknown, and investigation being conducted. The dies had been cleaned, polished and gauged the morning of the day the incident occurred and tools were free and loose in the machine after the explosion.

Reference Number of this Incident: T-169

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 52

Cryogenic Laboratory Fire

Description: On October 19, 1961, at approximately 2:40 PM, a fire occurred in a hydrogen cryostat during the dismantling of associated tensile equipment. Testing was completed at approximately 2:15 PM. At approximately 2:25 PM the bottom retaining ring and teflon seal were loosened. (See attached sketch.) The next step was to remove the lower loading rod in the test chamber. The lower loading rod coupling was frozen solidly in place. Temperature at the center of the cryostat at this time was -300°F. Test personnel used a heat gun (hot air dryer) to free the coupling. As the loading rod was being pulled up through the bottom of the cryostat, a flash fire occurred. Three test personnel received first and second degree burns on hands, arms, and face. Evidence of the fire was found as far as 4 feet from cryostat and on the outside of the cryostat, indicating fire was not confined to interior of cryostat. The test cell exhaust fan was running during this period.

Cause: This test program had been underway for approximately 4 months. Test personnel, in the interest of saving time, had bypassed Standing Operating Plan requirements for purging and bringing cryostat up to room temperature prior to entering test cell. This allowed the condition as noted to exist. It is assumed that this fire resulted from gaseous hydrogen remaining in bottom portion of cryostat, due to the failure to purge, cold temperature of cryostat increasing the gas density and poor ventilation of bottom of cryostat. The cause of ignition is assumed to be spark from or ignition by open filament of heat gun used to free loading rod coupling.

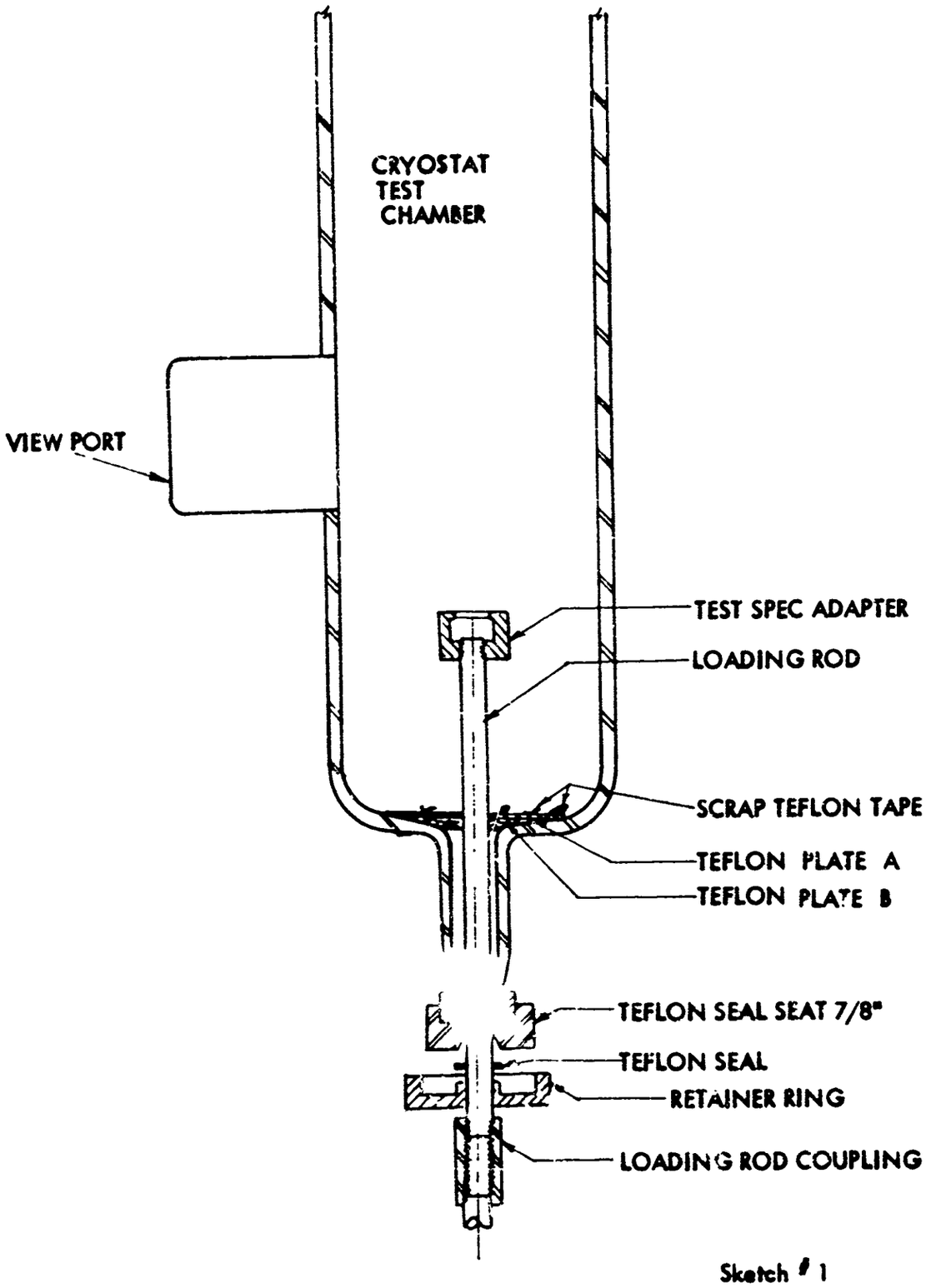
Preventive Measures:

1. Closer surveillance of all routine cryogenic operations has resulted from this incident.

2. Importance of cleanliness, purging, and Standing Operating Plan compliance was reiterated to all test personnel.

Reference Number of this Incident: L-34

Duplication of this report is authorized.



Sketch # 1

EI-52

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 53

Laboratory Incident

Description: A reaction system was set up on a lattice rack for the isomerization of an organic chloride. An electric mantle was used to heat the two liter flask, which was vented through a glass tube filled with granular cuprous chloride in firebrick. A condenser and product pot were installed after the catalyst bed. The catalyst bed was heated by an asbestos-wrapped nichrome wire. The reaction appeared to be going smoothly when suddenly a flash occurred and the flask ruptured. The burning liquid contents sprayed out over the immediate work area. Burning droplets sprayed and fell on two men in the area. Both received scattered burns. One received burns which required skin grafting.

Cause: It is believed that a hot spot in the catalyst bed (300°C at time of flash) caused decomposition, an immediate pressure rise and a flash back into the flask.

Preventive Measures:

1. Adequate flash shielding around reaction equipment is to be provided.

2. Flame resistant laboratory coats are being placed in use for all research and development personnel.

3. Further study as to the cause of the hot spot in the catalyst bed is to be made.

Reference Number of this Incident: L-35

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 54

Ignition of Powder When Hopper Fell

Description: An employee had moved a hopper of powder into the screen house and hooked it to an air-operated hoist. As he raised the hopper, it hit the limit switch but the switch failed to operate. This caused the cable to break and the hopper started to fall. The employee saw this and started to run toward the door but was enveloped by flames when the hopper struck the floor and the powder ignited. Ignition of the powder was caused by impact or heat generated when the hopper bottom was pierced by landing on a sharp edge of the tram car. The SOP requires that this hoist be operated from the second floor of the building after raising the hopper part way. This allows the hopper to be raised without going into the limit switch. Had the employee been operating the hoist from the second floor, he may have avoided the limit switch. Even though the hoist had gone through the limit switch and sheared the cable, the employee would have had a better avenue of escape by using an escape chute provided on this floor.

Cause:

1. Failure to follow SOP.

2. Failure of hoist limit switch.

Preventive Measures:

1. SOP's will be re-emphasized to all operating personnel.

2. Operating procedures will be revised to include a daily check by operating personnel of all safety devices and cable condition.

3. All hoists have been reinspected for cable wear and properly functioning limit switches.

4. Use of fire-resistant clothing on all dry operations will be investigated.

5. The practicality of remote control during the hoisting phase of this operation will be investigated. If remote control is not practical, a secondary limit switch arrangement will be studied.

6. The operating height of this hoist will be increased so that it will not be necessary to raise the load so close to the limit switch during normal operations.

Reference Number of this Incident: L-36

Duplication of this incident is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 55

Reaction Kettle Explosion

Description: At approximately 10:00 PM, a series of explosions occurred in the vicinity of the esterification kettle. Although there were no injuries, the explosions demolished the kettle room, ruptured natural gas lines and hurled the kettle and associated components (estimated projectile weight 6000-7000 pounds) a distance of 340 feet. Fires resulting from escaping gas caused extensive damage to the adjacent building and its contents. Most of the fire damage was caused by escaping gas. The direct gas-fired kettle was last fired 40 hours before the explosion. Warm "intermediate" material was transferred to the kettle between 14 and 30 hours before the explosion. The kettle room was last entered 13½ hours before the explosion and the plant last occupied 5½ hours previous to the explosion. Physical examination of the evidence and testimony of witnesses led to the conclusion that the incident was triggered by a rapid increase in pressure and temperature within the kettle. No evidence was found to indicate the rise of pressure and temperature was caused by conditions external to the kettle. The material involved in this accident was a polyether-alcohol, made by the reaction of a mixture of propylene oxide and ethylene oxide with a polyhydric alcohol. Both chemical analyses and infrared examination did not reveal any significant differences between samples of the batch in question and earlier production of the same product. Particular examination was made for peroxides and for epoxides. A laboratory study was undertaken to determine the product's inherent thermal stability. Conditions which were varied included temperature, pressure, surface area, air versus nitrogen atmosphere, sample size and accidental additives. No high velocity (brisant) decomposition could be made to take place, but it was found possible to cause rapid decomposition with the generation of substantial heat and pressure, which in a closed vessel could exceed its bursting strength. Two sets of conditions were found which could lead to exothermic decomposition. The first is an oxidizing process, whereby air (or chemical oxidizing agents such as hydrogen peroxide) reacts with the polyether-alcohol rupturing chains and producing volatile oxidized products. The speed of the reaction is a function of the surface area and temperature. If surface area is large, rapid temperature rises can occur as low as 100°C. The second condition is in the absence of air or other oxidizing agent. Rapid exothermic decomposition does not occur below 300°C. At slightly above 300°C an exothermic decomposition occurs producing substantial quantities of gaseous products. Pressure appears to favor the decomposition reaction. Rapid air oxidation with a substantial temperature rise was found to occur with other ethylene oxide and propylene oxide adducts. Furthermore, exothermic decomposition in the absence of air was found to take place for other ethylene oxide adducts at initial temperatures between 300°C and 350°C.

Cause: It is known that the product was pumped to the kettle at slightly over 100°C and remained there for a number of hours without agitation. The charge was exposed to air at the surface since a vent line was open. In the course of nearly half a day, the temperature rise perhaps would be sufficient to raise the

temperature of some of the product above 300°C. At this point, a rapid exothermic decomposition, not requiring air, would commence and would sustain itself and generate more and more heat and gaseous products until the kettle ruptured. This is believed to be a reasonable explanation, based on sound chemical principles, of the known facts of the accident.

Preventive Measures:

1. Avoid prolonged elevated temperature storage of ethylene oxide or propylene oxide adducts.

2. Provide means for agitation of vessels containing such products.

3. Protect ethylene oxide and propylene oxide adducts against air, particularly at elevated temperatures.

4. Install recording thermometers equipped with alarms on storage and reaction vessels.

5. Consider the use of anti-oxidants to stabilize such products.

Reference Number of this Incident: L-37

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 56

Flammable Vapor Explosion in Centrifuge

Description: A centrifuge had previously been charged with a full cake of purified phenacetin and the alcoholic mother liquors spun off. The operator then proceeded with the spray washing of the cake, using hot ethyl alcohol:water (80:20) wash solution. Normally, the wash solution is used at room temperature; but in this instance, a new solution freshly prepared from hot, freshly distilled ethyl alcohol was used without being allowed to cool. The spray washing was completed and the cake was being spun to reduce the moisture content before unloading. The cake had been spinning for approximately 15 minutes when the operator heard metallic scraping sounds coming from the centrifuge. He immediately shut off the power, applied the brake and brought the basket almost to a stop. The operator then turned away from the centrifuge to go and examine the solvent discharge pipe and the sump to find out whether the centrifuge had finished draining. At this point, a loud explosion occurred inside the centrifuge. The force of the explosion blew open the hinged cover and flames shot out, striking the operator on the right side of the face and neck. The hinged cover fell closed again, following the explosion. The injured operator recovered himself and pulled the cover open again, while other operators and supervision used extinguishers and water hoses to prevent re-ignition of the solvent. The foregoing description of the accident is based on the testimony of the injured operator and nearby witnesses. The injured operator was wearing safety spectacles at the time, which probably prevented more severe injury around the eyes. The investigating committee ordered the centrifuge partially dismantled and then examined the interior, and the parts, to determine cause of the metallic scraping sounds reported by the operator. Circular marks of abrasion were found on the top rim of the centrifuge basket and these matched corresponding abrasions on the splash ring on the underside of the centrifuge cover. There was evidence of repeated contact in this area and in some sections the metal surfaces had been blued by frictional heat. Further examination of the reassembled unit showed that when the cover was in place, the splash ring cleared the top rim of the basket by approximately 1/16" to 1/8". A comparison was drawn between the clearances in this instance and a clearance of 1" on a similar model centrifuge in the research pilot plant. There was also evidence indicating that on some previous occasion, not within memory of anyone contacted, the bolting flange of the cover had approximately 5/8" cut from it and new bolt holes drilled. This, in effect, permitted the cover to be mounted and the splash ring to position itself within 1/8" of the rim of the basket. The shaft bearings were checked for wobble and end play and appeared satisfactory. Electrostatic grounding of the entire assembly was checked with an ohmeter. The electrical resistance of the unit was less than 1 ohm. It was concluded that either a minor imbalance in the centrifuge cake or flexing of the basket or shell at high speed would have been sufficient to spoil the clearance between the splash ring and the rotating basket, thus permitting metal-to-metal contact and abrasion.

Cause: In the opinion of the investigating committee, the fire and explosion was caused by metal-to-metal contact and abrasion of the rapidly rotating centrifuge basket with the fixed splash ring on the underside of the fixed cover. The evidence showed that considerable heat was generated by this contact with the possible evolution of sparks. The metal-to-metal contact was made possible by the cutting and refitting of the bolting flange on the centrifuge cover at some previous date. The heat generated and/or the sparks evolved ignited the mixture of air and ethyl alcohol vapors within the confines of the centrifuge shell, causing a flash fire and explosion.

Preventive Measures:

1. That the clearance between the rim of the basket and the splash ring on the underside of the cover be restored to 1 inch. This work is already in progress.

2. That the use of warm or hot solvents in the centrifuge be discontinued, or special precautions be taken when they must be used.

3. That a liquid seal, such as a dip leg, be installed on the discharge pipe from the centrifuge, where it enters the solvent collecting sump. Although this feature had no bearing on this accident, it is considered an essential safety device.

4. That a suitable carbon dioxide purge and blanketing system be designed and installed on the centrifuge, to be used to render an inert atmosphere in the centrifuge at any time flammable solvents are being used.

Reference Number of this Incident: L-38

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 57

Explosion During Cleaning of Reactor Vent System

Description: The following standard procedure for cleaning the vent system of four sodamide reactors was being followed: (1) nitrogen purging, (2) installation of blanks at each reactor, (3) removal of a large nozzle cover on the seal tank, (4) steaming of the system. Several seconds after a pipe fitter removed the nozzle cover, an explosion of unknown cause occurred in the system and was relieved through the open nozzle. The pipe fitter, who was standing partially in front of the nozzle sustained severe burns on his lower right leg; operating foremen and another employee who were standing nearby received minor burns.

Cause: Probable cause of the explosion is a hydrogen-oxygen ignition resulting from inadequate purging of the presence of explosive azides or peroxides. Cause of the severity of the injury is position assumed by the pipe fitter.

Preventive Measures:

1. The cleaning procedure is being modified to insure adequate purging.

2. Methods of rendering possible azides or peroxides inert are being studied.

3. Protective clothing such as asbestos suits will be worn for step (3) in addition to step (2) unless there is a certainty that dangerous materials are not present.

4. Employees have again been reminded to stand to the side rather than directly in front of possible trouble.

Reference Number of this Incident: L-39

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 58

Propellant Mixer Flash

Description: A propellant mixing operation had just been started. This operation constitutes, firstly, performing a massing action on the binder ingredient. Massing had proceeded for approximately two minutes when a flash occurred. The mixer vented by the cover being raised. Investigation revealed that a valve in a system used to introduce flammable solvent into the mix on a subsequent operation developed slight leakage. There was no damage to personnel or to the mixer and the flash was not sufficient in magnitude to activate the sprinkler system in the building.

Cause: The most probable cause is believed to be an adiabatic compression of the entrapped flammable solvent vapor-air mixture in the mass of the material in the mixer. Other less likely causes could be a static spark discharged within the mixer, metal-to-metal contact of the mixer blades within the mixer, or the presence of tramp metal. Clearances of the blades to the bowl were checked and found to be within specification. No tramp metal was found in the mixer contents. Grounding continuity for the entire system was checked and found to be within specifications.

Preventive Measures:

1. The valve which developed the leak has been replaced with a superior type and the entire solvent system rechecked for leakage.

2. A quick disconnect fixture has been included on the solvent line, and it will not be connected except to introduce solvent into the mixer.

3. It has been determined that the massing operation is not necessary and has been discontinued.

Reference Number of this Incident: L-40

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 59

Explosion Dinitrofluoroethane During Nitration

Description: On June 19, 1961, an explosion occurred in a small room in a corner of the nitrating building which resulted in the death of one employee and injuries to two others. The incident involved the distillation of dinitrofluoroethane (DAPHNE). This particular operation is a fractional distillation conducted at reduced pressures. The procedure involved heating the water bath from room temperature to approximately 60°C and reducing the pressure in the system to about 15mm Hg absolute. The low boiling fractions are condensed in the water cooled condenser and the distillant collected in a receiver cooled by dry ice and acetone. All vapors not condensing are passed through two cold traps connected in series prior to reaching the vacuum pump. Fractionation was accomplished in a 24-inch long glass column packed with small Berl saddles. When the vapor temperature reaches 30°C and the absolute pressure is 15mm mercury, the hot water circulating system is stopped, the vacuum pump turned off and the vacuum released. The receiving flask containing the foreshot is removed from the apparatus and the low boiling fractions collected are weighed and measured volumetrically, a new receiving flask is attached, vacuum pump started and the hot water circulating system started. The distillation is continued, the distillate being that portion containing the main portion of DAPHNE. This particular distillation was started at 1:00 PM. At 3:45 PM the process was stopped for removal of the low boiling fractions. The vapor temperature at this time had reached 30°C as per operating instructions. At 4:30 PM the distillation was proceeding normally. At this time the pot temperature began to increase at a faster rate than the bath temperature and at 5:45 PM exceeded the bath temperature until 6:45 PM, the last recorded data available. The charge of crude DAPHNE weighed 20.74 pounds, with a volume of 7235 milliliters. Between 4:30 PM and 5:30 PM the temperature differential between the pot and the bath decreased from 12°C to 1°C with the pot temperature lower than the bath temperature and the pressure remaining at 15mm Hg absolute. Sometime between 5:00 PM and 6:00 PM the engineer was absent from the building for a period of 30 to 45 minutes. Between 5:30 PM and 5:45 PM, the pot temperature went higher than the bath temperature by 1°C and the pressure increased to 18mm Hg absolute, an increase of 3mm Hg, which indicated an exothermic reaction was taking place. Between 5:45 PM and 6:45 PM, the distillation showed more signs of an exothermic reaction with the pot temperature increasing from 71°C to 79°C while the bath temperature remained at 70°C and the pressure increased from 18mm Hg absolute to 45mm Hg absolute. Somewhere between 5:45 and 6:40, the engineer recognized the distillation was not proceeding normally and sometime between 6:40 and 6:45 he started shutting down the distillation by adding cold water from the condenser into the bath. Between 6:45 PM and 6:59 PM the bath temperature reduced to 60°C. Just before the explosion, the engineer started reducing the vacuum by purging. He was standing in front of the distillation system at the time of the explosion and the blast threw him approximately 8 feet across the room. The operator saw the flash, started to run down the

passageway, but was thrown to the floor of the passageway by the blast. He recovered himself, ran to the front of the building and phoned for help. The utility man heard the glass break and a swishing sound; quickly turning around, he saw material spraying out the top of the column and ran from the building. He heard the explosion, was struck by flying material, and jumped into a ditch approximately 25 feet from the doors of the building. The engineer in charge was fatally injured. The operator received lacerations to the right ankle and back of the head. The utility man received lacerations of the right side and left hip and rupture of the right ear drum. The engineer had been working for 6 months or more with this project and had assisted in preparation of the standard operating procedure for this operation. The SOP was in the room and readily available for reference. Property damage was approximately $15,000.

Cause: Admission of air to reduce the vacuum without first cooling the flask, thus causing an explosive reaction between the air and the products of the chemical reaction. This resulted from failure to recognize in sufficient time a dangerous condition which had been developing over a period of time; and failure to follow standard operating procedure which required cooling to room temperature before reduction of the vacuum.

Preventive Measures:

1. All standard operating procedures for operations involving materials which may cause exothermic reactions will contain a section detailing action to be taken to meet emergency conditions.

2. All standard operating procedures involving experimental processes will include special safety precautions to cover that particular process.

3. Require that operations not proceeding normally be secured and that the next echelon of supervision be notified.

4. Insofar as possible, conduct all hazardous operations from behind suitable barricades.

Reference Number of this Incident: 1019

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 60

Explosion During Mixing Experimental Propellant

Description: An explosion occurred during mixing an experimental propellant in a 500-pound slurry mixer. The explosion involved 350 pounds slurry mix plus 340 pounds of casting solvent remaining in a desiccator. All ingredients had been incorporated into the mix in step-by-step operation, and during this time the material had been mixed for a total of 44 minutes. The mixer was shut down, the lid placed on the mix pot, vacuum applied to the pot and operating personnel evacuated to remote control house. Final vacuum mixing was started and had been in process for approximately 30 seconds when the explosion occurred. This formulation had been made 9 times previously. A thorough mechanical inspection of the mixer had been made approximately one month prior to the explosion and the mixer was reported to be in excellent condition. The mixer was operated from this time until time of the accident. One employee in remote control house (approximately 75 feet from mix house containing mixer) received cerebral concussion and facial lacerations. Three other employees received minor injuries (one - mild abrasion of ankle; one - minor contusion of right side of head and mild injection of right ear drum; one - contusions of left shoulder, elbow and wrist and small laceration of left knee). These three employees were treated and returned to work. Two buildings (mix building, and mechanical and office building) were completely destroyed. The mix building was concrete 3 sides, 1 side wood frame, wood floors and asbestos shingle roof. The building was barricaded on 3 sides by 12-inch reinforced concrete walls backed up with earth mounds, with the front protected by 12-inch thick sand-filled, wood constructed bullet shield. Damage to surrounding plant buildings, with distances from explosion site, as follows:

Weigh Bays and Dry Building - 140 feet.

Bay No. 1 - north frame wall broke loose at northeast corner and pushed out 4 inches; half of the panic door shattered, other half, spars and plastic panels broken; two explosion proof lights torn from ceiling and left hanging from conduit, no damage to the lights; roof was lifted but settled back down leaving a gap between ceiling and walls of from $\frac{1}{2}$ to 1 inch.

Bay No. 2 - panic door completely shattered; bracket holding fire line to ceiling pulled out when ceiling was lifted; roof was lifted, then settled back leaving a gap between ceiling and walls; the gap was greater at the center, then diminished toward side walls.

Bay No. 3 - the fire line was pulled out of the ceiling when roof was lifted up; radiator on west wall was torn loose when west wall was lifted up with the roof; the wall then broke loose leaving a gap between ceiling and walls as in Bay No. 2; panic window and vent louver in the door were blown out.

Bay No. 4 - damage same as Bay No. 3.

Bay No. 5 - roof lifted slightly, then settled back; the fire line stayed solid to the ceiling; half of the panic door shattered, the other half, the plastic window panels and one spar were knocked out.

KG Catch Tank House - 270 feet. Plastic window panels (3'x4') and $\frac{1}{4}$" plywood door paneling blown out of east, north and west sides of building; window paneling on south side of building loosened on top, bottom and north sides of panel.

Metal Spare Parts Building - 365 feet. Three plastic skylights on west slope of roof torn loose on south edge and partially pushed in; two of four large metal sliding doors knocked off tracks and dropped on catwalk running in front of the doors; the doors were bowed out slightly, indicating pressure from within the building; wooden shelves filled with spare machine parts knocked over and shelves broken. This building was not barricaded.

Mix House - 430 feet.

West side of building - west doors of elevator entrance blown off hinges; top window on west wall of elevator shaft blown out; panic door on west wall, top floor, was shattered - only part of door sash was left hanging on hinges; panic window and door on lower level damaged as follows: wirdow closer and glass broken, sash left intact, door sash and glass shattered; plywood panel used to board up hole in wall where window once was, blown off; half of panic door in west end of north portal blown off and glass broken, however, sash was left intact; other half of door left intact but for three glass panels blown out; piece of 2" pipe 4' long struck the top elbow, mashing it in on the 18" diameter air intake duct as it leads into top floor of building - as a result, air duct was pulled loose from its connection leading into blower at the lower level and pipe came to rest after cutting through roof over the water air filter; shelter roof over the stairs on west side of building pulled away from the building at the top.

South side of building - glass and sash of the panic window on the south side of the building at the lower level of elevator shaft shattered.

East side of building - two glass panels broken in panic door to air intake blower room and door frame across top and on south side of doorway torn loose; panic window sash and glass shattered in blower room; half of the panic door on lower level of building in the northeast corner shattered - other half of door had one broken spar and three broken window panels.

North side of building - outside frame wall in north portal was pushed out from top plate 8 inches; three 2x4 studs 9 feet high were split 3/4 of their length; half of the panic door (built into the large 6" sliding door on the north end of the building) was shattered - other half had only one broken glass panel.

Motor Room - Outside of Barricade, East of Building - lower window sash broken on southwest end of motor room; lower half of window sash pushed in on east wall of motor room; one 2x4 wall stud 7' high (on north wall) split halfway down. Barricades are on north, south and east sides of Mix House, no barricade on west.

Packer Building - 435 feet. West panic door blown completely off hinges, screws pulling out of door; very little damage done to door; no glass or sash breakage involved.

Material Rest House - 450 feet. Outside panel of double plexiglass door window panel (5'x6') broken; two vent louvers on front of building blown off. Building barricaded with earth covering but unprotected on west front side.

Cartridging Building - 510 feet. Two panic doors on north side of building completely shattered; one large sliding door dropped from roller track; one explosion proof fluorescent light fixture broke loose at one end and hanging in doorway.

NC Catch Tank House - 720 feet. Three plastic window panels blown out of east side of building. Building not barricaded.

Wash House - 725 feet. One door panel on buggy storage side torn from its hinges, other panel split down the hinged edge of the door and hinges were loose; one door panel on wash room side torn from hinges, other panel also split down the hinged edge of the door and later fell to floor; window panel on north side of building blown partially out of frame. This building not barricaded.

Propellant Loading - 780 feet. Panic doors blown open and door closers broken; sash spars and glass window panels broken out of skylight in apex of north wall.

Mix House - 875 feet. Half of panic door built into a large sliding door on the lower level opening into the north portal was ripped from its hinges and sash, spars and glass were broken (this door was in line with the northwest portal); one wall box light located on east wall at the oil drop broke at the base of the bulb and glass reflector but was contained within the box; panic windows and doors blown open on the oil buggy level, window closers and glass were broken; on top floor, dirt and debris fell into 6 ingredient hods; 2x4 wall studs on north wall of motor room were split lengthwise; two window frames on west side of motor room were pushed out 6" at the bottom.

NG Storehouse (Neutralizer) - 890 feet. Window spars and glass blown into building from skylight in apex of roof on north end of building, glass fell to floor in front of catch tank; rubber lid on storage tank knocked off; door closers broken as all panic doors were blown open. Skylight was not protected by barricade.

Line Office and Shop - 955 feet. Nine plexiglass windows broken out of north and west side of line office and shop. Desks opened and papers and books scattered on floor and across desks; plastic side shields jarred loose from fluorescent overhead light fixtures. Building not barricaded.

Cartridge Building - 1160 feet. All panic doors forced open and door closers broken.

Cartridge Building - 1165 feet. Panic doors on north, south and west sides of building blown open breaking door closers and glass; however, glass breakage not too extensive; north center panic door sustained damage by top cross member of door sash breaking, glass broken also; this door was in line with the north center portal.

Cartridge Building - 1180 feet. All panic doors on north, south and west sides of building blown open breaking door closers as they were forced open; very little glass breakage occurred.

Acid House at Nitrator Building - 1235 feet. Plastic window panels (3'x4') loosened on north, east and south sides of building. This building not barricaded.

Nitrator Building - 1285 feet. Three panic doors on west wall of operating room blown open and door closers broken; one spar on sash on one-half of panic door in north portal knocked off. No glass breakage; plastic window panel in door of storage room knocked out.

Nitrator Building - 1510 feet. All 14 panic doors and windows blown open and wooden closers broken.

Laboratory - 2350 feet. Plastic window panels and sash spars on north side of building knocked out, however, one new window with glass panels left intact; a wood rot condition in the window sash and frames to some degree responsible for their collapsing. This building is in safety area and not barricaded.

Ingredient Dry House - 2400 feet. Sash spars and glass broken in south and east windows of building. This building in safety area and not barricaded.

Power House - 2400 feet. One skylight at top of power house knocked out of its pivots but not broken; large window frame on west wall of old boiler room pushed in 3" along top edge of frame; double safety panel window in south wall of motor room split at seam. Building in safety area and not barricaded.

Carpenter and Pipe Shop - 2410 feet. Extensive glass breakage and sash damage to windows on north side. Building in safety area and not barricaded.

Drying Building - 2530 feet. Ten glass window panels on north side of building broken. This building in safety area and not barricaded.

Main Gate Guard Station - 2760 feet. Large section of $\frac{1}{4}$" plate glass blown out of northwest front corner of the guard station.

Office Building - 2780 feet. Plastic side shields on fluorescent light fixtures knocked off and chains holding fixtures on one end loose (this condition developed with 50% of the light fixtures on east side of building); pictures, papers and books scattered in office area. This building in safety area and not barricaded.

Damage outside plant area - one window glass broken in farmhouse approximately 1 mile in northwest direction from blast.

Cause: Exact cause unknown. Investigation continuing on following possible causes:

1. Foreign object in mix.

2. Friction at the shaft seal augmented by contamination with materials from the mixer.

3. Shock effect caused by cavitation initiated detonation in the propellant which was made more sensitive because of small bubbles resulting from vacuum mixing.

Preventive Measures:

Item 1 under Cause. Subject all ingredients to metal detection devices and improve methods of screening materials; tighten control on personal property (jewelry, badges, rings, etc.) on personnel working in the area; tighten control program on all tools, sample bottles and other portable objects used in the operating building; expand inspection check sheet to include inspection for foreign material in or on equipment.

Item 2 under Cause. Develop and conduct tests to substantiate or refute this theory; eliminate possibilities of contamination of the mixer shaft-to-the-lid seal by redesign of the seal or by change in process to eliminate seal; improve alignment of mixer shaft to bowl and bowl cover; eliminate vacuum mixing if possible; if vacuum mixing to continue, program application of vacuum so that foaming action is minimized; explore means of further reducing dusting.

Item 3 under Cause. Develop and conduct tests to substantiate or refute this theory; obtain data on research pertinent to this area.

Other. Tighten control on ingredient sampling identification and acceptance; investigate new design of impeller for incorporating materials and explore possibility of reducing peripheral speed of impeller; consider locating cast and cure facilities in mixing area to avoid excessive handling and transportation; check glazing in windows and doors in propellant operations to make sure it is of approved type and installation; modify entrance to remote control room to give adequate blast protection to personnel; modify warning system to extend time for personnel to clear the area; provide better control of entrance area.

Reference Number of this Incident: 1001

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 61

Explosion in Laboratory Propellant Cure Oven

Description: Specimens of experimental composite propellants were being cured in a steam-heated oven, located in a laboratory cell, when ignition occurred. The oven contained about 32 pounds of ammonium perchlorate propellant in open sample pans, and 70 grams of polynitramine propellant in 35 gram specimens, each in an aluminum weighing dish. One of these dishes was unconfined, the other was in a Parr combustion bomb under 60 psig pressure. Cure temperature was 170°F. After 54 hours of curing, at constant temperature, sufficient pressure developed in the bomb to shear the head retaining ring. About 50% of the propellant burned. The top of the oven was blown off and the oven doors were blown open. The Parr bomb head and its retaining ring were found embedded in the oven top. The nitramine binder contained one ingredient, nitrated alcohol Petrin, which requires stabilization against decomposition - typical of nitrate esters. A commonly-used stabilizer, ethyl centralite, was employed for this purpose. Previously, the pressure cure of similar formulations had been performed apart from other propellants in cure. The success of these earlier experiments prompted the use of the Parr bomb for curing small specimens concurrently with other propellant.

Cause: Decomposition of propellant under pressure cure.

Preventive Measures: A complete autoignition profile is being obtained on this and similar propellants. Modifications to the pressure cure process will be considered, including use of low pressure relief diaphragms and the return to separate cure ovens or appropriate heated vessels.

Reference Number of this Incident: L-41

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 62

Deflagration Experimental Igniter Mixture During Blending

Description: An experimental igniter mixture was being blended in a small twin shell V blender when a deflagration occurred. The operation had been in progress for approximately 20 minutes under remote conditions of operation. There were no injuries or damage to equipment.

Cause: A non-rigid screen had been used in the V blender to aid in the prevention of lumping of materials. It is believed that the screen became disengaged and the resulting deflagration was caused by impact or friction.

Preventive Measures: The use of non-rigid screens in the interior of the blender has been discontinued.

Reference Number of this Incident: 1021

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 63

Detonation of Delay Cap at Dynamite Development Test Ground

Description: Two employees of the test area were disposing of scrap explosive material by shooting. A delay cap had been set up and a current applied from the blasting machine, but the cap did not fire. The circuit was checked and found to be continuous. After approximately 15 minutes lapsed time, the employee entered the test pit. He removed the cap from the charge by pulling on the leg wires, and had disconnected the leg wires from the lead lines when the cap detonated. The employee required first aid only to remove two pieces of shrapnel in the face area. There was no property damage.

Preventive Measures: Delay caps should not be used to destroy powder, and all delay caps at the site have been destroyed. The waiting time has been increased to a minimum of 30 minutes with EB caps.

Reference Number of this Incident: 1020

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 64

Explosion During Mixing Tracer Composition

Description: Explosion occurred at start of final mix operation of 50 pounds tracer composition. Correctly weighed portions of the oxidizer and a catalyst are placed in the mixer and the mixer operated from the remote control location for approximately three minutes. Half of the binder and solvent mixture is then added and the mixer again operated for approximately two minutes. The magnesium powder and the remaining binder solution is finally added and the mixer operated for approximately 30 minutes. The mixer is stopped at 15-minute intervals during the final mix stage to accomplish scrapedown. The first two stages of the mixing cycle were completed and the magnesium powder and remaining binder solution added to the mix. The operators retired to the remote control station and within a few seconds after starting the mixer, a whistling sound, followed by an explosion, was heard. No death or injuries occurred. Damage consisted of a blown-out roof and door, damage to hollow tile "weak walls", hair-line cracks in the three 12" reinforced concrete walls, severe heat damage to the mixing equipment and burning of combustible items in the bay. The design of the roof and "weak wall" did not permit immediate venting of gas pressure, thereby resulting in damage to the reinforced concrete walls. Roof construction consisted of 2"x6" tongue-and-grooved planks covered with asphalt sheet roofing paper.

Cause: Exact cause unknown; probable causes:

1. Crushing of hardened particles of tracer composition left in the mixer from the previous mix.

2. Friction resulting from inadequate clearance between plows and muller wheels or muller wheels and bowl. (Close tolerance points were not checked prior to each mix.)

3. Increased sensitivity of the composition as a result of either improper amounts or ingredients being introduced into the mixer.

Comments: Results of the investigation indicated that the standing operating procedure was for 100-pound batches. Since 50-pound batches were being mixed, the amounts of ingredients and mixing times were reduced to one-half. The method being used for introducing ingredients into the mixer and the amounts of binder and solvent required were not included in the procedure. The vinyl-acetate resin, used as a binder, might have caused materials remaining in the mixer from the previous mix to harden after evaporation of the solvent (alcohol). If thorough cleaning of all points where explosives might lodge was not accomplished, sufficient friction to cause ignition could result from crushing of the

dried material. Review of the standing operating procedure revealed that the tracer composition was removed from the mixer by hand scooping, utilizing wooden paddles.

Preventive Measures:

1. Operating areas, process equipment and procedures involving the handling of hazardous materials should be reviewed and frequently checked by safety and supervisory personnel.

2. Standing operating procedures should be prepared in sufficient detail to insure operational safety and to provide adequate guidance to personnel performing the operation. Deviations from the applicable standing operating procedure should not be permitted.

3. Mixing bays should be provided with one weak wall. The roof should be of the free-lift type and should be constructed of lightweight material.

Reference Number of this Incident: 1024

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 65

Flash Fire, Rocket Motor Igniters in Assembly Bay

Description: Flash fire occurred while operators were placing rocket motor igniters into polyethylene bag. Igniter bodies are secured in a vise and the [illegible] squibs threaded in place. The assemblies are then transferred to another [illegible], secured in a vise equipped with flash shield, and the required amount of [illegible]er pellets (weighed out in paper cups) are loaded into the igniter tube. The [illegible] open end of the igniter tube is coated with adhesive and a plug is in-[illegible]d. The plug is coated with adhesive and the igniter is placed in a rack and [illegible]ed to dry for approximately 24 hours. After drying, the finished igniters [illegible] placed in polyethylene bags and sealed with tape. Two operators were labeling [illegible]d placing igniters into a polyethylene bag. One of the operators was holding [illegible]e bag open and the other placing igniters into the bag when the flash fire [illegible]curred. Both operators suffered second and third degree burns on face, hands [illegible]d chest and second degree burns on the back. Property damage was negligible.

[illegible]: Exact cause unknown; probable causes:

1. Ignition of igniter dust (generated during the pellet weighing and [illegible] operation) from friction as a result of movement of the drying racks on [illegible]e stainless steel tabletop.

2. Impact from dropping an igniter either into the partially-loaded [illegible]lene bag or onto the floor.

3. Static electricity.

[illegible]: Investigation of [illegible]e accident disclosed that neither operator was wearing face protec[illegible] A flash shield was not provided at the packaging [illegible]as required by appr[illegible]ed standing operating procedure. Packaging of ig[illegible] was being accomplished adjacent to approximately 200 exposed igniters [illegible] drying racks. Review of records indicated that periodic testing of con[illegible]s was not being accomplished.

[illegible]ive Measures:

1. Operating personnel should comply with standing operating procedures [illegible]t deviation. Supervisors should ascertain that operators understand all [illegible]spects of the standing operating procedure, and conduct sufficient inspections [illegible]k areas to insure compliance.

2. Grounding systems in hazardous operations (where static-sensitive [illegible]s are handled) should be tested initially and periodically thereafter. [illegible]ctive shoes should be tested not less frequent than semi-annually.

3. Operational shields should be utilized to separate individual work stations and to prevent propagation of explosives in event of an accident.

4. Packaging operations should be separated from the processing and drying location.

5. Only conductive type containers should be utilized when weighing out hazardous materials.

6. Finished ammunition components should be packed in suitable containers to prevent movement during handling.

Reference Number of this Incident: 1023

Publication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 66

Metallic Sodium Fire and Explosion

Description: At the start of a centrifuging operation outside of the building, a valve was left open causing organic material to run onto the cement slab. Before cleaning up the spill with water, a drum was disconnected from the centrifuge, and a bung was screwed into the opening. After a short time of washing the spill with water, a fire enveloped the area. The injured employee attempted to put out the fire with a CO_2 extinguisher while his co-workers went for help. The disconnected drum alongside the centrifuge exploded causing a flash fire which surrounded the injured employee. The injured employee received moderate burns to the hands and face. Pertinent facts of the incident prior to the explosion: 1) one step in this reaction is to add a metallic sodium dispersion into the reactor; 2) the reaction of all of the additions proceeded as planned throughout the day; 3) a sample of the reaction product was taken from the bottom of the reactor - part of the sample was thrown on the snow so that any un-reacted metallic sodium would react with water - no reaction of any type was noted - the reaction mixture was also treated with acetone and no reaction oc-curred - it was then decided that there was no metallic sodium present; 4) as the wheeling operation was started, the bottom outlet of the reactor was opened (there was approximately 8-10 psig Argon on the reactor) - as this was done, it was determined that the valve to feed the centrifuge was open, which allowed material to flow to the wheel and onto the floor - while this was happening, the drum on the filtrate side of the centrifuge was connected and approximately 2-3 gallons ran into the drum; 5) the drum was disconnected from the centrifuge and a bung was screwed into the bung opening; 6) the operator using a service water hose washed the spilled material toward the sewer - all of a sudden, the spilled material was enveloped in flames.

Cause:

1. Metallic sodium was in the spilled material because of an incomplete reaction.

2. Water was used on metallic sodium because tests failed to show its presence.

3. The valving was not checked prior to the centrifuging operation.

4. The bunged drum in the area was heated by the fire resulting in an explosion.

Preventive Measures:

1. Develop a more adequate test and sampling procedure to determine the presence of residual metallic sodium in the final product.

2. The drums used on the filtrate part of this job will be equipped with flame arresters. Containers of flammable materials will be removed from area before cleaning up a spill.

Reference Number of this Incident: L-42

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 67

Ether Explosion in Laboratory

Description: A chemist was distilling ether from impurities when an explosion occurred, resulting in burns of the face, hand, arm and leg. The apparatus consisted of a distillation flask, coupled with a water-cooled condenser draining the ether into a three liter bottle. The source of heat was a single steam bath. The hood contained some extraneous equipment of which there was a thermostatically-controlled hot plate with exposed contacts. The distillation was being carried on when the chemist added more ether to the flask. A bump caused by the steam raised the flask slightly. The chemist stepped over next to the hood to cut the steam back, and at that moment, the explosion occurred. The explosion caused the explosion-venting windows to open, but the venetian blinds were broken.

Cau. The connection between the flask and the condenser broke, permitting ether vapors to fill the hood faster than they could be removed. The vapors were ignited by the hot plate.

Preventive Measures:

1. Sources of ignition should be removed from areas where flammable liquids can escape. Hot plates, open flames, unapproved electrical equipment, etc., are included in this category.

2. Laboratories should be designed so that it is not possible for persons to be trapped by fire.

3. Explosion venting windows should not be obstructed. Venetian blinds offer considerable resistance to explosion pressures.

4. Consider the hazards of a job and then choose the suitable conditions to carry it out.

5. Discuss new arrangements or procedures with the safety leader. His experience is valuable in recommending safe procedures.

Reference Number of this Incident: L-43

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 68

Gas Explosion in Open Compressor Cylinder

Description: An explosion occurred during maintenance work on compressor cylinder of ammonia unit. The compressor was shut down because a loud knock developed in the third stage cylinder. The compressor cylinder was blocked in and purged in preparation for maintenance work. The block valve on the suction line to the cylinder was closed. The block valve on the discharge line from the cylinder was closed, and a blank was installed in a flange set between the block valve and the cylinder. The compressor cylinder and connected snubbers and lines were purged with nitrogen to clear the system of flammable gas. A gas test was made with an explosimeter at approximately 10:00 AM which showed the system to be clear of flammable gases. Workmen proceeded to open the valve ports to investigate the trouble. A bolt which held the inboard suction valve assembly together had broken and fallen into the cylinder. The piston, rod, packing and valve were damaged and removed for replacement. New parts were prepared to install. The pounding of the piece of bolt between the piston and the crank end of the cylinder burred over some metal of the bulkhead between the cylinder and stuffing box where the rod passes through the bulkhead. It was decided that the burred metal would have to be ground off to make clearance for the new rod. The maintenance foreman told the mechanics to have another gas test made before any grinding was done. It is the practice to have a gas test made prior to doing any spark-producing operation in the course of such a maintenance job. The time was then approximately 6:00 PM. Before the gas test was made, the mechanics prepared for the grinding operation. An unguarded, sealed beam spot light was being placed over the suction valve port to provide necessary light in the cylinder. One mechanic was looking in the open outboard end of the cylinder to see the effect of the light. The sealed beam lamp struck a metal part of the valve port and broke. Immediately, an explosion occurred inside the cylinder. No injuries were sustained, but the mechanic who was looking in the end of the cylinder had his eyebrows singed. He was wearing safety glasses. A blank was then installed in a flange set in the suction line of the compressor. The system was purged again, a gas test made, and repair work continued.

Causes:

1. Failure to blank the suction line to the cylinder.
2. Accumulation of gas in the cylinder.
3. Breaking of the light bulb causing a spark which ignited the gas.

Preventive Measures:

1. Suction and discharge lines of each section of a compressor will be blanked before purging prior to doing repair work. In lieu of a blank, double blocks and a bleed may be used where they exist.

2. New holders with a guard, no switch and three-wire grounding cable will be purchased for the sealed beam type lamp.

3. The procedure of gas testing before work starts and before any sparking operation is done will be continued.

4. Standard operating procedures should be developed and followed for repair operations on hazardous systems to prevent violations of good practice.

Reference Number of this Incident: L-44

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 69

Fire and Explosion in Blasting Agent Mix Building

Description: An explosion occurred involving approximately 55 tons of blasting agent (AN - ammonium nitrate and AN-FO - ammonium nitrate, fuel oil mixture) during welding operations on the fuel oil addition system at a combined mix and storage building. No deaths resulted; 26 persons were reportedly injured, although all but 5 were treated and released from the hospital for minor injuries. Of the 5 requiring hospitalization, one suffered extensive cuts, one a fractured skull, one shock and one suspected back injury. The fifth person suffered injuries as an incidental result of the accident; he was hit by a car while directing traffic in the congested area. Property damage was estimated in the range of several hundred thousand dollars. The operation consisted of mixing oil (No. 2 diesel fuel) with ammonium nitrate and packaging the product for local mining and quarrying industries. Prilled AN in 80-pound bags was received at a nearby rail siding (usually in 50-ton carload lots) and trucked to the storage and mixing building. The oil was delivered to the mixer through a plastic pipe by electric pump from oil storage tanks located next to the storage building on the side away from the mixing house (2 tanks, one 500-gallon and one 1000-gallon). After the AN was mixed with oil, it was stored in the same building until moved by company trucks to mine or quarry. The mixing and packaging equipment and procedure were as follows: dry AN prills were dumped into sheet-metal hopper (approx 4'x4'x4') which fed 5" pipe through which an auger (driven by electric motor through reducing pulleys) moved the prills past a second, smaller bin into which oil was sprayed. Flow of oil was controlled by manual valve. A short distance beyond the point at which the oil was added, the auger discharged into a bucket elevator which raised the mixture to the top of a hopper approximately 5'x5'x5' in size. The top of this hopper was approximately 10' above the floor. At the bottom of the hopper, 4 filling tubes (closed off with simple slide valves) controlled flow of mixture into packages. Most commonly, the mixture was repackaged into the multi-wall paper bags in which the AN had been received, although some of the blasting agent was packaged in 5" x 25-pound or 2"x48" polyethylene tubes. Sewing, heat-sealing, and wire-tie equipment was available for closing the blasting agent packages. The exact amount of raw AN and AN-FO mixture present in the building at the time of the fire and explosion could not be determined as company records were lost in the fire, but it was estimated that the building contained: approximately 20 tons untreated AN prills (in a single pile about 15' wide x 18' long x 10' high); approximately 30 tons AN-FO in 80-pound paper bags (in a single pile about 18' wide x 20' long x 6' high); 1 small pile containing approximately 2 tons AN-FO cartridged in 2" polyethylene; 1 pile containing approximately 3 tons AN-FO in 5" polyethylene. At the time of the accident, mixing and packaging operations had been completed for the day and the AN hopper, screw conveyor, bucket conveyor and mixture hopper had been emptied, and two welders were engaged in making modifications on the mixing and

packaging equipment. One welder, using an oxyacetylene torch, cut off the filling tubes from the loading hopper (for mixed material) while the other stood by with quart-size carbon tetrachloride fire extinguisher. Two of the loading tubes were replaced (using a small portable arc welder) with new tubes having a modified valve arrangement. After completion, the welders began to make some changes on the fuel oil addition system, again using a cutting torch. At this time, they noticed a fire at the bottom of the bucket elevator which, owing to its height, extended about 4' below floor level. The carbon tetrachloride fire extinguisher was ineffective and the fire increased in intensity. One welder phoned in the fire alarm, then they obtained two more quart-size carbon tetrachloride fire extinguishers from two trucks located outside the building, but these were emptied also without apparent effect on the fire. By this time, fire was spreading up the bucket elevator, presumably in the accumulations of oil and AN at the bottom of the pit and alongside and around the buckets. The fire department arrived within approximately 10-15 minutes after receiving the alarm, and ordered the area evacuated. The explosion occurred about 30 minutes after the fire was first noted. The combined mix and storage building was 1-story, frame construction, with flat sheet-metal roof approximately 12' above the 2-3/4" x 8" plank floor (floor planks spaced approximately 1" apart), and walls of sheet metal extended to within 6" of roof (leaving gap for ventilation). The ground at the site of the building sloped towards a small stream so the floor of the building lay from 1 to 4 feet above ground level. The mix house was approximately 40'x60' in size, attached to an older wooden building used primarily for storing spare parts for strip-mining equipment. There were no heating facilities in the building and posted NO SMOKING signs were reportedly observed. The explosion resulted in: complete destruction of the mix house, attached storage building, adjacent office building, 5 residences in the immediate vicinity; 3 trucks and 2 automobiles destroyed by airblast; 1 truck and 1 automobile destroyed by fire from burning fragments; the fire trucks, rescue trucks, a school bus, house trailer, and numerous automobiles belonging to firemen and spectators were severely damaged by blast. Eyewitnesses stated that a severe airblast of long duration knocked many people to the ground. Many heavy steel parts from the storage building were scattered over a wide area. The extent of fragment distribution could not be immediately determined because of hilly terrain and snow cover; however, subsequently fragments were found on top of surrounding ridges at a radius of approximately 1000'. A small cap magazine was located within 100 yards of the office building and many of the electric blasting caps were damaged by high-velocity fragments although base charges were usually intact. Electric blasting caps were scattered over a considerable area around the office building and a substantial quantity of safety fuse was found burned or partially burned at the site of the office building where small quantities were stored temporarily. Paper and other debris floated down on town approximately 3 air miles away. Glass and structural damage occurred in neighboring communities. Glass breakage was generally limited to a radius of approximately 5 miles, however some breakage was reported in a town 9 air miles to the north. Damage to other structures in the vicinity of the explosion was undoubtedly limited by the mountainous terrain of the area. The plant was located in a very narrow valley surrounded by ridges approximately 400' higher than the valley floor. The explosion created a crater approximately 100' across and varied in

depth from 4' to 14'. Sound of the explosion was reportedly heard 35 miles away.

Preventive Measures:

1. If a blasting agent is stored in the same building with ammonium nitrate, combined quantities of both materials should be considered as blasting agent. The storage building should be suitably isolated from the mixing house.

2. The storage building and mix building should be constructed of non-combustible or fire-resistant materials; however, a SUITABLY ISOLATED wooden structure may be satisfactory for the storage of ammonium nitrate.

3. The floors of storage buildings and mixing houses should be concrete, of such design and construction as to eliminate open pipe drains into which the molten ammonium nitrate could flow and be confined in the case of fire.

4. Plants used for mixing ammonium nitrate with fuel or sensitizing agent should be isolated from inhabited buildings, roads and highways.

5. Blasting agents should be stored in locations that are so isolated that employees, the public, and their property will be protected.

6. Standard magazine construction is preferred for buildings for storage of blasting agents. However, if buildings of other construction are used for such storage, they should be of one story, basementless, of noncombustible or fire-resistant construction, equipped with a water-quenching system, and free from open pipe-connected floor drains.

7. No more than 1 day's production of fuel-mixed ammonium nitrate should be permitted in or near the mixing and packaging plant.

8. Neither smoking nor open flames should be permitted in the storage building, or in or near the mixing house.

9. All electrical switches, controls, motors, and lights located within the mixing or blasting agent storage area should conform to the requirements of Class II, Division II, of the most recent edition of the National Electric Code; otherwise, they should be outside the mixing room.

10. The floors and the equipment of the mixing and packaging rooms should be cleaned frequently to prevent the accumulation of ammonium nitrate or fuel oil and other sensitizers. The entire mixing and packaging plant should be cleaned periodically to prevent the excessive accumulation of dust.

11. The interior of the building used for storing blasting agents should be kept clean and free of debris and empty containers.

Reference Number of this Incident: 1025

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 70

Liquid Oxygen Explosion

Description: An explosion occurred at the liquid oxygen filter near the storage tanks at a static test stand. The liquid gases unit of the propellant handling section was requested by the static test stand to pump liquid oxygen to the missile booster. At 11:15 AM the foreman placed one crew of men on the 28,000-gallon tanks and another crew consisting of 3 men on the 14,000-gallon tanks. Precooling of the 6" line from the 28,000-gallon tanks and precooling of the 4" line and filter from the 14,000-gallon tanks was started at 11:30 AM. At 11:40, the tower notified the crews that the liquid oxygen pumps should be started. The crew on the 14,000-gallon tanks noticed that there was no power to the pumps and notified the foreman, who went to the tower and located an electrician who threw a main breaker which connected power to the pumps. In the meantime, the pumps at the 28,000-gallon tanks were primed and pumping. At 11:50 AM the 250 gpm liquid oxygen pump at Tank No. 2 was started and put on the line. At 12:00 AM the foreman went to the 500 gpm liquid oxygen filter of the 14,000-gallon tanks and noted that the pressure drop across the filter was approximately 2 psi. The pump discharge pressure was 175 psig. At 12:05, the foreman reviewed overall conditions at both tanks and went to the static test stand. The 3 crewmen at the 14,000-gallon tanks were positioned at the end of the No. 1 Tank observing the pump discharge pressure and tank level gage. At 12:10 AM, without any warning, the 500 gpm liquid oxygen filter at the 14,000-gallon tanks exploded. The shock wave from the explosion struck the concrete fire wall and knocked the 3 crewmen against the guardrail installed around the operating platform. Parts of the filter, and steel grating over the filter, were blown with considerable force over the entire area, up to distances of 450 feet. The ruptured liquid oxygen lines immediately covered the area with liquid oxygen vapors and at this point, the 3 crewmen ran from the tanks in the direction of the pillbox south of the tanks. The crew on the 28,000-gallon tanks also left their station, but shut down the pumps prior to departure. The pumps at the 14,000-gallon tanks being left in operation caused a very large spillage of liquid oxygen at that location. However, by 12:15 AM, the foreman and the test stand personnel had called the fire department, sent the 3 crewmen to the hospital for medical check, thrown the 14,000-gallon pump breakers to shut down the pumps, and turned on the deluge sprinkler system at the 28,000-gallon tanks. The chief of the propellant handling section arrived at this time and directed the action to control the spillage hazard. By following behind the spray from the water hose used by the propellant crew at the tanks, he was able to clear a path through the heavy liquid oxygen vapor and close the liquid discharge valves and open the vent valves on the 14,000-gallon tanks. The foreman, in the meantime, secured the 28,000-gallon tanks in a similar manner. The fire department arrived at approximately 12:20 AM, connected their water hose, and commenced to wash down the

liquid oxygen spillage. By 12:45 AM the liquid oxygen vapors had been cleared from the area and the tower area was cleared for access. There were no injuries.

Cause: A detailed study of the damaged filter components indicated that the explosion could have resulted from one of the following conditions (listed in the order of most probable cause):

1. A filter element became loose and was vibrating in the aluminum header plate. A particle of contaminant was lodged between the element and header plate and was impact detonated causing subsequent burning of the aluminum header plate.

2. Contamination had built up on the filter element and a heavy foreign particle traveling at considerable velocity in the line struck the contaminant when it reached the filter element with sufficient impact to cause detonation and subsequent explosion.

Preventive Measures:

1. All liquid oxygen filters will be dismantled, inspected, cleaned, and elements and gaskets replaced with clean components every 2 months, unless for some reason the allowable pressure drop across filter reaches the maximum.

2. All liquid oxygen tanks will be chemically cleaned every 12 months in lieu of original schedule of 18 months.

3. All filter aluminum components will be replaced with stainless steel as soon as they become available.

4. Develop improved filter design (such as element threaded connections to prevent movement, etc.) and incorporate these design modifications at the earliest possible date.

5. All remotely located circuit breakers which control power to the propellant facilities will be clearly identified so that in the event of future accidents, responsible personnel can quickly disconnect all power to these facilities. As soon as all power to these facilities has been disconnected, notification of such will be given to emergency crews and other personnel who are required to enter the accident area.

6. Install remote controlled, pneumatic operated liquid oxygen tank discharge valves so that remote operation may be had in event of emergency.

Reference Number of this Incident: 1026

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 71

Match Flash

Description: A match head operator received second degree burns on his right hand and wrist and minor facial burns as a result of a match flash of approximately 6000 regular match heads. The accident occurred as the operator was transporting 3 dipping trays of matches plus a small sample box of approximately 300 matches from the match head dip room to the match comb unloading room. The operator stated that the matches flashed as he was carrying them. From the visible evidence of the location of burnt trays, matches, footprints, etc., it appears that the operator was backing through the door between the dip room and unloading room, and in so doing, very probably bumped the trays against the door or door jamb with enough force to jar a rack (or racks) from the guides or tray causing the match heads to rub or scrape against the bottom or side of tray resulting in the flash. The sample box of matches remained intact and the matches in it did not flash. The floor in the dip room is non-conductive and that in the unloading room is conductive. The humidity in the dip room was 36% at the time of the accident and 33% in the unloading room. It is considered that neither static electricity nor humidity was relevant in this case.

Preventive Measures:

1. Consider different type door arrangement to provide easier passage than the present one.

2. Additional protective clothing and equipment for unloading operator.

3. Consider providing a protective carrier to contain match trays while transporting them from dip room to unloading room.

4. Consider grounding of floor in dip room.

Reference Number of this Incident: 1027

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 72

Fire in HMM Operation

Description: Sometime between 4:00 PM and 7:45 AM the next morning, a fire occurred in the nitromannite operation. It extinguished itself before any serious damage resulted. The results of the fire were discovered by the operator when he entered the building at 7:45 AM to start the operation. A filter cloth lying on the primary filter was approximately ⅓ burned, a lead-covered wood table with a lead-covered shelf was partially charred, an aluminum bucket containing filter cake from previous shift was blackened, a rag on the shelf was burned, and charred material was scattered in a 3' radius from the bucket (including top of table and filter). The aluminum bucket had been placed in a galvanized bucket. The fire had been hot enough and of sufficient duration to melt some of the lead on the table top skirt. About 4' from the bucket containing the charred filter cake was an aluminum dissolving tub containing 120 pounds of nitromannite. This was the product obtained from the centrifuge near the end of the operating shift. It contained approximately 40% water when placed in the dissolving tub. There was no lid or cover over the tub; it appears miraculous that some of the charred material found scattered around did not enter the dissolving tub and ignite the nitromannite. If this had occurred, the entire operation may have been demolished.

Cause: The fire probably started in the rag lying next to the bucket. This rag had been used at the end of the shift to wipe off the top of the filter. It had been saturated with acetone and contained some HMM. It does not appear likely that any acid could have been on the rag; however, the rag almost certainly was dry because of acetone evaporation. The nitromannite being processed at the end of the shift was being reworked after failing stability tests. The filter cake obtained from this rework batch contained ammonium oxalate and chalk. A sample of this filter cake from the bucket was analyzed but no trace of nitromannite could be found. This leaves us with no explanation for the charring of this material, source of fire in the bucket, or the cause for spattering material out of the bucket unless a small amount of nitromannite may have been present on top of the material in the bucket.

Preventive Measures:

1. No dirty rags, paper, or other refuse is to be left in the building. These items are to be removed immediately to a covered metal waste can outside the building.

2. No filter cloths in the building should be permitted to become dry. They must be stored under water in aluminum cans.

3. All filter cake and/or other scrap process materials must be removed from the building at the end of each operating shift and dumped into the decomposing tanks.

4. No filter cloth will be returned to a filter after washing until just prior to use. Previous practice of placing a filter cloth on the filters at the end of the operating shift (to be ready for the next day's operation) has been discontinued.

5. Strict housekeeping - complete washdown of all floor areas, equipment and walls every shift.

This incident emphasizes how gradual changes and errors in procedures build up and eventually result in serious consequences. Frequent review of operations at different times may help in revealing unexpected conditions.

Reference Number of this Incident: 1028

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 73

Ignition of Rocket Motors

Description: Four solid propellant rocket motors (approximately 9200 pounds propellant) exploded during curing operations. Rocket motors, after casting, are delivered to the curing ovens by hoist and a monorail system, for curing at required temperatures for a specified time. An operator, on hearing a metallic noise or clang inside one of the curing oven bays, proceeded to investigate. He had advanced within 50 feet of the bays when he observed fire at the entrance to one of the bays. Within several seconds, an explosion occurred in an oven of the bay, followed by two other explosions at close intervals. The third explosion occurred approximately 1 minute from the time the fire was first observed. The four motors were in 2 curing ovens of the bay (2 in each oven); the remaining ovens in this bay were empty. The ovens involved were equipped with dual temperature controls. Each oven was heated by 2 floor type steam heaters utilizing 440-volt motor with fan approved for Class II, Group F locations. The heat units were directly beneath the suspended motors. Maximum steam pressure in the oven coils was 15 psig. Temperature capability maximum in the coils was 249°F. The ovens were equipped with high temperature safety cut-out on steam if oven temperature exceeds 205°F. The fire actuated the deluge and alarm system, thus evacuating personnel in the building. The spread of fire was limited due to activation of the deluge and automatic sprinkler system in the adjacent corridors and bays. There were 11 minor injuries. Ten employees leaving the building and one employee approaching the building were given first-aid treatment for shock, bruises or minor lacerations. The equipment and facilities within the oven bay involved were destroyed or damaged beyond repair. Instrumentation on back of reinforced concrete walls enclosing the oven bay was destroyed or damaged. Other equipment left in front of the curing ovens (not required for the operation) was destroyed. Heat and pressure damaged, beyond repair, the 12" reinforced concrete walls enclosing the oven bay involved at the back and one side. All missiles fell within 400' of the accident location, with few exceptions.

Cause: Exact cause unknown; probable causes:

Ignition of spilled or released propellant by friction, impact, or heat on contact with steam type floor heater equipped with electric motor and fan when: 1) head end alignment fixture dropped off motor due to failure of clamps; 2) propellant sample can, secured to motor, dropped on failure of brackets; 3) head end alignment fixture dislodged when motor dropped on failure of monorail system in oven.

Preventive Measures:

1. Inspections relating to installation of components on rocket motors should be increased to assure serviceability and/or adequacy of attachments or closures prior to casting, curing and cut back.

2. Procedures for inspection and preventive maintenance of monorail systems and weight-lifting equipment should be reevaluated to assure adequacy.

3. Engineering studies should be made of present and future curing facilities with a view toward preventing propagation of fire or explosion from motor to motor.

4. Installation of curing ovens should be considered for placement at intraline distance from other operations in new construction.

5. Engineering studies should be made with a view toward providing heat to curing ovens other than by use of floor-type steam heaters utilizing electric motor and fan.

6. Containers for propellant samples should be designed to prevent spi[illegible]e.

7. Instrumentation should not be placed on fire or substantial dividing walls.

8. All equipment (not required for explosives operations) should be removed to prevent loss in case of an accident.

Reference Number of this Incident: 1029

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 74

Explosion of Primer Mix

Description: Approximately 3/4 ounce primer mix exploded at the primer mix scooping station of the loader. The operation consists of hand scooping primer mix on the loader utilizing a small plastic powder scoop approximately 2-3/4 inches long. This scoop is approximately the diameter of a pencil and has a small calibrated scoop on one end that is dipped into the conductive rubber container containing primer mix. This scoop, when dipped into the primer mix, is drawn under a conductive rubber wiper blade that levels the scoop prior to the operator placing the primer mix through a plastic funnel permanently attached to the loader, and into a detonator that is held in a holding device consisting of a base fixture and covered by a funnel. One injury (traumatic amputation distal phalanx first, second, and third fingers right hand; multiple puncture wounds third and fourth fingers right thenar and hypothenar eminences and volar surface right forearm).

Cause: Observation of the extent of injuries to the employee's thumb, index, and middle finger of the right hand, and the damage to the plastic scoop that the operator was using at the time of the incident, indicated that initiation was caused by the operator dipping too deep into the receptacle of primer mix and actually contacting the bottom of the receptacle with the scoop end of the plastic powder scoop. This determination is based on the damage to the operator's fingers being primarily to the upper or nail portion of the thumb and two fingers involved rather than the lower surface of the thumb and fingers which is not the exposed portion of the fingers when the operator is in the act of actually scooping. Investigation of the part of the loaders at the exact location of the incident disclosed that there was no evidence of a flash coming from the dial of the loader through the permanently attached plastic funnel and initiating the primer mix in that manner.

Preventive Measures:

1. Design an automatic volumetric loader to replace powder scoopers on the detonator loading machines.

2. Recheck all equipment to assure being in proper working condition.

Reference Number of this Incident: 1030

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 75

Nitrostarch Fire

Description: A fire involving 100 pounds of dry nitrostarch occurred during routine operation of unloading dryer at nitrostarch dry house. One death resulted. The building involved was constructed with 2" plank walls, flat galvanized cover outside and lined with pressed wood. There was no damage to neighboring buildings (nearest building located at 300'). Maximum distance fragments thrown: 1 dryer tray 24"x48" at 75'. There was no glass breakage.

Cause: Unknown.

Reference Number of this Incident: 1033

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 76

Ethylene Oxide and Ammonia Explosion

Description: A feed storage tank containing several thousand gallons of ethylene oxide exploded, injuring a number of employees and causing extensive property damage. There were 22 employees involved in the accident, one of whom was injured fatally. Three were hospitalized but none are expected to suffer permanent disabilities. The remainder were taken to the hospital for treatment of cuts, bruises and minor burns or for observation. Process equipment and buildings in the vicinity of the explosion were either destroyed or severely damaged. Blast and missiles caused destruction in areas throughout the plant, and there was structural damage, mostly glass breakage, to buildings in the neighborhood. The explosion occurred in an ethanolamine manufacturing area which had been in operation for several years. In the process, ammonia and ethylene oxide were fed into a horizontal, tubular reactor using pumps which were interlocked to assure the desired proportion of reactants. Immediately prior to the explosion we experienced unusual variations of pressure in the unit and there are indications that during a period of high pressure, unreacted ammonia got back into the process feed tank containing ethylene oxide, resulting in a chemical reaction which caused the explosion. Property damage is estimated at several million dollars.

Reference Number of this Incident: L-45

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 77

Waste Solvent Explosion

Description: An unwashed empty triethylamine drum was moved into an area between two laboratories and a funnel was placed in the 2" end bung opening. Static lines were connected to both funnel and drum. Shortly thereafter, an employee working in the vicinity noted the drum smoking. He immediately turned a cold water hose on the drum. The drum contents exploded, ripping the top end nearly off and deforming the drum. Investigation showed that in the short time between placement of the drum and the explosion, someone dumped what was indicated by chemical analysis to be residues from a distillation containing phosphorous oxy-chloride and sulfur compounds into the drum. No fire occurred and there were no injuries. No damage, other than the drum, resulted.

Cause: It is believed that the addition of cold water to the phosphorous oxy-chloride residue could cause such an explosion.

Preventive Measures:

1. Strong acids, or other extremely reactive compounds must never be placed in organic waste drums.

2. Each laboratory should have its own waste drum so that control can be maintained of materials being dumped.

3. Waste drums, whenever possible, should be isolated so that the person using them is protected by a concrete block wall.

4. Waste solvent drums should be vented by removing the 3/4" bung to relieve pressure.

Reference Number of this Incident: L-46

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 78

Explosion and Fire Experimental Compound

Description: An experiment in crystal growing involving 20 grams of II-VI compound consisted of slowly passing the compound sealed in a quartz tube through a graphite ring heated by an RF induction heater to about 1200°C. Two fans were positioned to control the heat distribution, and nitrogen gas was used as a blanket around the ring. Several hours after starting this normally automatic operation, which had been unattended for about six hours, a mild explosion occurred, scattering the compound, broken quartz, and the graphite over the methyl methacrylate side and stone floor of the hood. The fans continued to run, as did the RF heater, and some time elapsed before a member of the night cleaning crew discovered the exact location, called in the alarm to an emergency phone, and returned with extinguishers to fight the fire. By this time, the fire was rapidly spreading up the hood side and flames were creeping up the outside of the hood, catching a wooden trough which extended across the room. After unsuccessfully using two $2\frac{1}{2}$-pound CO_2 extinguishers, about half of a 30-pound dry chemical successfully extinguished the fire before the community fire department arrived. Due to prompt and rapid action, damage was confined to the apparatus and hood.

Preventive Measures:

1. All experiments intended to be left unattended overnight be logged in by the control center, so the patrol and other night personnel will have specific knowledge.

2. All combustibles and corrosives, such as bottles of solvents and reagents, be removed from hoods to preclude more serious fire spread or danger to fire-fighting personnel (a glass bottle of toluene and a plastic bottle of HF narrowly escaped rupture in this incident).

3. Transite be used instead of plastics for hood shields wherever heat may be involved.

4. A fail-safe electrical hook-up be installed to cut off the fans and RF heater in case of fire.

5. The experiment be as adequately shielded on all sides as possible.

Reference Number of this Incident: L-47

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVE SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 79

Ignition of a Cast Ammonium Perchlorate Propellant Grain

During Cutting by Hand

Description: Two operators were cutting laboratory test specimens from a 92-pound cast ammonium perchlorate propellant grain. The operation was attendant. Beryllium alloy knives were used to obtain the specimens, utilizing only the pressure afforded by one hand on the knife. In the course of cutting, both operators simultaneously observed sparks at the point of cut and promptly evacuated the cell. There were no injuries. However, the grain burned so rapidly that flame singed the hair on the back of one operator's head as he was departing the cell. The automatic deluge system function as designed. Damage was negligible. About forty similar specimens had been previously taken from the same grains, with hand knives, without incident.

Cause: Ignition is attributed to the friction inherent in the cutting action.

Preventive Measures: Design studies have been initiated to determine the feasibility of providing remotely controlled machine tooling that will cut specimens of any desired shape from perchlorate propellant grains.

Reference Number of this Incident: L-48

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 80

Explosion During Sawing Composite Propellant Samples

Description: Explosion occurred in sawing bay during cutting composite propellant samples. The propellant is cast and cured in a one-half-gallon cardboard container and transported to the test laboratory. Various sizes and thicknesses of propellant samples are cut on a standard band saw equipped with a vacuum system. The saw operator had completed cutting a 1¼" thick sample from the end of the block of propellant and placed it on a laboratory cart. He was in process of completing a ¼" thick lengthwise cut when an explosion occurred in the vacuum line. One fatality resulted when fragment from the vacuum line struck the fatally injured, causing large puncture wound over the right eye. Two employees received minor injuries - one operator in the bay suffered burns to left leg and small puncture wound to left hip and the other injured suffered slight burns to both hands as he pulled the fatally injured operator from the bay. All propellant in the bay (approximately 7 pounds) was consumed by fire. Damage consisted of weak wall and roof blown off, extensive damage to equipment and electrical facilities within the bay. Hairline cracks were noted in one section of a 12" reinforced concrete wall.

Cause: Ignition of propellant fines in lower guide blocks of band saw which, in turn, ignited the propellant fines in the vacuum system. Ignition resulting from friction at the saw guide blocks propagated to the metal vacuum lines where an explosion fragmented approximately 12-14 feet of the 2-inch pipe. Review of operating procedures revealed that the frequency and method of cleaning the vacuum lines was not established. The vacuum collection system in use did maintain propellant fines wet at the collection unit, which was located approximately 25 feet from the pickup point. The vacuum system included several short radius bends which introduced a potential hazard by possible accumulation of propellant at these points. Method of cleaning the vacuum lines was by inserting hose and flushing with cold water. A recommendation to perform this operation remotely was made as a result of a safety survey 10 months prior to the accident; however, the operation had not been changed.

Preventive Measures:

1. Sawing or cutting of composite propellant samples should be accomplished by remotely controlled equipment, with operators protected by adequate operational shields.

2. Positive follow-up action should be taken to ensure that all deviations reported as a result of accident-prevention inspections are corrected promptly.

3. Short radius bends should be prohibited in standard pipe vacuum lines used for conveying propellants.

4. Dust collection systems should be of the type that will provide for wetting of the explosives as close as possible to the point of intake.

5. SOP's should incorporate provisions for thorough cleaning of the complete vacuum system to ensure removal of hazardous accumulations of explosives.

Reference Number of this Incident: 1038

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 81

Perchloric Acid Explosions in Exhaust Blowers

Description: A maintenance worker was killed and two others were injured (one seriously) when an exhaust blower connected to a laboratory hood exploded. In September 1960, a similar explosion occurred at another uranium mill and a worker suffered painful injuries. In the summer of 1959, during the course of a casual inspection of a blower at another laboratory, an explosion occurred and the chief chemist suffered injuries to his face and eyes. Following this incident, and during the course of shop maintenance on four other blowers from the laboratory, four more explosions occurred, but there were no injuries since trouble was expected and safety shields had been set up to protect personnel. The intensities of the explosions have varied. Some were very slight and involved no physical damage, while others were of such violence that they completely shattered the blower and propelled fragments for several hundred feet.

Cause:

1. All of the blowers which have exploded have been used to exhaust laboratory hoods and the explosions are believed to be due to the formation of explosive compounds formed from reactions between perchloric acid fumes and a litharge-glycerine cement. However, other reactions involving laboratory reagent fumes may be contributory.

2. All of the blowers involved in explosions are made of a very hard and brittle corrosion-resistant cast iron alloy which shatters into sharp angular fragments. In each case, the explosions have occurred while an attempt was being made to probe or remove the grouting cement which seals the rear face plates to the blower housing. On this particular blower, the manufacturer reports that the cement is composed of litharge and glycerine and it appears that this cement undergoes some reaction with perchloric acid fumes to form an explosive compound which is highly pressure-sensitive. Explosions have occurred while lightly probing the cement with a screwdriver, while attempting to chip it out with a cold chisel, and during the course of removing it by sand blasting. Consequently, if using this type of blower for exhausting perchloric acid fumes, it is considered that there is very nearly a 100% probability that an explosion will occur when an attempt is made to remove the cement grout on the rear face plate.

Preventive Measures:

1. If this model fan is used in perchloric acid service, it is recommended that the glycerine-litharge cement be removed and that the plates be

sealed with an inert cement. The following mixture is suggested: 92 ounces silica flour, ¼ ounce sodium fluosilicate (accelerator), sodium silicate (water glass) sufficient to make a stiff paste.

2. We have not been aware of any explosions with fans in which the face plate is calked with asbestos rope and held in place by a steel retaining ring and dog clamps nor have we heard of explosions with other makes of fans or blowers. However, since it is well known that perchloric acid reacts with organic bearing materials to form explosive compounds, careful examination of laboratory hood exhaust systems for presence of wood or other organic construction materials such as rubber, plastics, and various sealing compounds is recommended. The use of corrosion resistant or ether paints on the interiors of blower housings and ducts should also be regarded with suspicion. If any are present it would be advisable to remove such materials, but such removal should be done only after setting up adequate safeguards to protect personnel.

3. Hosing down of ductwork and blowers at weekly or more frequent intervals is common practice at many laboratories, but is not a guarantee against this particular hazard. This is standard practice at the laboratory involved, but an explosion occurred even after soaking the blower in soda ash solution.

4. Although we know of no instances of spontaneous explosions, this must be regarded as a distinct possibility. Safety measures should be employed when moving blowers and, in particular, personnel assigned to servicing of these blowers should be cautioned about inadvertently striking the face plate or sealing compound with a tool or grease gun. It is suggested each blower be conspicously stenciled or tagged to indicate this hazard.

5. To guard against injury to personnel who must remove the face plates, the following setup has been devised: the equipment is removed to a safe area and a steel shield erected and fastened to the fan housing; the nozzle on a sandblaster is rigged on a crank inside the shield and all the sealer removed by sandblasting; this method not only protects the mechanic from shrapnel and flying grout in case of an explosion, but also eliminates the possibility of injury to his hands from holding a chisel or other tool that he may use to to remove the sealer.

Reference Number of this Incident: L-49

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 82

Flash Fire

Description: Mixing operator had completed loading first part (425 gallons) of a batch of primer surfacer in the thousand gallon mixer. Among the last items loaded were four drums of nitrocellulose and two drums of gum. A flash fire occurred while he was cleaning the neck of the loading chute with a wooden-handled, bristle-type brush wet with flammable solvent while the chute was still in the mixer manhole. The flash ignited the vapor above the liquid level in the mixer. The searing flame erupting from the manhole burned the employee on the face, neck, and shoulders before he was propelled from the mixer by the force of the explosion. Fortunately, he was wearing safety glasses which protected his eyes.

Cause: Specific cause of flash fire is not known, However, the use of a solvent wet brush for cleaning the residue from the loading chute was not standard practice and may have contributed to the development of a static spark which ignited the vapors in the mixer.

Preventive Measures: The clean-up procedure during loading is being reviewed, and standards are being raised, including minimum of clean up until mixer manhole is covered. The necessary brushing of the sloping sides of the brass loading chute (never the neck) will be done with water wet brush which does not have wire wrapping.

Reference Number of this Incident: L-50

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 83

Propellant Explosion in Vertical Blocking Press

Description: Explosion involving approximately 50 pounds triple base propellant occurred in a 12-inch vertical blocking press during blocking and screening operations. The operator had placed a charge of propellant into the press powder cylinder and retired to the remote control bay. He commenced with normal procedures for operation of the hydraulic press ram and brought the low pressure up to approximately 350 psi. He was then requested to delay final blocking of the propellant due to a delay in the graining operations which take place in the next room. He held the propellant charge in the press basket at low pressure for a period of 5-6 minutes. When the graining process was caught up, he continued the blocking operation by switching from low to high pressure. When the pressure reached approximately 400 psi, explosion occurred. The propellant was completely consumed. This was the last block being made on this shift and contained 100% rework material. The operator received a bruise on the forehead (force of the explosion apparently caused the pressure gage, in the remote control room, to bend forward and strike him on the head). Effects of the explosion were confined to the press room and consisted of a few small holes in the ceiling and plastic window panes blown out. The press room was separated from other rooms of the building by reinforced concrete dividing walls. The exterior walls of the building were of brick and hollow tile; the floor was reinforced concrete; the roof was asbestos-protected corrugated metal with framing members of steel; windows were of the plastic type.

Cause: Exact cause unknown. After examining possible causes, it was considered that generation of heat by friction of the ram head or hard pieces of composition against the cylinder walls is most suspect.

Preventive Measures:

1. High priority be given to incompleted job orders on this blocking press dealing with installation of blow out shear ring and pilot light, in order to help in prevention of future incidents.

2. Conduct engineering study to include:

a. Better protection for the operator (overhead protection for control room, closure of pipe trench from the pit to the control room, replacing of glass cover on pressure gage with nonbreakable plastic).

b. Pressure relief port for gases in the powder basket.

c. A cushioning mechanism at the bottom of the ram travel to minimize metal fatigue of the ram.

3. Replacement press be equipped with automatic controls and a better method of inert gas purging.

4. Study be initiated to provide for more complete inspection procedure for this press and others of similar type; specifically, include provision for clearance check of the ram head at the bottom of the press.

Reference Number of this Incident: 1040

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 84

Propellant Fire in Extrusion Press

Description: Propellant ignition occurred during the extrusion of Butadiene/Methylvinylpyridine-Ammonium Nitrate composite propellant in a 1070-ton extrusion press. Secuence of events was as follows: Propellant was being extruded into cylindrical form for use in turbine starter units for liquid rocket engines. Propellant extrusion is conducted remotely with all personnel evacuated from the building. Two mixes (550 pounds/mix) of propellant were extruded on the day prior to the incident with no abnormal conditions being noted. At the completion of these extrusion operations, the die holdup of propellant (approx. 40 pounds) was allowed to remain in the press and cool water was circulated through the basket of the extruder. This was normal procedure. Extrusion operations were resumed on the day shift of the day of the incident. Operator completed the required checkout of the extruder and found everything to be normal. A new mix of propellant was moved to the extrusion building where the operator loaded 75 pounds of crumb propellant into the basket of the extruder, erected traffic barricades, and retired to the remote control panel where he completed one extrusion cycle. No abnormal conditions were noted. Operator returned to the extrusion building and removed extruded propellant grains from the grain conveyor. Following prescribed procedure, operator removed propellant flashing from the head of the ram and the vacuum grooves, checked the o-ring seal, and inspected the vacuum port screens to make certain that they were securely fastened and free of propellant. Operator charged 75 pounds of propellant to the basket of the extruder, erected traffic barricades, and proceeded to another building where he made shift relief with the oncoming evening shift operator. The evening shift operator was advised that everything was in order for the next extrusion cycle. The evening shift operator proceeded to the remote control panel and started the extrusion cycle. Normally, once the extrusion cycle is started, the press proceeds through the extrusion cycle automatically. The piston moves forward at a rate of 34 inches/minute until the ram head just enters the basket of the extruder at which time the speed of the piston is reduced to 1½ inches/minute through the action of a limit switch at the tail rod of the extruder. The ram moves forward at slow speed until an o-ring seal is accomplished between the ram head and the extruder basket. The forward movement of the piston is then stopped by a limit switch at the tail rod assembly and the evacuation portion of the extrusion cycle is accomplished. The operator reports that the piston of the extruder moved into the extruder basket at high speed and did not stop for the evacuation portion of the extrusion cycle. Before the operator could reach the manual controls to stop the forward movement of the piston, propellant ignition occurred. Personnel evacuated the area in accordance with prescribed procedures. There was no injury to personnel. The deluge system functioned as designed and power to the extruder was automatically cut off. Propellant fire within the basket of the extruder and die assembly was inaccessible to water from the area deluge, however, the area deluge prevented spread of the fire to the building proper. Fire within the basket and die assembly of the extruder continued to burn for approximately 30 minutes following the incident.

Cause: Investigation following the incident indicates probable cause to have been electro-mechanical failure of the limit switch which normally reduces piston speed from 34 inches/minute to 1½ inches/minute and stops the piston for the evacuation portion of the extrusion cycle. Malfunction of this limit switch permitted the ram to enter the basket of the extruder at high speed and by-pass the vacuum portion of the extrusion cycle thereby compressing entrapped air until its temperature reached the autoignition temperature of the propellant.

Preventative Measures:

1. Complete checkout of all limit switches and allied instrumentation to insure proper operation.

2. Review drawings and diagrams of the control system and insure that all electrical and hydraulic safety devices are functioning properly.

Reference Number of this Incident: 1048

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESE Explosive Incident Report No. 85

Laboratory Explosion

Description: An explosion occurred while attempting to condense diazirine with liquid nitrogen. There was 100-150 mm. Hg in the system and initial attempts to condense with methylcyclopentane, which is normally employed, were unsuccessful. Procedure was then switched to liquid nitrogen. There were no injuries but a considerable amount of glass was blown over the lab, and carbon soot deposited on the glassware. Had operator not worn prescribed safety equipment and worked behind safety shields, personal injury could have been considerable.

Cause: Probable cause of the explosion was air in the storage bulb containing the diazirine.

Reference Number of this Incident: L-52

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 86

Incident During Monomer Synthesis

Description: An explosion occurred during synthesis of about one pound of NF propyl acrylate (NFPA). This was the third NFPA batch made from A-3, the other two having gone smoothly. In this case the NFPA had been synthesized, the byproducts had been stripped out, and the product was being distilled from the stainless steel pot. The operator noticed that the pot temperature (then at 60°C) was rising slowly and he applied cooling; within seconds the pot vented and what is thought to have been a vapor phase explosion in the bay occurred. There was no personnel injury, and property damage was minor.

Cause: It is assumed that rapid polymerization of the NFPA led to decomposition and the very sudden temperature and pressure rise. The normal inhibitor schedule had been used, but the batch process had been modified to eliminate the chemical destruction of byproduct acrylic anhydride. It may be that this material would consume the inhibitor, leaving the NFPA uninhibited. This conjecture will be tested.

Reference Number of this Incident: L-53

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 87

Vinyl Chloride Polymerization Explosion

Description: Early in the morning, August 9, 1961, an explosion broke out at a Nitrogen Fertilizer Company Plant, claiming four lives and injuring ten people in or around its premises. The plant occupies about 100 acres in which there are about 500 buildings accommodating manufacturing plants, warehouses, offices and many tanks. The total floor area of buildings is about 1,430,000 square feet and the number of employees exceeds 3,500. These buildings are principally of asbestos or stucco-clad steel frame or stucco-clad wood frame construction, with some office buildings of wood construction. The plant produces varieties of chemical fertilizers and plastics including polyvinylchloride. The explosion occurred in the vinyl chloride polymerization plant, a building containing 18 pressure vessels, in which polyvinyl chloride is produced from vinyl chloride monomer under the pressure of 100 to 160 lb./in. at the temperature of 120° to 140°F. It takes between 10 and 15 hours to complete this polymerization in the pressure vessel. The characteristics of vinyl chloride monomer CH_2CHCl are as follows: boiling point - -13°C. (9°F.); specific gravity - approximately 2; explosion range - between 4% and 22%. During the polymerization process, the vessel is cooled because heat is generated during the reaction. The temperature and pressure within the vessels are checked by the operators with gauges and meters in the controller's room. When the temperature has stabilized and the pressure has settled down, thus indicating completion of the reaction, they stop the churning of material and open the lid on the top of the vessel. They then open the discharge valve at the bottom through which the liquid products are transported through a manually-operated funnel, and pipe to the drying and crushing plant adjoining the polymerization plant. About 6:30 AM as the reaction in the polymerizing vessel No. 3 was completed, a foreman and three employees set to work to discharge the contents according to directions from the controller's room, but in error they opened vessel No. 4 instead of No. 3. Thus the gaseous vinyl chloride monomer just in the process of polymerization burst out of the vessel filled the room, and shortly afterwards exploded, presumably ignited by a spark from electric machines, or by static electricity generated by the bursting gas, or some other unknown cause. The explosion was heard at the municipal fire department about a mile distant from the factory. A fireman on the watchtower saw black smoke clouds rising from plant buildings, but he did not see any flame. When firemen arrived at the scene, there were thick white smoke clouds with a smell of gas around the polymerization plant, and near vessel No. 4 a little flame was found. The fire was extinguished after a few minutes. They worked to rescue the wounded employees, and stayed for a possible secondary explosion, which fortunately did not occur. The foreman was found dead at the top of No. 3 tank and one of the two workers at the bottom was dead on arrival at the hospital. An employee in the controller's room died instantly and another

worker in the burner plant, a building next to the polymerization plant, died after two days. Within the premises of the factory, 8 additional persons were injured, most of them not seriously, and outside the factory two persons were injured slightly by flying glass. All the asbestos plates on the roof and walls of the polymerization plant fell out, and parts of stucco walls were also blown down. Inside the building, the steel frame was dented or buckled by the shock of the explosion. Iron floor plates, in particular, were seriously damaged with some cut off and others blown away. All the glass panes on the doors and the windows were blown off. None of the 18 vessels were damaged seriously, with the exception of vessel No. 3 which was greatly dented on the side.

Reference Number of this Incident: L-54

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 68

Aluminum Triethyl Fire

Description: A chemist dropped a gallon glass bottle containing about two liters of a 20 per cent solution of aluminum triethyl in kerosene when his feet slipped on slick mud on the walk at the entrance of a sample storage shed. The released solution flashed on contact with air and moisture, enveloping the chemist who had fallen to a sitting position. A plant safety inspector, fully dressed in protective clothing, mask, and gloves who was present to destroy discarded samples, immediately pulled the chemist to a dry area and extinguished his burning clothing. The safety inspector secured help from the adjacent laboratory and carried the chemist inside to a safety shower where clothing was removed and showering was continued for fifteen minutes under supervision of the plant nurse. The nurse also gave him a pain-killer. The local hospital was alerted and a team of doctors was waiting for the patient upon his arrival in the plant ambulance. They found the injured man to have second and third degree burns on both hands and forearms, second or third degree burns on both buttocks, and first degree burns of the face. Treatment was spectacularly successful, with release from the hospital in 17 days with prognosis of no permanent disfigurement and no necessity for skin grafting. The injured man returned to work with no limitations on the thirty-third day.

Cause:

1. Detailed safe-handling rules for aluminum triethyl had not been issued for laboratory workers, although such rules were in effect in the plant.

2. The chemist wore no protective clothing, mask or gloves while handling the comparatively large container of aluminum triethyl.

3. The glass container was carried in the hand rather than being cushioned in an inert absorbent material in a bucket.

Preventive Measures:

1. Glass bottles containing more than eight ounces of aluminum triethyl solution will be carried only in a bucket cushioned with vermiculite or other inert material.

2. Approved protective clothing will be mandatory for anyone handling amounts of aluminum triethyl solution exceeding eight ounces.

3. Proper grading of the area will be done to prevent rain-washed mud from coating the concrete walk between the laboratory and sample storage house.

4. Detailed safety rules have been promulgated covering aluminum triethyl handling in the laboratory.

Reference Number of this Incident: L-55

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 89

Laboratory Explosion

Description: A solution of 195 gm. of dibromomalononitrile in 600 ml. of ethyl ether was added to a solution of 197.5 gm. of sodium azide in 600 ml. of water (mechanical stirring) over a period of 45 minutes, while maintaining the temperature of the reaction at 5°-8°C. by means of an ice-bath. After the addition was complete, the reaction mixture was stirred for an additional 2 hours at 10°C. The ether layer was then separated and discarded. The aqueous layer was extracted six times with 500 ml. portions of ether and these extracts discarded. The water solution was then acidified with 175 ml. of a 1:1 mixture of concentrated H_2SO_4 in water. An oily product separated out which was taken up in 500 ml. of ether. The water was extracted once with an additional 500 ml. of ether and the water discarded. The ether extracts were combined and dried over anhydrous sodium sulfate. After filtering off the drying agent, the product solution was poured into a large evaporating dish in a hood late in the afternoon. The next morning the chemist stirred the oily product left in the dish and at about 10:00 AM noted that some crystals had started to form. Several times later in the day, the chemist stirred the slurry with a metal spatula in order to induce more crystallization. At about 4:05 PM, the laboratory technician reached into the hood to adjust a rack. He did so without touching or otherwise disturbing the evaporating dish. Just as he withdrew his arm, the slurry in the evaporating dish (estimated to be 75-100 gm.) exploded with great violence breaking bottles containing solvents and sodium stored in the hood. The technician's shirt and safety glasses were blown off and he sustained multiple abrasions (blast effect) of chest and both arms, multiple puncture wounds of the chest, abdomen and right arm, ruptured right ear drum and scratch on right eye. The reaction between dibromomalononitrile and sodium azide had been run previously using 1/5 the quantities used in the run which exploded. The products of these runs when isolated as an oil suspension of crystals did not explode when struck with a hammer on a steel plate. The material would decompose rapidly when heated in a flame. Pure crystals of the product isolated by dissolution in ether followed by reprecipitation by the addition of chloroform were very shock-sensitive when dry.

Cause: The amount of material being handled was grossly in excess of that considered safe to be used in a laboratory hood. Even if shielding, remote handling devices and ear protection had been employed, it is probable that a serious injury would have been sustained. The fact that two of the four frontal hood shields were in the open position probably permitted the explosive force to be dissipated and resulted in lesser initial damage and less serious injury than would have occurred had all shields been lowered.

Preventive Measures: A maximum of 2 grams will be handled during any future reaction.

Reference Number of this Incident: L-56

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 90

Firebox Explosion - Dowtherm Vaporizer

Description: At approximately 8:40 AM instruments in the control room indicated a flame failure of the Dowtherm vaporizer, F-5. Operating personnel immediately checked F-5 and found it was not operating. According to furnace start-up procedure, the firebox was checked before activating the control unit which automatically purges and lights the furnace. After the purge cycle, when the pilot ignited, there was a firebox explosion at 8:50 AM. Extensive boiler casing and refractory damage resulted from the explosion. No other equipment or buildings were damaged. These events occurred several hours after a severe rain and electrical storm.

Cause: A short developed across the fuel selector switch which allowed the fuel gas valve to open during the purge cycle, thus purging the furnace with a mixture of fuel gas and air. When the pilot ignited, the explosion occurred. There were no personnel injuries as a result of the explosion.

Preventive Measures: The fuel selector switch has been removed from the control circuit and all exposed connections have been weather-proofed. Consideration is being given to the installation of a roof over the front end of the boiler; the use of a continuous pilot flame and isolation of wiring circuits to reduce probability of "shorting." Damage was estimated at $15,000.

Reference Number of this Incident: L-57

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 91

Underground Blasting Accident - Ammonium Nitrate-Fuel Oil Mixture

Description: Premature detonation of an explosive charge occurred at a face being prepared for blasting in an underground salt mine. Two injuries resulted, one fatal. Two men were working as a powderman - helper team to charge a previously-drilled round of 72 boreholes in a 26' x 65' face. Prior to the accident, 9 holes along the right rib in 3 horizons had been loaded with explosives, and some interconnections of detonator leg wires had been made. The platform had been elevated to allow access to the upper three horizons of boreholes, and four holes near the right rib had been completely loaded, but the shunts had not been removed from the detonator leg wires. The helper reported that he had placed the initial 2' or 3' column of ammonium nitrate-fuel oil (AN-FO) in the next hole to be loaded and had handed a primer cartridge of dynamite containing a No. 4 millisecond-delay detonator to the powderman. The latter was further reported to have shoved the primer cartridge into the borehole with the air-placement loading tube so as to contact the initial charge of AN-FO, whereupon detonation occurred. The powderman received multiple severe injuries from the explosion. He remained conscious until transported to the surface, but died shortly after being admitted to a hospital. The helper suffered injuries to his right hand and minor eye injuries. Examination of the borehole in which the premature detonation occurred revealed that when the primer cartridge detonated, it was probably in contact with the bottom charge of AN-FO. The first 8 or 10 feet of the polyethylene loading tube was completely destroyed, and the remaining loading tube was found 75 to 100 feet from the face, having been ripped off the control valve and blown there. The hole in which the premature blast occurred did not pull, and adjacent loaded holes were not initiated. Apparently, AN-FO was not flowing through the hose at the time of the accident, because the control valve was found to be in the "off" position. The face was left undisturbed until careful examination had been made. Ten days after the accident, loading of the uncharged boreholes was completed, using collar priming, and the entire round was fired. During this loading, it was reported that drill cuttings in some of the boreholes were wet and mushy.

Cause: Exact cause could not be determined. The premature blast may have resulted from:

1. Mechanical damage to the detonator while inserting or tamping the primer cartridge in the borehole.

2. Stray electricity.

3. Discharge of static electricity while using polyethylene tubing to place the primer cartridge in the borehole.

Preventive Measures:

1. Holes loaded with air-placed AN-FO or similar blasting agents should be collar primed unless it has been adequately demonstrated in a particular mining operation that dangerous quantities of static electricity cannot be accumulated in the course of charging operations.

2. A wooden tamping rod should be used to insert the primer into the hole.

3. When inserting primer cartridges into boreholes, excessive force should be avoided. If a cartridge becomes lodged in the hole, the hole should be stemmed and fired with the round as if the hole were normally charged.

4. The primer should be made according to recognized safe practices.

5. The preparation and placement of primers should be a separate operation from the air-placement of the blasting agent.

6. The leg wires should be unfolded as the primer is being inserted into the hole and the remaining wire kept coiled or folded at the mouth of the borehole until after all the holes have been charged and primed.

7. All detonator leg wires should be kept shunted until ready to hook up the firing circuit; the firing line should be kept shunted at all times until ready to blast.

8. Conductive rubber or conductive plastic tubing should be used for the air placement of AN-FO to minimize the development of a static charge.

9. Floodlights or other illumination used should not be attached to the loading rig.

10. Splices in trailing cables should be mechanically strong, of adequate electrical conductivity, effectively insulated, and sealed to exclude moisture.

11. Trailing cables should be placed in trenches where they cross roadways or wherever they are exposed to moving equipment to avoid their being run over.

12. Dust-tight electrical equipment, approved in accordance with Article 500 of the National Electrical Code as Class III, Group F, should be used in mines or plants where conductive dusts, or dust that may become conductive by action of moisture or other substances, is present.

13. Electric shocks experienced by personnel in the vicinity of charging operations for blasting from equipment frames, housings, and the like should be located immediately and the cause corrected.

14. Electricity should be cut off equipment at or near a face before explosives are taken to such face, during charging, and between charging and firing of shots. If electrically-powered compressors serve loading operations, they should have no electrically-conductive connection with equipment at the immediate face during loading operations.

15. Frame-grounding conductors should be fastened securely to the equipment and maintained suitably connected to a mine grounding circuit.

16. All metal or conductive parts in proximity to loading operations should be electrically bonded and grounded to a mine grounding circuit.

17. The grounding system should be one which will limit a fault current, thereby limiting the voltage gradient in the earth, and also will provide means for immediately de-energizing the power circuit upon the occurrence of a ground-fault on the equipment or power circuits.

Reference Number of this Incident: 1044

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 92

Explosion Mercury Fulminate During Drying

Description: Six pounds of mercury fulminate detonated during drying operation. No death or injury resulted. The conditioning dry house was the "bee hive" type and set about 3 feet above the ground. The building was of frame construction, unbarricaded. No equipment was involved. Damage to neighboring buildings consisted of: minor structural damage to wood frame building, unbarricaded, at 20 feet; minor structural damage to wood frame building, unbarricaded, at 28 feet. Unbarricaded wood frame building at 30 feet was undamaged. Missile (fragment) distance was 50-60 feet, with glass breakage at 50 feet. There was no crater from the detonation.

Cause: Unknown.

Reference Number of this Incident: 1045

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 93

Detonation of Small Amount of Diazodinitrophenol

Description: Operator was in process of cleaning charging device for detonating compounds at Charge House. Powder had been removed from the building, and he was brushing dust from the hopper when it slipped from his hand and fell to the floor. The impact resulted in a detonating of powder that had accumulated under the lining of the hopper. There were no injuries and no property damage.

Cause: Impact, when hopper dropped to floor.

Reference Number of this Incident: 1046

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 94

Detonation of Powder During Disposal by Burning

Description: Minimum powder control tester was burning excess powder from the day's testing program. It amounted to a total of eighteen sticks of Coalite S, Gelodyn 3, 60 Giant and 40 Giant. The Coalite was 1-1/2 x 8 while the remaining sticks were 1-1/4 x 8. The operator had cut the sticks in half and spread the four-inch pieces evenly over the burning paper. There were no caps, fuses or other forms of explosive material beside the dynamite and gelatin sticks. The operator has used this procedure since he started the job in mid 1956. After igniting the paper he proceeded into the testing building and commenced writing up his results for the day. Approximately two minutes after he lit the paper the powder detonated causing damage to the barricade and knocked out a window in the test building. There were no injuries.

Cause: Unknown.

Preventive Measures: Excess powder from the day's testing program will not be burned by the Powder Tester but instead by the labor gang at the burning grounds. The powder tester will strip his excess sticks and failures so that only loose powder will be delivered to the burning grounds. This will be done each morning so that no excess powder will be allowed to accumulate on the testing site.

Reference Number of this Incident: 1047

Duplication of this report is authorized.

(3) Keep agitating until blend is approved for pumping or trim.

(4) If blend is satisfactory, take an additional sample for the laboratory to check thiocyanate concentration. Then pump to storage.

Reference Number of this Incident: L-51

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 95

Pipeline Rupture at Solutions Area

Description: At approximately 6:00 AM on July 6, 1962, the trim line in the solutions area ruptured. The line is 3" 304 SS, Schedule 40. The rupture occurred at the ell on the riser before the horizontal run to the blend tank inlets. The analysis of the blend in tank F-4 showed it was ready to pump except for a slight adjustment in pH. The acid pump was started, the valve opened at the trim line and acid pumped into tank F-4. At this time, the circulation-transfer pump was running. The valve on circulation line was then closed off as line to tank F-6 was opened. The operator then went to the top of the blend tanks to set valves for the blend being made in tank F-5. He opened the trim line valve into tank F-5 and closed the valve to tank F-4. He then proceeded to the thiocyanate tank to set valves for the addition of thiocyanate to tank F-5. After doing this, he opened the thiocyanate block valve at its connection into the trim line. He then went to the control house and shortly after arrival there, the line ruptured. One missile (9" x 3½") was found at a point approximately 50' northeast of the break. The block valve at the circulating-transfer pump outlet was also damaged. One portion of the split gate was bent and the bonnet gasket was blown out. When the pipe ruptured, the vertical portion was blown into the tank (F-4) causing a caving in of an area approximately 14' in circumference and a tear through the tank approximately 4" in length and 1" wide. The weld on the trim line inlet nozzle was cracked on the north side. The weld on one leg of the platform was broken loose. The pipe support on the tank foundation was bent and both the air and steam pipes attached were bent.

Cause: The trim line was full of acid when the thiocyanate was blown in. The oxidation reaction of thiocyanate and nitric acid was checked out in the laboratory, and a violent reaction occurred.

Preventive Measures:

1. Immediate reviping of the thiocyanate line, removing it from the trim line and putting it into the manheads of the tanks.

2. The following revised operating instructions were issued:

a. At no time will trim be added unless the circulating pump is in operation.

b. Thiocyanate addition: When a blend is finished and the laboratory man has taken a sample, the thiocyanate should be added through the line at the manhead.

(1) Turn on air agitation in blend tank.

(2) Add thiocyanate.

(3) Keep agitating until blend is approved for pumping or trim.

(4) If blend is satisfactory, take an additional sample for the laboratory to check thiocyanate concentration. Then pump to storage.

Reference Number of this Incident: L-51

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 96

Deflagration - DNT/TNT Blend Pumping Equipment

Description: A fire occurred involving pumping equipment used for DNT/TNT movement through steel pipe to a dynamite mixing house. The fire was accompanied by two minor reports and third report of higher intensity at intervals of approximately 1 minute. All personnel evacuated the area after the first report and no injuries occurred. The plant manager and area superintendent, who were in the vicinity, approached to within 1000' of the fire in a protected spot, and observed that only the mixing house barricade shoring timbers were burning. Under their direction, the fire was extinguished with water. DNT/TNT blend had been pumped from a 55-gallon drum to an overhead tank at the mixing house 2 hours prior to the fire. The operator had de-energized the pump motor after use. The pipe line to the overhead tank was blown clear with air after use, but the 1¼" plugcock between the pump and the 55-gallon drum had not been opened for draining. The pump, suction and discharge lines were lagged and traced with 8 psig steam. The pump inlet line was 1¼" diameter and the outlet was 1½" diameter pipe. The 55-gallon drum was not lagged and traced. The pump casing was thrown 6'. The drum end was moved 12' and the remainder of the drum approximately 4'. A 5' section of 1½" pump discharge line was thrown 100'. One foot of this line was disintegrated. The aluminum drip cover for the motor and pump impeller were melted. The alemite fitting for the pump was intact. The lubricant had last been applied 2 days earlier. The outboard bearing was lubricated with engine oil with a drip feeder. The packing gland was intact.

Cause: Cause of the ignition of the DNT/TNT blend and subsequent deflagration is uncertain. Possible causes:

1. Local overheating of the blend inside the pump casing.

2. Ignition of material which might have leaked from the casing into the lagging. This ignition could well have been catalyzed by the alkaline lagging materials and moisture, although no substantiating tests have been run.

Preventive Measures:

1. Previous tests have shown that the critical diameter for propagation of a detonation in DNT/TNT blend (70%-30%) at 125°F is in excess of 4½". Although this incident is considered a rapid deflagration rather than a detonation, additional tests on blend propagation are being performed for corroboration. The pipe lines in use were less than the critical diameters for solid TNT (3.8 cm) and liquid DNT (25 cm) and satisfactory for the DNT previously handled in this equipment.

2. Any lines used in DNT/TNT blend service will be less than the critical diameters for either solid or liquid material or will be equipped with a plastic propagation breaker.

Reference Number of this Incident: 1052

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 97

Fire and Explosion - Organic Peroxide Compounds

Description: A shipment of organic peroxides aboard a tractor-semitrailer combination caught fire and exploded at approximately 1:20 PM on April 3, 1962, during unloading operations. The shipment consisted of 37,900 pounds (not including container weights) - 17,150 pounds benzoyl peroxide; 18,000 pounds lauroyl peroxide; 2400 pounds cadox MSD (methyl ethyl ketone peroxide); 350 pounds cadox TBH (tertiary-butyl peroxide). Unloading operations commenced at approximately 12:50 PM, and 50-pound cartons of benzoyl peroxide were being unloaded and placed upon pallets on the platform. A fork lift truck was employed to remove the loaded pallets to the storage building. After 6 or 7 pallet loads had been removed, the driver and 2 warehouse employees saw gray-white smoke billowing over the top of the lading, apparently from fire in the front of the trailer. They shouted to other employees that the truck was on fire. One employee notified the fire department, including the information that the truck contained explosive chemicals. This call was recorded at 1:22 PM. Meantime, the driver sent an alarm from a fire alarm box located on a pole near the truck and this call was recorded at 1:25 PM. The driver and a warehouse employee indicated that as soon as they saw the heavy smoke coming from inside the cargo compartment, they went immediately to the front of the semitrailer and observed no evidence of fire there at that time. The driver started to detach the tractor from the semitrailer, but refrained when he heard a series of muffled explosions in the cargo compartment. About this time, several persons noted flames and smoke coming from the underside of the van, near the front and the building was evacuated as quickly as possible. The fire trucks arrived within a few minutes and a warehouse official notified them that the truck and building contained explosive chemicals. Firemen laid 2 hoses to the rear of the warehouse and took up positions to the rear of the loading platform, the 2 groups standing approximately 30' apart at angles of 20° to 30° on each side of the open doors of the semitrailer. It was intended that the two streams of water be crossed at the back of the trailer, causing a heavy spray effect throughout the cargo compartment. The water was turned on and after the stream of water had been played upon the fire for approximately ½ minute, there was a muffled explosion - then a tremendous blast. The explosion demolished the truck, caused extensive damage to the buildings and surrounding property, and is reported to have broken windows more than ½ mile from the scene. Fire immediately engulfed the entire building area, including the fire-fighting equipment. All buildings and vehicles were completely destroyed. Casualties included 4 firemen killed, 2 firemen injured, and injuries to 3 warehouse employees. The warehouse buildings consisted of 2 main structures, several small sheds and service buildings. The north building was a 2-story frame structure with asphalt siding, 175' long and 42' wide and a small brick boiler room was located near the north end, adjoining the east side. The south building was a 1-story brick and concrete structure 75' long and 30' wide, with 2 small sheds attached to the south end. A space approximately 35' wide separated these two main buildings, providing an area into which vehicles could be backed for loading and unloading at a concrete platform situated at the rear of the buildings. The truck was parked at this platform when the fire and explosion occurred.

Comment: A national fire authority had conducted tests of various peroxides, including those involved in this incident, and stated that each of the compounds is hazardous by reason of high active oxygen content which directly supports combustion and explosion processes, even though air is excluded. These tests showed that of those involved here, lauroyl peroxide was the most difficult to ignite, and burned slowly and incompletely. Methyl ethyl ketone peroxide and tertiary butyl hydroperoxide were found to ignite readily under various conditions and burn vigorously. This authority found, however, that benzoyl peroxide (solid) was extremely sensitive. It ignited under 20% of the flame exposure required for black powder, and under moderate impact, pressure or heat, and decomposed very rapidly with explosive violence, depending upon the size of the sample and extent of confinement. Several serious explosions or fires resulting from the handling of benzoyl peroxide were cited: In one instance, loose granules being swept up with a broom ignited causing a costly fire; in another case a 300-pound shipment of this compound was exploded as the truck on which it was being carried was sideswiped by another vehicle; in other instances, fire or explosion occurred when the product was subjected during ordinary handling to small sparks or overheating.

Cause: Investigation of this accident was difficult because of total destruction of the vehicle and its contents. Every effort was made to account for the handling of the shipment from the loading of the vehicle at its origin, to its arrival at the warehouse where it was to be unloaded, and to obtain complete description of events which preceded the fire and explosion while the vehicle was at the warehouse. The trailer was sealed at the shipper's plant, and traveled the 550-mile distance to destination without reported incident. The seal was not broken until the vehicle arrived at destination and just before unloading began. The only reported situation in which the cargo might have been subjected to stress occurred as the driver crossed a raised sidewalk, which caused the combination to yaw and lurch. However, this occurred more than an hour before the unloading operation began. The possibility exists that the cargo may have been subject to an impact shock as the truck was backed into the dock, or that some of the cartons fell from an upper to a lower level during the unloading process. It was not possible to make any determination of the containers used in this shipment because of the total destruction; however, with the cooperation of the consignee, stocks of the same products in their usual shipping containers at another warehouse were examined and found to be packed in accordance with ICC specifications and carried the required labels. Records indicated that the vehicle had received regular inspection and maintenance and was apparently in good mechanical condition. Consultations were also held with well-informed chemists and other specialists of major fire prevention organizations. Despite these efforts, it has not been possible to determine the cause of ignition of the cargo.

Preventive Measures: This accident demonstrates the extent to which materials commonly shipped in commerce are charged with unusually hazardous properties. It serves to emphasize the vital importance of taking all precautions to assure that such articles are loaded and handled strictly in accordance with established regulations and good practice.

Reference Number of This Incident: 1053

Duplication of this report is authorized

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 98

Vapor Phase Ignition

Description: Vapor phase ignition occurred during welding operation. The bubble cap column, part of the ethyl alcohol recovery system, was shut down approximately 1:00 PM Sunday. Dismantling was begun on Monday, when the old vapor line was removed and a 20-gauge slip blank and a backup flange were bolted to the top of the column to close the system. On Tuesday, at approximately 12:30 or 1:00 PM, on instruction from maintenance foreman because of doubt about the effectiveness of the gasket used, 2 mechanics removed the slip blank and gasket from the top of the column and reinstalled the slip blank with a new gasket, using 6 bolts to tighten the flange. The new 8" vapor line was raised into position, one end fitting into the flange on the column and the other end fitting into the flange on the condenser. When the pipe had been placed in position, department supervisor approved a light-up for the welder. Immediately upon striking an arc to tack weld the pipe, a report was heard. Welding was stopped immediately. In removing the old vapor line, blanking the column and again removing the blank to replace the gasket, the column had been open to atmosphere possibly 2 or more hours. It is considered that this provided ample opportunity for oxygen and ethyl alcohol vapors to form a combustible mixture in the head of the column. In examining the 20-gauge stainless slip blank, a spot on the blank indicated it had been very hot and had been struck by a welding electrode; the blank had been flat on installation but was now bulged from the inside out, about $\frac{1}{4}$". There had been approximately $\frac{1}{4}$" to 3/8" space between the pipe and the flange, thereby giving ample room for the electrode to pass between them and strike the stainless blank, causing it to heat and ignite the mixture in the head of the column. The column apparently was vented through a seal into the building.

Cause: The incident was caused by inadequate preparation of the equipment for the scope of work attempted. No efforts were made to displace the alcohol vapors in the column by any approved cleaning method. It was probably assumed that the 20-gauge metal blank backed by a ring gasket would prevent ignition of any flammable material trapped in the column.

Preventive Measures:

1. Before welding on equipment which has contained flammable liquids or gases, the equipment should be boiled out or thoroughly washed out and vapor tested. Whenever the process and/or equipment permits, it should be filled with water.

2. Where the presence of water in a system is not desirable, proper blanking procedures should be followed and all flammable vapors displaced by an inert gas.

3. The committee strongly recommends that no welding be permitted on equipment known to have contained flammable liquids or gases without preparation of the equipment by an approved cleaning method or the displacement of flammable vapors by an inert gas.

4. On all jobs requiring welding on equipment containing flammable liquid, alternate method of performing the job should be investigated to minimize hazard.

Reference Number of this Incident: L-58

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 99

Vapor Ignition

Description: Ignition of styrene monomer vapors occurred during drum filling operation. A helper of the polymerization department was ordered to fill ten 55-gallon steel drums with styrene monomer. This operation is done rather infrequently. A scale was placed near the feed line on which the drums are weighed. When the first drum was placed on the scale and connected to the ground with a spring-loaded clip-type clamp, the department supervisor ordered the electrical maintenance department foreman and an electrician to check with a Megger analyzer if the ground connection was good. They proceeded to scrape the paint on the drum in the place where the clamp was placed. The ground was satisfactory, and the filling operation was started. As filling started on the sixth drum, the helper moved it and a spark occurred between the filling line and the drum, causing an explosion. No fire followed. The supervisor immediately pulled out the feed line, but as he did not close the valve first, the styrene monomer spashed both persons. The supervisor closed the valve and both persons were taken to the safety showers.

Cause: A spark caused by static electricity ignited the styrene monomer vapors due to a poor ground connection; negligence in not scraping the paint off each drum when placing the ground connection; thoughtless action in pulling out the feed line without first closing the valve, causing the styrene monomer splash.

Preventive Measures:

1. Replace the rigid filling line used to fill the styrene monomer drums by a flexible metallic hose extending to the bottom of the drum.

2. Verify the effectiveness of ground connection of the system (with low voltage tester) before starting to fill the drums.

3. Replace spring-loaded clip-type grounding clamps with screw type grounding "C" clamps.

4. Emphasize the importance of good ground connections while handling flammable materials and the dangers of static electricity.

Reference Number of this Incident: L-59

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 100

Ignition of Incendiary Compounds

Description: An employee was preparing an incendiary mixture, and while adding ingredients, a small amount fell on the framework inside the mixer. Starting the mixer, he raised the lid to brush the material off the framework. While doing this, he dropped the lid, causing a spark which ignited the ingredients. The flame engulfed him causing first, second and third degree burns. He was hospitalized immediately, but died 5 days later as a result of the burns.

Preventive Measures:

1. The present mixer lid will be replaced with a non-ferrous metal lid.

2. All employees of this area have been reinstructed in the approved method of operation:

a. Operators entering the building or handling mix compound will wear protective equipment consisting of aluminum asbestos coat, hood, gloves and safety glasses.

b. Operators will not enter the building while the mixer in in operation.

3. A gate will be installed at the mixing bay entrance with an interlock to the mixer motor. This will make it impossible for persons to enter the mixing room while the mixer is in operation.

Reference Number of this Incident: L-60

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVE SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 101

Fire During Reworking Rejected Flare Pellets

Description: Ignition occurred during reworking of flare pellets, which resulted in two fatalities from severe burns and nineteen minor injuries from smoke inhalation, minor bruises, etc. Within two minutes of ignition, approximately thirty-five additional pellets caught fire and burned. The operation consisted of removing felt strips from the pellets, gluing on thinner felt strips by application of a bead of nitrocellulose dissolved in acetone, drying for approximately ten minutes, and then gauging. Damage was confined generally to the room in which the ignition occurred. The room sustained considerable damage and portion of a powder can was imbedded under a 3-inch square steel plate on the southeast wall of the room, apparently propelled from original location on the assembly table. Room construction consisted of hollow tile walls throughout, reinforced concrete floor covered with conductive linoleum, reinforced concrete ceiling, fire resistant double steel doors three inches thick with wire-reinforced glass windows at either end of the room.

Cause: Exact cause unknown. Accidental ignition of the flare pellet believed due to static discharge or friction from one of the following sources:

1. Operator could have generated a large electrostatic charge upon his person (relative humidity 10% and operator was wearing woolen trousers under his powder uniform). Acetone-air mixture at the pointed end of the plastic adhesive dispenser could be readily ignited by spark discharge from operator's body. Operator also could have discharged directly to the pellet or from a pellet held in his hand to the grounded hood as he placed the completed item behind it for storage.

2. One of the flare pellets could have been ignited by abrasion (rubbing it on the side of the hood or the shield as it was placed in the vicinity of those pellets already reworked, or by friction resulting from the removal of the felt strips from the pellet.

3. Either of the two operators could have dropped or rolled a pellet off the rounded edge of the loading table upon which the work was being done. The pellet may have impacted on a rough or sharp object on the floor in such a manner as to have caused ignition.

Preventive Measures:

1. Discontinue specific operation of removing felt on these flare pellets until more positive safety measures are established.

2. Take action to insure conductivity of safety shoes, only cotton clothing worn by operators, only non-sparking devices utilized by operators, adequate work space available for the assembly operations, extraneous hazardous

materials removed prior to starting an operation with explosives, and to provide written instruction to operators on the rework operation.

3. Require means of relative humidity control for this and similar operations and review adequacy of pyrotechnic loading facilities.

4. Initiate study to determine feasibility of installing an efficient manual alarm system which cannot be interrupted by an accident in an area involving reactive materials operations.

Reference Number of this Incident: 1058

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 102

Tank Rupture and Explosion of Propane Gas

Description: 6876 gallons of propane gas was being transported as liquid under pressure in a frameless type MC-330 tank trailer. The tank vehicle ruptured and its cargo of propane exploded, resulting in 10 deaths and 17 injuries. Property damage was estimated to exceed $200,000. Nine dwellings, one church, one garage, one house trailer, six outbuildings, two school buses, four trucks and five passenger vehicles were totally destroyed and two other houses were damaged. The accident occurred on a county highway approximately 560 feet northeast of the center of a town. The grade of road at the fatal curve was estimated at approximately 11%; the grade from the point of the curve sign around the curve was approximately 10% descending; the curve itself estimated to be more than a 70° curve. It appears that the vehicle tipped, or was at least partially out of control just prior to the rupture. The cargo tank had a capacity of 8532 gallons. The tractor trailer unit was over 45 feet in length and, as loaded, had a gross weight in excess of 60,000 pounds. The trailer had never been in an accident.

Cause: Failure of a specification MC-330 cargo tank vehicle.

Metallographic examination of ten sample sections cut from points on the weld where fracturing had occurred and of so-called "mating samples" (samples directly adjacent to those ten cut from the tank) showed a number of "undesirable features" in the welding of the cylindrical shell and hemispherical head. One of the samples showed a clear undercut which would create an area of stress concentration. The convexity of the weld in most of the samples appeared to be more than the Code allows. The Code specifies that in steel plate up to $\frac{1}{4}$ inch in thickness, the weld build-up shall not be more than 1/16 of an inch. The samples show build-ups as great as 3/16 of an inch. Such excess weld causes a focal point and the tensile stress transferred to the shell by the pressure of the contained gas will therefore not be uniform. One section shows a considerable misalignment between the shell and the head. The Code provides that in plate up to $\frac{1}{4}$ inch thickness, the misalignment should not be more than 1/16 inch. Misalignment shown in the sample is 7/64 of an inch. Such misalignment not only causes undue stress but also a bending moment increasing the possibility of fracture. Chamfering of the $\frac{1}{4}$ inch plate of the cylindrical part of the tank was insufficient in all cases to reduce its thickness to that of the thinner plate, and in addition, was done by a heat process which altered the structure of the metal, making it more brittle so that any strain would tend to crack it rather than to merely deform it (the hardness was nearly doubled by this process). Pressure exerted by the gas against the very front of the tank is only half as great as the pressure exerted on the cylindrical portion of the tank. The sharp turning of the vehicle back to the right side of the road at the bottom of the hill may have applied an additional stress factor to the weld in question. In addition to the above, evidence obtained during the investigation of this accident supports the conclusion that neither the condition of the vehicle driver, the vehicle, nor the driving of the motor vehicle contributed

to the accident, except to the extent that the motion of the vehicle negotiating the curve contributed to the stress on the front girth weld.

Preventive Measures:

1. Inspection by ICC of tanks of this particular model presently in service throughout the country to insure that they do not constitute a threat to public safety.

2. Recommend that regulation be promulgated requiring manufacturers of specification MC-330 pressure tank vehicles for transportation of explosives to file the data and certificate of compliance for such tank vehicles with the ICC, and that ICC register each vehicle and maintain record of its manufacture, major repairs, accidents, and transfers of ownership, which the carrier will be required to report to the ICC.

3. Consideration given to both more frequent and more modern testing specifications. During investigation of this accident, it was brought out that the ASME Code (which ICC regulations require specification MC-330 cargo tanks be built in conformity with) is a Code for stationary pressure vessels. It is possible that over the course of years since its manufacture, this tank was subjected to such external stresses and that they cumulatively contributed to its final weakness. Also, frameless vehicles, where the tank itself must absorb such external stresses, are as a general rule undesirable. It is recognized that regulations provide that such frameless tanks must be so constructed that the force of such stresses will be safely absorbed or dispersed, but it may be that such vehicles should not be approved at all. It is also noted that the hydrostatic retest required every five years by terms of present regulations is actually destructive in nature and may (although not shown to have done so in this accident) actually weaken pressure tanks.

4. The proper specifications and the desirability of frameless tanks are matters for careful study and for the gathering of much more expert and technical information. Recommend that proceeding be instituted, looking toward revision of standards for pressure cargo tank vehicles and, specifically, the consideration of the question of whether frameless cargo tank vehicles should be prohibited from transporting explosives.

5. Recommend new regulation be adopted requiring motor common carriers of explosives to specifically route each shipment of explosives from origin to destination. (Different routing would not have prevented this accident; however, it is considered that motor common carriers of explosives must exercise a higher degree of care toward the public than must other transporters.)

Reference Number of this Incident: 1059

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 103

Explosion - Casting Solvent

Description: An explosion occurred involving approximately 4000 pounds casting solvent, which resulted in three fatalities and eighteen minor injuries. The three fatally injured were in the building at the time of the explosion (two employees were engaged in cleanup following sampling, and the third employee entered the building just prior to the explosion) and those sustaining minor injuries were located in the surrounding area. An analytical sample of the casting solvent was present in the building in a metal pitcher and the last known position of the solvent in the pitcher was in a deep recess of the sample table. At the time of the accident, cleanup was in progress, and it was concluded that the most likely source of initiation was in some manner associated with the sample. The building in which the explosion occurred was destroyed. This building was frame construction with concrete slab lead-covered floor and barricaded (single revetted barricade) on north, west and south sides. Exterior damage, primarily, to buildings in the surrounding area consisted generally of the following:

	Distance from Point Zero	Damage
Field Toilet, unbar	285'	Major repair.
Part Storage Bldg, unbar	300'	East wall slightly bent.
Catch Tank Bldg, unbar	335'	East wall replacement; west door repair.
Casting Bldg, bar (one-half)	335'	North - wall out 2", 5 doors and 2 vents down; East - wall out 6", 2 doors and 3 windows out; South - 3 door halves and 1 vent require replacement; Upper west door requires repair.
Pump House, unbar	340'	East wall badly bent and requires replacement; north wall slightly bent.
Utility Bldg, unbar	350'	South - wall bent in slightly; corner sheet metal bent; West - entire wall bent in 1'-2', all metal requires replacement, 2 windows and door out; North - entire wall bent beyond repair, door bent beyond repair; East - wall bent in 6", 1 window out; West - roof damage.

Utility Bldg, unbar	365'	2 broken windows.
Assembly Bldg, earth bar on west, north & east sides	440'	East - wall did not move from footing, 2 window sections out, 1 door off, 3 door halves require repair; North - wall kicked out at bottom 4", 6 studs broken or cracked, 15 window sections out, 3 of 4 door halves damaged beyond repair; West - main supporting studs not moved from footing - small wall section moved in 3", wall of storage shed completely down (roof intact but down approx 1'), 4 window sections out, 7 of 8 door halves damaged beyond repair; South - wall did not move from footing, 4 windows out, door glass out, vents require minor repair.
Field Toilet, unbar	600'	2 windows each out on south & north sides.
Garage, unbar	625'	4 east doors require minor repair.
Utility Bldg, unbar	720'	North door pulled off track but no apparent door or wall damage; 2 west windows out; east wall kicked in 3" in 4' section only; no apparent damage south side.
Garage, unbar	740'	3 small holes in roof; 1 south side door broken in several sections.
Assembly Bldg, earth bar on west, north & east sides	810'	East - wall kicked in 3" 1 bay; 2 doors require repair (no glass broken); North - wall kicked out 1" at bottom, 3 studs cracked, 1 window out; 2 windows out on south door; West - all glass out, 3 doors completely gone, 1 door requires minor repair.
Operating Bldg, single revetted bar against wall of bldg, 3/4 earth	830'	West - bay wall on top (wood) completely out; South - wall on top (wood) not completely out but substantial damage, ceiling from inside

		loose with main rafters & beams split; North - upper wall firm but has been flexed out and returned to almost normal, bay entrance overhead door pushed out of its track; East - east bay upper wood wall firm, but flexing damage.
Shop Bldg, unbar	955'	Ladder shed door requires adjustment & metal bent on south side.
Inert Surveillance Rest Bldg, unbar	1010'	South side fascia board loose & double door slightly bent; East side - northeast corner top, open ¼" crack completely down side, 4 blocks damaged by fragment, southeast corner, from top down, 3/8" crack to footing.
Storage Bldg, bar earth cover, open on side facing south	1070'	Door facing south damaged.
3 Trailers, unbar	1080'	Broken windows & roof flexing; south wall flexing of 1 trailer.
Office Bldg, unbar	1080'	East cement block wall loose & pushed in at top approx half the length of the bldg; north side overhead door blown out; south wall buckled & door on south side inoperative; all plastic windows loose.
Assembly Bldg, unbar	1080'	Top galvanized section on east, south & west bowed out from pressure on top of bldg; 1 galvanized sheet torn loose on south side.
Operating Bldg, unbar	1090'	Junction of south & west wall separated by 3/4" at top; south wall leaning to south from top; plastic windows pushed out on south wall; south cement block wall buckled in several places & many blocks broken.
3 Trailers, unbar	1100'	Broken windows & roof flexing of two trailers.
2 Trailers, unbar	1190'	Broken windows.

Surveillance Rest House, bar full earth cover	1255'	Doors sprung and cracked.
Surveillance Rest House, bar full earth cover	1295'	Inside doors sprung.
Operating Bldg, bar full earth cover	1320'	Bottom hinges on bay doors torn loose; weather stripping on bottom of west door broken & bent; door latch bracket on west door torn loose.
Butler Bldg, unbar	1380'	Plaster board cracked & 1 square foot knocked from wall.
Warehouse, unbar	1420'	Inside door pulled from hinges between 2 bays; minor door damage on south side of 1 bay; 3 broken windows south side of another bay.
Shop Bldg, unbar	1450'	1 window out and 7 loose; blockwall joint opened up on east wall.
Laboratory Bldg, unbar	1500'	2 north windows partially out and 3 east windows loose.
Laboratory Bldg, unbar	1690'	Doors on north side to west require adjustment.
Change House, unbar	1850'	1 broken window on east side.
Office Bldg, unbar	1920'	5 broken windows east side.
Warehouse, unbar	2020'	5 broken windows - 3 on south side and 2 on north side.
Warehouse, unbar	2050'	2 broken windows on south side.
Surveillance Bldg, unbar	2070'	6 broken windows.
Administration Bldg, unbar	2135'	Minor damage to roof from fragments; wing wall cracked.
Equipment Storage Bldg, unbar	2170'	West sliding doors buckled outward approx halfway up.
Change House, unbar	2195'	2 broken windows east door.
Operating Bldg, bar earth on east and west sides, 3/4 earth cover	2280'	Crack in west wall between large doors running from ceiling to just above top of the doors.

Warehouse, unbar	2315'	2 broken windows south side.
Conditioning House, bar on east side	2420'	2 broken windows.
Rest House, bar earth, full cover, operating portals on west & east ends	2500'	3 broken windows on south side.
Repair Shop, unbar	2900'	Windows facing south and west broken.

The heaviest concentration of missiles (fragments) was within approximately 700' of point zero to the east and southeast, with farthest distance missile thrown approximately 2210'.

Cause: Exact cause unknown. Possible causes: accidental impact, electrostatic discharge, chemical contamination. Initiation by impact is considered the most likely source of the accident.

Preventive Measures:

1. Elimination of the sampling procedure, or if not feasible, modify sampling procedure so that retention of the sample in the building for any appreciable time is precluded.

2. Replace the acetone (which was used in small quantities for clean-up) with a less flammable cleaning solvent.

Reference Number of this Incident: 1057

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 104

Reaction - Unstable Compound

Description: Two employees were preparing to remove a bearing assembly from a shaft. The bearing was part of a sodium bromate crusher that had been transferred from the bromide plant to the machine shop for repair. The pillow block bearing had been degreased at approximately 255°F, removed from the degreaser and placed on the floor. One machinist, using a lead hammer, tapped the bearing to check alignment and tightness of the bearing sleeve on the shaft. There was an internal explosion shattering the bearing assembly into multiple pieces. Three employees were injured; two machinists and a nearby crane operator. One employee sustained fatal injuries. One was hospitalized with severe injuries and the third hospitalized with less serious injuries.

Causes:

1. The pillow block bearing apparently was contaminated with sodium bromate that may have been carried into the bearing during service, water washing, or solvent degreasing.

2. The bearing was lubricated with a petroleum base grease that contributed to the formation of an unstable compound in the internal parts of the bearing.

3. The bearing was placed in a vapor phase degreaser elevating the temperature to approximately 255°F. The degreasing may have concentrated the chemicals in the bearing.

4. Shock to the outer surface of the bearing may have initiated the reaction of the unstable compound.

Preventive Measures:

1. Hal-O grease (chloro tri fluoro ethylene polymer) will now be used to lubricate the bearings on the crusher unit. Petroleum base lubricants will not be used.

2. The department will continue to replace all bearings with new bearings when maintenance work is required on the crusher.

3. The bromide department and maintenance services department will maintain complete communications to perform safe work.

4. Engineering and construction department has been assigned the job of searching for an improved method of crushing bromate. Any improved method will be considered for installation.

5. A study will be conducted by the bromide plant to determine any potential hazards in equipment or processes that may be caused by the presence of incompatible chemicals.

6. It is recommended that all plant departments carefully examine all equipment or processes involving unstable chemical materials.

7. A task force has been appointed under the jurisdiction of the engineering department to assist plant departments in evaluation and correction of hazards related to unstable chemicals.

Reference Number of this Incident: L-61

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 105

Ignition - Dry Nitrostarch

Description: A glass sample bottle of dry nitrostarch fell from the tram truck, broke on rail, and wheel of truck ignited contents. This ignited canisters and contents and resulted in partial detonation. Total quantity involved was 500 pounds. One employee sustained slight injury. Buildings in surrounding area sustained slight damage, principally glass breakage. Weather was clear, with temperature approximately 50°F.

Reference Number of this Incident: 1061

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 106

Laboratory Explosion - Cyanoacetic Acid - Furfuryl Alcohol

Description: An explosion occurred when cyanoacetic acid was reacted with furfuryl alcohol in an attempt to form the ester, furfuryl cyanoacetate. The reagents had been mixed and transferred to a 1-liter, 3-neck flask equipped with a thermometer, stainless steel agitator, and a condenser. Three to four minutes after the agitator was turned on and heat applied, the explosion occurred. The explosion was of considerable force, and came with no preceding observable rise in temperature of the mixture. A heating mantle holding the flask was slightly deformed by the force with which it was thrust against the ring stand. Part of the glass cloth and glass wool lining were blown out of the heating mantle. The flask was blown to bits, the thermometer and goose neck were broken, but the condenser was undamaged. The inside of the hood was spattered with a solid, dark brown product of the reaction. Small pieces of glass were blown out into the laboratory, causing a slight injury to one employee in the laboratory.

Cause: Very few reference or textbooks give any warning of danger in reacting furfuryl alcohol with acids. Some books do note that furfuryl alcohol is unstable in the presence of strong mineral acids. "Organic Syntheses, Collective Volume I, page 85", describes preparation of furfuryl acetate by reacting furfuryl alcohol with acetic anhydride using sodium acetate as a catalyst. There is an appended note indicating that the product can be obtained without the sodium acetate, but there is no warning, anywhere, of danger of explosion in running the reaction. A further library search seeking to establish the cause of the explosion turned up the statement that furfuryl alcohol reacts with hydrochloric acid with explosive violence, with the formation of a dark brown product. (Marcusson, Berg., 58, 869). It is concluded that either a strong acid was present as a contaminant, or that cyanoacetic acid is strong enough to cause the violent polymerization of furfuryl alcohol.

Reference Number of this Incident: L-62

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 107

Vapor Ignition

Description: Ether and hexane had been mixed in equal proportions to a total of 4 gallons in a 5-gallon carboy placed on the floor without any protective container. As the bottle was being moved slowly across the floor, it struck a nearby empty glass carboy and broke, spilling the contents on the floor. One employee left immediately to warn occupants of the adjacent laboratory. At this moment, a laboratory service man arrived and was sent for bucket and mop. He had returned and had mopped up a considerable amount of the spilled solvent into the bucket, when the vapors were ignited. There was no strong explosion, although the concussion was felt for a considerable distance in the building. The two employees in the laboratory sustained minor burns. The entire laboratory area was evacuated because of the thick smoke which developed from the ensuing secondary fires which started in the space between the backs of the center bench cabinets and in trash containers. Five automatic sprinkler heads functioned and held the fires in check. The fire department completed extinguishment of the fires.

Cause: The source of ignition is believed to have been one of several muffle furnaces operating in excess of 1000°C in the adjacent laboratory. This was indicated by scorch marks on cabinets facing the furnaces in the adjacent laboratory. There was no evidence of any sustained fire in that laboratory. It is believed that the solvent vapors travelled from the laboratory where the spillage occurred into the adjacent laboratory through any one of a number of openings in the common wall. It has been demonstrated that this is the normal direction of air flow between these laboratories.

Preventive Measures:

1. Protective containers will be used for all glass bottles larger than 5-liter size in which flammable solvents are being used, stored or handled.

2. The muffle furnaces in the adjacent laboratory were shut down pending further investigation.

3. A more suitable location for research work involving muffle furnaces is being sought. Meantime, this laboratory is being provided with an auxiliary air supply to keep it positive in respect to the adjoining organic laboratories.

4. Efforts are also being made to provide more suitable space for large-scale column chromatography and other semi-commercial operations. At the present time, much of this work is done in a two-man, small-scale organic research laboratory.

Reference Number of this Incident: L-63

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 108

Electrical Switch Explosion

Description: An operator energized the control circuit and then turned on the operating switch for an air compressor, which caused an adjacent mercury overtemperature control switch to explode. No personnel injuries were sustained. The operator, in accordance with safety training instructions, was positioned at the side instead of in front of the switch mechanism when it exploded. The compressor had been shut down for replacement of the cooling water valve and was being restarted. The operator activated the switch, and the mercury overtemperature switch exploded, blowing the switch cover and mercury approximately 15'. The operator immediately de-energized the compressor control and locked out the power supply. Subsequently, the mercury spill was cleaned up.

Cause: Investigation revealed that the insulation inside the operating switch had failed, allowing 400 volts to short to ground through the operating switch cover and permitting excessive current to flow through the mercury overtemperature switch. The mercury inside the mercury switch apparently vaporized due to the excessive current and caused the explosion. The above apparently resulted from repeated use and wear of the control switch.

Preventive Measures: Convert control circuitry and components to 110-volt operation, where feasible, to reduce the possibility of such incidents.

Reference Number of this Incident: L-64

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 109

Explosion PBX During Pelleting

Description: Explosion occurred at 1254 hours during pressing PBX into pellets (approx 2.7 grams) in Kux Lohner single action press. Exact amount of explosive involved not determined, but estimated at approximately 5 pounds. The press, operated by remote control, had been in operation approximately 8-10 minutes when explosion occurred without warning. The press was in operation for approximately 15 days prior to the incident, during which time approximately 50,000 pellets had been produced without incident. The punch and die being used were magna-fluxed approximately 2 months prior to date incident occurred. The machine had been adjusted (raising punch to lengthen pellets) approximately 3 hours prior to the explosion and an estimated 3000 pellets had been produced since the machine was adjusted. The explosion occurred on the table of the machine as evidenced by the break-up of the table, die and the fragmentation pattern on the bay wall. Finished pellets (approx 250-300) in the holding tray immediately below the machine table did not detonate as evidenced by scattering of the pellets inside the bay and area immediately adjacent thereto; also, the pellet tray remained intact. The pelleting machine was located in the bay to provide maximum protection by 12-inch reinforced concrete wall. There were no personnel injuries. The deluge system functioned, and the fire department was on the scene in approximately 5 minutes. In addition to press damage, windows, doors and bay roofs required repair. Electric lines, lights and fixtures, steamline and deluge system also require repair.

Cause: Probable cause - mechanical failure of the press. The cam lever of the machine had broken and this appeared to be an old break on a part of the broken surface as evidenced by grease being present on the broken surface. The broken cam lever is attached to a shaft which operates the shoe to move the explosive over the pelleting die, therefore a broken cam lever could possibly cause the brass shoe to fail to recede from directly under the punch, allowing the punch to pierce the shoe which was filled with PBX.

Preventive Measures: Routine inspection schedule be continued and records maintained of mechanical checks of pelleting presses.

Reference Number of this Incident: 1063

Duplication of this report is authorized.

[illegible] EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 110

Explosion Aluminized Composite Propellant During Mixing

Description: At approximately 11:40 PM on 1/2/63 a 100-gallon Read Horizontal mixer located at a Solid Propellant Manufacturing Plant exploded with a full charge (approximately 1300 pounds) of an aluminized composite propellant containing ammonium perchlorate. The incident occurred at the end of the first 20-minute vacuum cycle and immediately after the mixer blades were reversed. No personnel were injured. The building and all equipment included in the building were completely demolished. In addition 4 other structures suffered severe damage with minor damage observed in 12 other facilities. The incident was of short duration with no fires reported. The first mix was being made in the 100-gallon Read mixer following a monthly check by the maintenance department on 12-28-62. During this check the mixer bearing packing was changed in all the bearings, and the mixer was run for 50 minutes by the maintenance men. Also during this time a check was made for vacuum leaks and for bearings operating with excessive heat. Following the normal preventive maintenance check, the mixer was turned over to production with the recommendation that the mixer be operated further to break in the new packing. The mixer was operated empty for another 5 hours during which time vacuum and temperatures were observed to operate within the proper range. At the end of this check the mixer bowl was cleaned and prepared for the next mix. The mix progressed normally throughout the eight material addition steps, with the mixer being reversed for 30 seconds at the end of each of these additions. After blending the final addition of material, a 20-mirute vacuum cycle was satisfactorily completed with the blades operating in the forward rotation. At this point in the mix cycle, as required by the mix procedure, the mixer blades were stopped for about one minute prior to initiating the reverse rotation cycle. As soon as the reverse button was pushed the mixer exploded. There were no personnel injuries although one operator was knocked to the ground when his safety helmet was struck by a fragment from the explosion. A detailed analysis of the blast area and fragments involved showed that a high-energy explosion occurred as opposed to a detonation. The confinement presented by the mixer bowl contributed significantly to the violence of the explosion. The damage sustained is comparable to that which would be expected from detonation of approximately 700 pounds of TNT. This represents approximately 25% of the total potential energy.

Cause: The cause of the explosion could not be definitely established from the blast pattern, analysis of fragments, or a review of the operating procedure used in the mix. However, because of the correlation of the time of the blast with the operation being performed, two probable causes were assigned.

1. A piece of tramp metal smaller than the 0.250" feed screen openings may have entered the mix and may have been nipped by the blade operating in the reverse direction.

2. A concentration of unblended perchlorate in the shaft seal housing could have reacted to the impact between the upper shaft housing and the shaft upon blade reversal and initiated a flame path to the mixer.

The appearance of pitting and flame scarfing on both a blade and on a mixer shaft allows either conclusion as to the source of the deflagration.

Preventive Measures:

1. All mix components are screened prior to adding to the mixer using screen meshes smaller than the mixer blade-to-bowl clearances.

2. All blade-to-bowl clearances have been increased to a minimum of 0.125".

3. All mixers above 60-gallon capacity will be of the vertical shaft design as opposed to the horizontal shaft design involved in this incident. Thus, the possibility of deflagration initiating in the mixer shaft housings will be minimized.

4. The method of feeding the mixer has been revised such that the minimum number of perchlorate additions are made at the end of mix cycle instead of the previous method of adding perchlorate throughout a large number of addition steps. By adoption of such a procedure the formation of the explosive sensitive matrix configuration is limited to a shorter period during the mix cycle.

5. Mixer blades are not operated in reverse direction during the course of a mix.

Reference Number of this Incident: L-65

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 111

Liquid Oxygen Pump and Piping Explosion

Description: An explosion occurred, after a deriming operation and during the start-up period of an oxygen column, in the impeller section of a liquid oxygen pump and in the inlet and outlet liquid lines and the vapor vent line, killing one man and injuring three others. Following the explosion, a fire occurred at the refrigerating unit (halogenated hydrocarbon) 3 feet away involving a mixture of the refrigerant and oil. Since the inlet valve to the pump was bent so that the oxygen escaping from the column could not be shut off immediately, it took approximately 15 minutes before the local foreman could extinguish the fire. Damage was confined to the pump, piping, and refrigerating unit.

Cause: The explosion apparently involved oil accumulations in the base of the pump impeller casing sump and in horizontally installed bellows type flexible hose lines leading to and from the liquid oxygen reflux pump. The source of ignition is not known although the explosion occurred during or immediately after the slow opening of the inlet valve introducing liquid oxygen into the warm pump.

Preventive Measures:

1. Drains will be installed in the bases of the impeller casings.

2. Increased efforts will be made to keep oil from being introduced into the air or oxygen stream and to remove it more efficiently wherever it is introduced.

3. All new flexible hoses will be installed with axes vertical.

4. Present pumping equipment will be modified, at least temporarily, to provide cooling and inerting with LQN before starting up or repairing.

Reference Number of this Incident: L-66

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 112

Spontaneous Ignition of Overheated Wax

Description: A trainee with only 3 weeks experience on work assignment had been carrying out coating trials with a resin and paraffin wax blend. He had melted the blend in a stainless steel beaker about mid-morning and had put the beaker with the unused part of blend back on the hot plate to keep it molten. When he returned to the area about mid-afternoon, he noticed that the blend was smoking on the hot plate. After turning off the hot plate, he carried the beaker across the area to a 50-gallon pail used as a receptacle for waste wax. As he started to pour the blend into the pail, a flash fire started. When he dropped the beaker a fire occurred in the pail, in the beaker, and in a few spots of dropped wax between. Some of the wax had also spilled on his clothing and ignited. He sustained burns on both hands, abdomen, and right thigh and arm.

Cause: The wax blend had been allowed to heat above its autoignition temperature. The fire did not start until the blend was poured, because the surface was covered by gaseous decomposition products which were relatively cool.

Preventive Measures: Better safety training will be given new employees and controlled-temperature equipment will be used for wax-blend storage.

Reference Number of this Incident: L-67

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 113

Explosion During Casting and Curing Operations

Description: Explosion (s) occurred at 3:31 AM during casting and curing operations resulting in 3 fatalities and 11 injuries. At the time of the incident, the weather was clear with relative humidity 60% and temperature 37°F. Four motors, in varying stages of processing, were involved in the incident. One motor had been cast and was in its second 48-hour ambient cure; one motor had been cured and was on air sparge following alcohol wash; one motor was in the casting pit and was in the process of having excess solvent removed from the nozzle stacks; one motor was awaiting transfer to the pit for casting. Approximately 4800 pounds of 90% nitroglycerin solvent in two stainless steel desiccators was located in room adjacent to the casting bay nearest the pit containing the motor; approximately 865 pounds of casting powder was stored in metal powder boxes in room adjoining the room containing the solvent; approximately 250 pounds of scrap casting solvent in sawdust was contained in solvent scrap cans; up to 30 pounds of residual casting solvent was contained in the aspirator catch tank. Reportedly, the only equipment in operation just prior to the explosion was an aspirator used to siphon off the casting solvent from the nozzle stacks. The vacuum pump for this system was remotely located from the building. The solvent removed from the nozzle stacks by the aspirator was passed through a rubber hose line to a catch-tank containing triacetin which was intended to dilute and desensitize the 90% casting solvent. It was reported that the sight flask (an aspirator casting solvent overflow indicator) was checked approximately 2-5 minutes prior to the explosion and there was no evidence of solvent in the flask. The operators working in the building were reportedly in the process of removing casting solvent from the nozzle stacks on the motor located in the pit. The hoses leading from the casting solvent manifold to the stacks had been emptied. Casting solvent was being removed from the nozzle stacks and replaced with triacetin. It was reported that this operation had been completed on two of the four nozzles and preparations were being made to move to the third nozzle. Reportedly, three separate and distinct explosions were heard: the first was relatively minor; the second occurred immediately after the first and was of considerable magnitude; the third occurred approximately 20-30 seconds later and had the least intensity of the three. The three fatally injured were apparently close to the center of the largest explosion and were killed by the blast. It is believed that the dry-cast motor, the casting solvent in the desiccators, the aspirator and the solvent scrap cans, and part of the motor in the pit detonated and that the two cured motors burned with probably high pressure failure. It is considered possible that the 865 pounds of casting powder in a room separate from the casting operations did not detonate. The building in which explosion occurred was destroyed and four neighboring buildings (unbarricaded utility and control building at approximately 150' from explosion site, barricaded utility building at approximately 300', barricaded catch tank building at approximately 450' and barricaded quonset-type process equipment building

at approximately 450') were destroyed. 161 of 247 buildings sustained varying degrees of damage. A high percentage of broken windows and doors in buildings occurred within a 2000-foot radius of the explosion site. The building barricade helped to minimize high velocity low-angle missiles but did not contain trajectory-type missiles. In view of the minor damage sustained by the light wood frame buildings within 800' to 2000' of the explosion, it appears that the barricade served to appreciably attenuate the over-pressure blast wave. The wooden doors on operating and control buildings were a serious source of missiles which would have been extremely hazardous to personnel had the buildings been occupied. A motor center port casting adapter was found 850' from the explosion site. Approximately 70 pounds of partially cured, unburned propellant was found within a radius of 1500' of the explosion site. There were two obvious craters at the site of the building where the explosion occurred - the largest (approximately 62' long, 46' wide and 10' deep) centered around the casting pit area and the second crater was located in the area of the casting solvent. There was evidence of a third crater in the vicinity of the solvent scrap cans. The operation involved had been performed successfully on 30 motors prior to the incident.

Cause: Sensitivity tests of the material contained in the building at the time of the incident indicated that the casting solvent was most sensitive to inadvertent initiation. No most likely sequence of events were determined at the preliminary investigation, but the following combinations of events are considered possible:

(1) That solvent material being drained from and the residual material in the aspirator tank was initiated by a handling accident, causing practically simultaneous detonation of the dry-cast unit, the material in the casting solvent desiccators, the scrap solvent, and a portion of the motor in the casting pit. In turn, the remaining two motors burned with a resulting high pressure failure.

(2) Casting solvent being hand-carried from the aspirator or the pit to the solvent scrap can was initiated with the same general sequence of events occurring as described in (1) above, with the exception that the material in the aspirator tank was included in the major detonation.

(3) That a handling accident occurred at the pit containing the motor with the same general sequence of events occurring as described in (1) above.

(4) While it is not considered to be a probable cause, the possibility of the explosion being initiated by falling equipment inadvertently left behind when repairs were made to the overhead hoist cannot be eliminated. (Maintenance work had been accomplished on the air hoist in the area of the pit during the shift preceding the incident.)

Preventive Measures:

1. That a single processing operation be conducted at one time in any operating building.

2. That the process for mixing scrap casting solvent and desensitizer be improved to insure more uniform blending of these materials.

3. That a non-shatterable translucent or transparent plastic material be substituted for glass in all windows in all buildings and that restoration efforts and new construction criteria be directed toward minimizing the window area.

4. That doors on control houses be designed to prevent shattering and be oriented to minimize blast effects on operating personnel.

5. That procedures for hand-carrying high nitroglycerin content casting solvents be reviewed to minimize the inherent hazards, with an intent to eliminate hand-carrying wherever possible.

6. That the practicality and economics of using reusable video and audio tapes to record critical processing operations be investigated. Such use would be extremely valuable in determining the cause of similar incidents.

Reference Number of this Incident: 1066

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 114

Fire - Tracer Composition During Mixing

Description: Ignition occurred involving one 50-pound batch of tracer composition during final stage of mixing. The last ingredient had been added and the operators returned to the remote control station. Immediately upon activation of the mixer, the ignition occurred. The tracer composition consisted of magnesium powder, strontium nitrate, dechlorane, and vinyl acetate - alcohol resin (Palmer Cement). Weather conditions at the time of the accident were - temperature 46°F, clear with northwest wind, relative humidity 60%. All personnel of the building were in the approximate area of the remote control station at the time of the accident, and no injuries were incurred. The roof over three cubicles and ramp was destroyed by fire, and walls require repair. Two 500-pound capacity mixers were damaged. (The bays were covered by a non-flammable type material but supported and joined by wooden trusses and rafters.)

Cause: The specific cause was not determined, but indications are that one or a combination of the following are probable causes of the accident:

1. Friction or impact as a result of the possible introduction of extraneous material into the mixer during preparation of the mix.

2. Friction or impact as a result of hardened particles from previous mixture being rolled over or crushed between the plow and bottom or side wall of the mixer with the presence of the sensitive component of the tracer composition. (Scoring of the wall and bottom of the mixer are indicated.)

Preventive Measures:

1. The complete standing operating procedure be reviewed and revised where necessary to insure adequate instructions for preparation and mixing of the tracer composition, and for the cleaning and gaging of the mixer.

2. Adequate written procedure be prepared for the millwright performing the inspection and gaging of the equipment involved.

3. A blow-out type roof and exterior wall be constructed covering the explosive bays of the building; supporting materials should be metal or other type non-flammable material, and roofing of material such as fiberglass, carlox, etc.

4. Testing of equipment grounds be performed more frequently.

5. Containers used in preparation of sensitive materials should be completely cleaned prior to reuse to prevent the possibility of extraneous materials inadvertently getting in the sensitive mixture. Consideration should be given to throw-away type containers for use with compounds such as Palmer Cement.

6. More effective supervisory control exercised.

Reference Number of this Incident: 1067

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 115

Explosion - Burning Operations

Description: An explosion occurred while the operator was transferring fuze shrapnel into baskets for reburning in the bullet furnace. The operator had poured fuze shrapnel into a pan and was shoveling the material into a reburning basket when explosion occurred. Apparently an unburned detonator exploded. A piece of shrapnel was thrown, piercing the operator's protective clothing, and a small fragment of metal imbedded in the lower portion of the right lung. Subsequent to this incident, an examination of the remaining scrap material in the pan revealed other unexploded fuzes.

Preventive Measures:

1. All demilitarization operations involving fuzes will be suspended until refined handling methods for residual scrap are studied. Equipment design and operating procedure changes will be devised to relieve the operator of the responsibility of judging the effectiveness of the initial burning. (Explosive scrap burners (operators) were instructed to visually inspect the baskets after they have cooled to determine the extent of demilitarization effectiveness and to remove the scrap contents for transfer only when, in their opinion, the burning was complete.)

2. Before any burning work of this nature is resumed, all operators will be reinstructed and operating procedures reviewed in detail.

3. Closer inspection of scrap components to be returned from the burning grounds will be made to avoid handling unexploded items. In the event any live material is noted in the shrapnel, the basket will again be subjected to a complete burning cycle before further removal is accomplished.

4. The fuzes will be burned at the burning grounds only in the small baskets in the future to assure that contents are subjected to adequate heat.

5. The Engineering Section will be requested to design a means of burning fuzes using oil or gas in such a way that the heat can be increased at the end of the cycle to guarantee all fuzes will detonate. Also, that a design study be made for possible use of remote controls for dumping of the residue after burning.

6. Studies are being made on possible changes in sensitivity of initiating explosives which have been subjected to heat, but not exploded.

Reference Number of this Incident: 1068

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 116

Explosion - Shock Sensitive Contaminant

Description: Two employees were preparing to remove a bearing assembly from a shaft. The bearing was part of a sodium bromate crusher that had been transferred from the bromide plant to the machine shop for repair. The pillow block bearing had been degreased at approximately 255°F, removed from the degreaser and placed on the floor. One machinist, using a lead hammer, tapped the bearing sleeve on the shaft. There was an internal explosion shattering the bearing assembly into multiple pieces. Three employees were injured; two machinists and a nearby crane operator. One employee sustained fatal injuries. One was hospitalized with severe injuries, and the third was hospitalized with less serious injuries.

Causes:

1. The pillow block bearing apparently was contaminated with sodium bromate that may have been carried into the bearing during service, water washing, or solvent degreasing.

2. The bearing was lubricated with a petroleum base grease that contributed to the formation of an unstable compound in the internal parts of the bearing.

3. The bearing was placed in a vapor phase degreaser elevating the temperature to approximately 255°F. The degreasing may have concentrated the chemicals in the bearing.

4. Shock to the outer surface of the bearing may have initiated the reaction of the unstable compound.

Preventive Measures:

1. Hal-O grease (chlorotrifluoroethylene polymer) will now be used to lubricate the bearings on the crusher unit. Petroleum base lubricants will not be used.

2. The department will continue to replace all bearings with new bearings when maintenance work is required on the crusher.

3. The bromide department and maintenance services department will maintain complete communications to perform safe work.

4. Engineering and construction department has been assigned the job of searching for an improved method of crushing bromate. Any improved method will be considered for installation.

5. A study will be conducted by the [illegible] plant to determine any potential hazards in equipment or processes that may be caused by the presence of incompatible chemicals.

6. It is recommended that all plant departments carefully examine all equipment or processes involving unstable chemical materials.

7. A task force has been appointed under the jurisdiction of the engineering department to assist plant departments in evaluation and correction of hazards related to unstable chemicals.

Reference Number of this Incident: L-6

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 117

Ignition of Ligroin in Centrifuge

Description: A fire occurred when a static charge built up in a centrifuge and discharged within a vapor rich atmosphere. A centrifuge operator was looking into the basket of the centrifugal extractor into which the slurry of ligroin and crystals was being fed by gravity from the reaction vessel. A flash occurred which burned the operator's face and hand. The fire which ensued enveloped the equipment and also discharged into the floor drains surrounding other chemicals in the area with flames.

Cause: Static charges are generated whenever liquids are broken up into droplets, fine streams or mists. As they leave the container they carry a charge, leaving an equal and opposite charge on the container. If the container is not grounded the charge may build up to a high degree and when conditions are right a spark occurs. If the spark is within a flammable atmosphere ignition results. After the fire, the centrifuge was checked for grounding and bonding. It was discovered that the resistance between the basket and ground was greater than 15 megohms. It is thought that the grease on the bearings was sufficient barrier to prevent adequate drainage of the static charge and that the bolts in the framework were near enough the basket to provide a point for the discharge of the static in the form of a spark. It is also a remote possibility that the mist could have created a charge on some insulated portion of the vent duct which then discharged and ignited vapors which flashed back to the centrifuge.

Preventive Measures:

1. Frequent checks should be made on equipment handling flammable liquids to be sure all parts are adequately grounded. This should include the equipment, pumps, pipelines, hoses, ductwork, etc. This practice should be followed more frequently during winter months because the air within the buildings is dry, preventing drainage of static easily through the thin film of moisture which forms on equipment.

2. Grease on bearings may isolate from ground all parts of machines and equipment (such as rolls, rotors, drums, etc.) which run in bearings and therefore should be carefully checked.
(The use of conductive grease would contain graphite and would act more like an abrasive at the high speeds of centrifuges.)

3. Each fall, grounding techniques should be reviewed with operating personnel, as a reminder prior to the dry winter months.

4. Gravity flow of flammable liquids is hazardous. An emergency means of shutting off the flow should be installed whether it be remotely

operated valves, self-closing valves under fire conditions, or by pumping liquids.

Reference Number of this Incident: L-69

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 118

Magazine Fire

Description: A magazine 75% full of pyralin wads* for 5"/54 and 6"/47 caliber cartridge cases was damaged structurally and the contents destroyed by fire. The magazine was the center one of a group of three of the Corbetta type. (Circular type igloo magazine of concrete construction 52' diameter, 16' ceiling height at center, deck reinforced concrete with 6" thick reinforced walls - reinforcing extending 12'9" from the base up toward the top, the top section of poured non-reinforced concrete also 6" thick. The magazines are built in groups of three and are earth-covered to a depth of 2' on top with continuous fill between igloos amounting to approximately 12' of earth with 1' of earth separating each igloo from its neighbor at the base. A common deck serves all three igloos.) The pyralin wads were packaged in cardboard boxes and palletized on wooden pallets within wooden pallet crates. The pallet crates consisted of sideboards with no top or bottom, exposing the top layer of cardboard boxes. The fire, which commenced at midnight, was allowed to burn out; no attempt was made to fight the fire because of the possibility of fire and explosion of the right-hand igloo which was 25% full of 6"/47 smokeless powder in Mk 27 powder cans. (The left-hand igloo was empty.) The magazine fire was extremely intense but was confined to the magazine interior with the exception of orange/yellow nearly smokeless flames emanating from the open door to a height of approximately 35'. Flames also emanated a few feet above the vent at the top of the magazines and burned the grass off the top of the center igloo as well as the grass up to the middle of each adjacent igloo. Weather conditions for two days preceding the fire were cool and damp; ground in the magazine line area was soft and moist, and vegetation in the area was green and moist. The two adjacent igloos were unaffected by the fire; the walls adjacent to the center igloo were cool to the touch and the magazine temperatures remained an unchanged 70° to 71° as indicated by the maximum-minimum thermometers. The magazine involved was considered structurally unsound after the fire and was put out of service as other magazines were available for use. There were a multitude of cracks in the dome and walls of the structure, however the dome vent was in place and apparently undamaged. Door casement and entrance walls were cracked. The door vent screens were loose but still in place. The doors were still on hinge pins. The left door was bowed and blown open and the right door was bowed and ajar.

* Pyralin is a mixture of low-nitration nitrocellulose and camphor with urea as a stabilizer. Since much of the nitrocellulose is not thoroughly purified, the stability of different lots of pyralin wads will vary considerably. Pyralin should be treated insofar as practicable like smokeless powder.

Cause: The cause of the fire was undetermined. No discrepancies or unusual conditions were noted in the bimonthly inspection of the magazine involved. Railroad dispatchers record shows that no rail traffic occurred in the magazine line during the day on which fire occurred. Records indicate that the material was stored in the magazine involved in 1953 and 1957, and 60-day 150°F surveillance test was completed two months prior to the fire. Pyralin wads were stored in accordance with standard requirements and a review of storage methods and safety practices employed relative to storage of pyralin revealed no improper or overt practices. Public maintenance crews had not worked in the magazine line area on the day fire occurred. Internal and external condition of the magazines of the line ranged from satisfactory to good, and no dangerous fire hazards could be located. All magazine vent screens were in place and undamaged, and dome vents were in good condition. Security patrols could recall no lightning activity over the depot, although it was overcast most of the evening prior to the fire.

In view of the successful 60-day 150°F surveillance test, as well as the cool magazine temperature documented on the day of the fire, the possibility of spontaneous combustion is considered remote. The possibility of a rodent igniting a match, while remote, still exists as there have been a few instances of finding matches within pallets of material when moving them from a rail car into a magazine, as well as when transferring material out of a magazine. There is a possibility of personnel leaving a lighted cigarette in the vicinity of the pyralin wads, although no evidence could be found to support this. (A thorough search conducted of the magazines in the group in question, as well as the adjoining magazines and grounds, revealed no burned matches, cigarette ashes or butts.)

Preventive Measures:

1. Regulations pertaining to smoking, match searches and introduction of smoking materials into the restricted area have been revised to make them clearer and more forceful.

2. Reinstall a sentry booth at the entrance to the restricted area to be manned during normal working hours. This will take some of the load off the main gate security requirements and also serve as a match-and-lighter surrender station. (A surprise match check conducted the day after the fire revealed that apparently the match checks being conducted twice monthly have been ineffective in detecting violators and use of an unmanned drop-box and the "honor" system for surrendering and reclaiming of matches and lighters apparently has discouraged people from leaving their lighters behind.)

3. Initiate formal training program for magazine inspectors and other storage division personnel in order to qualify and requalify periodically, personnel inspecting and stowing magazines. Conduct surprise field inspections.

4. Conduct pericdic explosive safety lectures for storage division personnel.

Reference Number of this Incident: 1077

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 119

Fire - ARP Propellant

Description: ARP propellant is transported in a closed truck from a cutting building to a forced air dry building. The propellant, in trays, is placed in wooden cabinets and the filled cabinets are loaded into the truck. When the vehicle reaches the dry building, the cabinets are unloaded and wheeled into the dry building. A truck (containing 3 loaded and 3 empty cabinets) was positioned at the unloading dock of the dry house. While the dock board was being placed between the truck and the dock, a flash occurred. The propellant in the cabinets on the truck ignited. The fire propagated from the truck to the dry house and ignited the propellant therein. There were approximately 10,920 pounds of propellant in the dry house and 780 pounds in the truck. The dock board was carried in the vehicle. It was necessary to remove it from the truck each time a trip was made. One man was assigned to position this board. The cabinets were not equipped with doors. During transit, it was learned that some spillage of propellant from the trays occurred, contaminating the truck bed. The man placing the dock board suffered first and second degree burns on his face, ears, neck and right forearm. Both the truck and the dry building were destroyed by fire.

Cause: Exact cause unknown. Probable causes:

1. Ignition of ether-alcohol vapors when the dock board was either dropped or dragged on the floor of the truck.

2. Ignition of propellant grains by friction or impact when dropping or dragging the dock board.

3. Discharge of static electricity from the operator to a metal object.

Preventive Measures:

1. Standing operating procedures should require two people to position dock boards. Instructions should be specific to state that dock boards will be kept on the dock and that boards will not be dropped or dragged during positioning.

2. The design of trays and cabinets containing propellant should preclude spillage of propellant during transit.

3. Prior to removing cabinets from vehicles, all spilled propellant should be removed.

Reference Number of this Incident: 1076

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 120

Explosion and Fire During Propellant Block Breaking Operation

Description: Nitrocellulose is pressed to form dehydrated blocks of propellant. The blocks of propellant containing 13.25% nitrogen are transferred to the block breaker building where they are mechanically broken. The total volatile content of dehydrated propellant blocks averages 14% (2% moisture and 12% alcohol). After charging the block-breaking machine with 130 pounds of nitrocellulose, two operators retired to the control room to start operations. Approximately 30-45 seconds after the machine started, an explosion occurred. The block breaker building was demolished. A buggy containing 440 pounds of nitrocellulose in block form ignited and burned. Missiles were projected to a distance of 900 feet. One employee received fractures of right ribs and shoulder blade, and facial lacerations. The other employee suffered from fractures of right forearm and upper jaw, and laceration of right ear.

Cause: Direct cause unknown. Probable causes:

1. Pinch points created by broken bolt entering process equipment.

2. Friction caused by basket blades impacting against each other.

3. Ignition of explosive solid or air mixture confined in the basket.

Preventive Measures:

1. The design of the breaker baskets should be revised and standardized to permit ease of inspection, proper maintenance and to preclude tramp material entering the block breaker. Inspections should be conducted on a daily basis. (An examination of the basket after the explosion revealed old cracks in several of the anchor bolts attaching the ribs of the basket to the hub. This could allow nitrocellulose to enter between the ribs of the basket and its base. If nitrocellulose entered this area, friction between metal parts could have ignited the nitrocellulose. The construction of the basket made it difficult to inspect the anchor bolts to determine their serviceability.)

2. Standing operating procedures for all phases of block breaker operations should be established and maintained. (There was no standing operating procedure for periodically cleaning the breaker basket. During the last maintenance check, a thorough inspection of the basket could not be made because it still contained residual nitrocellulose.)

3. Operating controls for the block breaker should be located at intraline distance from the block breaker building. Adequate frontal and overhead protection for operating personnel should be provided. (Block breaker operations were not remotely controlled.)

4. Heating facilities should be provided to accomplish thorough washdown and housekeeping practices during cold seasons of the year. (There was no heat available in the building. This prevented thorough washdown of the building and equipment during periods of extremely cold weather.)

5. Supervisors and maintenance personnel should take immediate action to repair defective equipment. (The switch which operated the drive motor for the block breaker was not functioning properly. Although this was previously reported, maintenance or repairs were not accomplished.)

6. All block breaker process equipment should be checked (fluoroscope or X-ray) prior to use and at periodic intervals thereafter. (The basket involved in this explosion had previously been flashed, re-assembled and installed without internal inspection by either Zyglo, dye-check or X-ray.)

7. Confinement of solid or air mixtures that could result in explosion (rather than fire) should be avoided. (A $\frac{1}{4}$" screen was used on the outer peripheral surface of the basket. The confinement of flame could have contributed toward an explosion rather than a fire.)

Reference Number of this Incident: 1073

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 121

Explosion and Fire During Mixing Operation

Description: A low order explosion and fire occurred involving between 500 and 1000 pounds of material in a mixer. During the fire which followed, approximately 2000 pounds of combustible material was consumed. The incident resulted in 3 deaths and 8 minor injuries. The mix house building construction was corrugated iron with heavy concrete barricades. Outside of the building destroyed mostly by fire, with very little damage within the plant. The weather was clear, with temperature 35°F and humidity 65%. Missiles were projected 500' (1-pound), 200' (5-pound) and 125' (200-pound). No glass breakage in plant over 500'. Unbarricaded building of light construction (unoccupied) at 250' west of explosion site sustained slight structural damage and building with natural barricade, also of light construction, located at 250' south of explosion site sustained glass damage. This building was also unoccupied.

Cause: Unknown.

Reference Number of this Incident: 1072

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Explosive Incident Report No. 122

Chemical Fire

Description: Ten kilos of an azido compound were being prepared. Smaller quantities had been previously prepared and no difficulties experienced. No difficulty was experienced in the chemical preparation of the material in methyl alcohol suspension. The material was finally dried in a tray dryer heated by an ordinary steam radiator. It was left overnight in the tray dryer in the laboratory where it had been prepared. During the night, while no one was in the laboratory, the material ignited. There was a puff or mild explosion sufficient in force to open the dryer doors, open the explosion venting windows and also to open the doors leading to a corridor. Burning material was distributed through the room and out into the corridor. Eight sprinklers in the laboratory and two in the corridor opened and controlled the fire. The number of sprinklers opened and evidence of charring of all wood surfaces indicates a fire of considerable intensity. It is evident that serious injury might have been expected if this had occurred while the laboratory was occupied.

Reference Number of this Incident: L-70

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Explosive Incident Report No. 123

Fire - Toluene

Description: A fire occurred when toluene at 75° was being recycled through a Sparkler type filter. The operator was at the filter manually bleeding off the air when he noticed the toluene surging in the line from the bottom of the vessel to the pump. He switched off the vessel agitator and the situation corrected itself quickly. Vapors then spurted out the filter-vent with such force as to cause a four-to-five foot ½-inch polyethylene hose from the vent to flip out of a plastic bucket located on an adjacent table. Some seconds later, a crackling noise was heard and the operator saw a flash of flames about his feet, and also at a wall behind the filter to his right. As he ran for the extinguisher, he heard cracking noises and, thinking an explosion was imminent, he rushed outside. He, and another man, called the fire department and turned in the plant alarm. The fire was extinguished in 30 minutes, principally with foam. Extensive damage resulted to service and chemical lines including electrical lines and instruments. The building was not sprinklered but structural damage was confined to windows and doors with superficial damage to reinforced concrete beams. A thick layer of soot was deposited everywhere, mostly from the 200 gallons of hot toluene in the extractor feeding the filter and consumed in the fire, when glass pipe lines broke from the intense heat.

Cause: It is believed that static ignition occurred when the hot toluene vapors issued from the plastic hose at sufficient velocity to blow the line from the bucket. Atmospheric conditions were dry. Prior to the incident, a bad leak developed in the feed line to this extractor while 30 gallons of toluene were being pumped in. Toluene ran onto the floor and into the drain which was hosed down. A couple of hours previously, washes containing toluene were neutralized and released down the drain. The pump was checked and found in perfect working order. The bonding wires on the glass lines were intact.

Preventive Measures: Preventive measures will include installing a vent receiver, flexible bonded hose and sight glass, with the receiver venting outdoors through a flame arrestor.

Reference Number of this Incident: L-71

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Explosive Incident Report No. 124

Explosion Methyl Azide During Vacuum Distillation

Description: A chemist was seriously injured when an explosion occurred while he was vacuum distilling methyl azide. He was either holding or shaking the trap containing the azide with his right hand when it detonated, seriously injuring his right hand. He also sustained superficial burns and lacerations about the face and chest. The shock wave broke the overhead fluorescent lights and bottles of organic reagents about the laboratory. Adjacent equipment in an area approximately 5' wide, and vacuum lines were completely destroyed. Burning liquid and glass were spattered on the chemist and the right lens of his safety glasses was broken. Ordinary glasses in a pocket case were completely demolished.

Cause: The method of preparation used was the methylation of an aqueous sodium azide solution with dimethyl sulfate. Four previously successful preparations had been made in the same manner. The pH of this reaction is controlled at 5-7 by use of methyl red indicator and addition of sodium hydroxide if needed. If the pH was close to 5 or dropped for a short time below 5, then hydrazoic acid, a powerful explosive, can be formed and distilled out with the methyl azide. It is believed this may have occurred, and, as in another case described in the literature, a slight shock caused mercury azide formed by reaction of the hydrazoic acid and mercury in the manometer to detonate.

Reference Number of this Incident: L-72

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Explosive Incident Report No. 125

Explosion - Nitroglycerin

Description: An explosion occurred at 1:24 PM involving 7540 pounds nitroglycerin in lead NG storage tanks at combined neutralizer-storehouse, which resulted in one fatality. The deceased was seen entering the nitroglycerin storage barricade carrying slum pail approximately one minute prior to the explosion. The building involved consisted of wood frame construction and was barricaded (natural configuration timber faced on 3 sides and single faced mound on one side). The timber facing was destroyed and artificial mound top ⅓ removed. Two unbarricaded wood frame buildings at 50' north of explosion site were demolished; three barricaded wood frame buildings at 300' east and west sustained serious structural damage; eight unbarricaded wood frame buildings at 300'-500' north sustained moderate structural damage; six barricaded wood frame buildings at 500'-1200' west sustained minor damage and unbarricaded wood frame building at 1400' west was undamaged. Glass breakage (one window) at 1 mile distant; missiles - a few pieces (5-10 pounds) lead and steel at 800'-1000' radius.

Cause: Unknown.

Reference Number of this Incident: 1079

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 126

Propellant Ignition During Mixing Operation

Description: Ignition of approximately 280 pounds of polybutadiene/ammonium perchlorate solid propellant occurred in the mix can of a 25-gallon vertical Beken propellant mixer. The propellant mix had proceeded normally. An extended run of 25 minutes had been completed and the point in the mixing cycle had been reached where personnel were to lower the bowl, enter the building, perform the second scrapedown of the walls of the mix can, and add the MAPO (Tris (1-2-Methyl) Aziridinyl) Phosphine Oxide) curative. Personnel entered the building and performed the scrapdown of the walls of the mix can, paying particular attention to see that all ammonium perchlorate had been incorporated into the propellant mix. The temperature of the propellant mix was 176°F. The MAPO curative was then distributed over the surface of the propellant in the mix can. Since the process specification requires very tight tolerances on the amount of MAPO used in the propellant formulation, the operator proceeded to weigh back the emptied MAPO container to determine the amount of MAPO hold-up in the emptied MAPO container in order to calculate the exact amount of MAPO added to the propellant mix. These calculations indicated that an excess of 1.6 grams of MAPO had been added to the propellant mix. The operator and the attendant quality control inspector had gone to the telephone (located immediately outside the south entrance of the mixer building in which incident occurred) to obtain instructions from their supervisor when spontaneous ignition of the propellant occurred. Approximately 2-4 minutes had elapsed since the MAPO addition had been made to the propellant mix. The operator and the quality control inspector immediately evacuated the area. The automatic deluge system functioned as designed, the automatic fire alarm sounded at the fire station, and emergency vehicles proceeded to the area, where routine emergency plans were carried out. There were no injuries to personnel. The propellant in the mix can burned completely, despite the timely operation of the deluge system. While the mixer building involved is of light frame construction (wood and gypsum board), activation of the deluge system limited damage of the building to scorching of the interior surfaces of the walls and ceiling in the immediate area surrounding the mixer. Exterior painted surfaces of the mixer were scorched, however, damage to the mixer appears to be of minor nature. Removal of water from the mix can revealed interior surfaces of the mix can to be bright and shiny.

Cause: Investigation following the incident has yielded no positive clue as to the cause of propellant ignition. Since the propellant was at rest at the time of ignition (mixer blades had been withdrawn from the propellant itself), the common causes of propellant mixer incidents, such as friction from metal-to-metal contact between the mixer blades and the mixer bowl walls or from the presence of foreign materials, were eliminated. Also, since this was a vertical mixer, contamination of submerged packing glands was not a factor.

There were no deviations from standing operating procedures or from propellant mixing operating instructions. Investigation revealed that propellant ignition was probably caused by an exothermic reaction between MAPO and ammonium perchlorate in the propellant mix. As the exotherm reached the autoignition temperature of the propellant, ignition occurred. MAPO is a highly reactive crosslinking agent and is reported to react with pure ammonium perchlorate at temperatures ranging from 160°F to 230°F to give spontaneous ignition. The fact that MAPO was distributed over the surface of the propellant in the mix can and not immediately dispersed, thereby providing localized concentrations of undiluted MAPO in contact with the propellant, may have been the contributing factor.

Comment: A similar incident occurred previously at another plant location. Subsequent to this incident, a laboratory study was initiated to determine the optimum method by which MAPO could be added to propellant formulations of this type to preclude the reaction of MAPO with ammonium perchlorate. After evaluating the laboratory data and analyzing the processing problems involved by the various alternatives, it was determined that careful scrapedown of the mix can to insure incorporation of all ammonium perchlorate into the propellant prior to addition of the MAPO and the remote addition of MAPO to the propellant mix while the mixer blades were turning to insure immediate dispersion of the MAPO to be the overall optimum solution. Design work was immediately begun on a system to remotely charge MAPO to the mixers. Propellant mixing operations were continued during the interim after all personnel had been reinstructed on the necessity of complete ammonium perchlorate incorporation into the propellant mix prior to the addition of MAPO.

Preventive Measures: All propellant mixing operations involving the use of MAPO (other than laboratory mixing operations where MAPO will be diluted with another propellant ingredient prior to addition) were suspended until provisions for the remote addition of MAPO to propellant mixers with the mixer blades turning have been provided.

Reference Number of this Incident: 1080

Duplication of this report is authorized.

Description of Photographs EI 126

(in sequence as assembled)

Exterior view of building as viewed from the north.

Interior view of building as viewed from the south end of the building. 25-gallon vertical Beken mixer can be seen in the right-hand corner of the building.

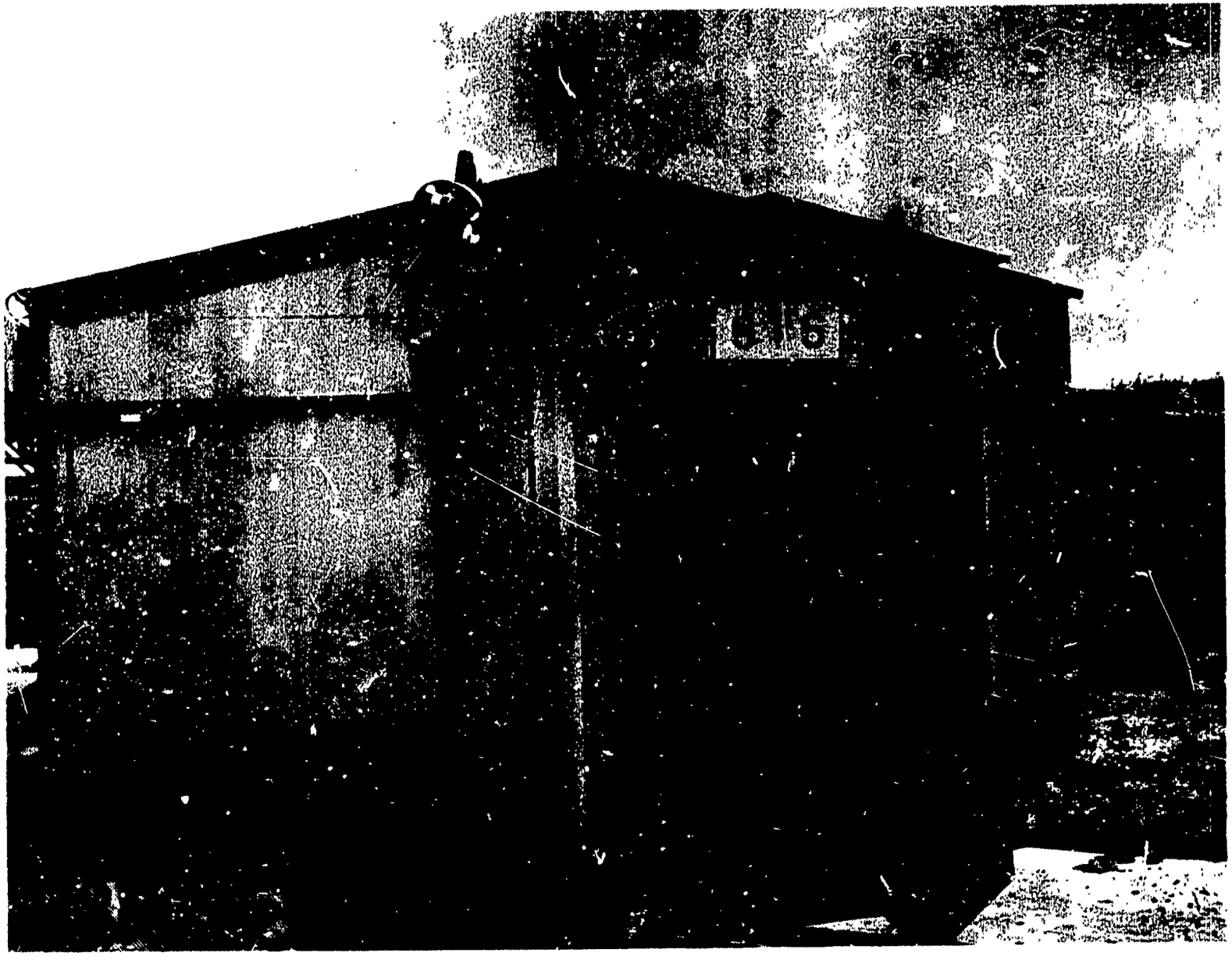
Interior view of building as viewed from the north end of the building. Rear of the 25-gallon vertical Beken mixer can be seen at the left-hand corner of the picture.

Close-up of 25-gallon vertical Beken mixer as viewed from the front.

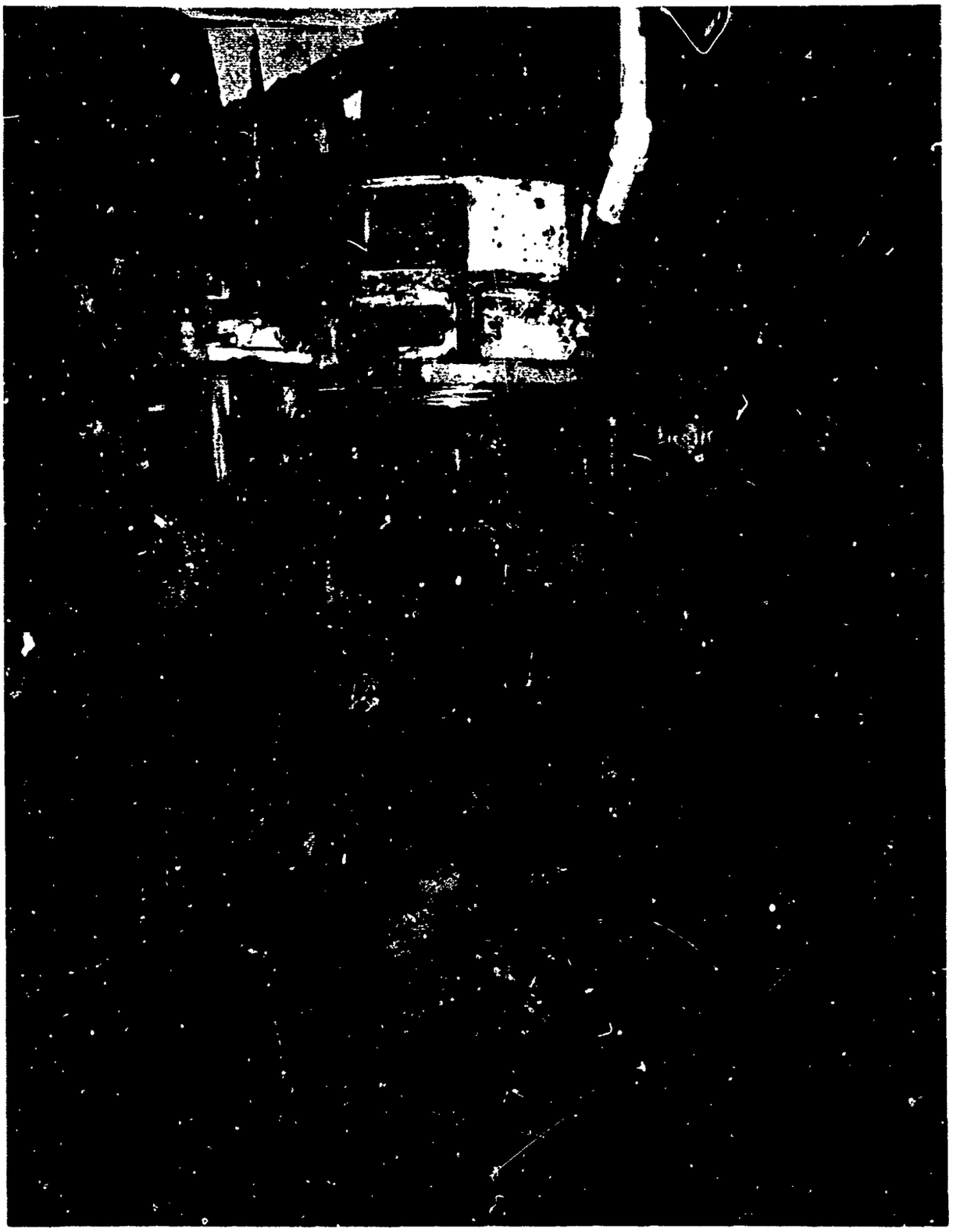
Close-up of 25-gallon vertical Beken mixer as viewed from the side.

Close-up view of the mixer blades and interior of the upper housing.

Close-up view of the interior of the mix can.



EI-126



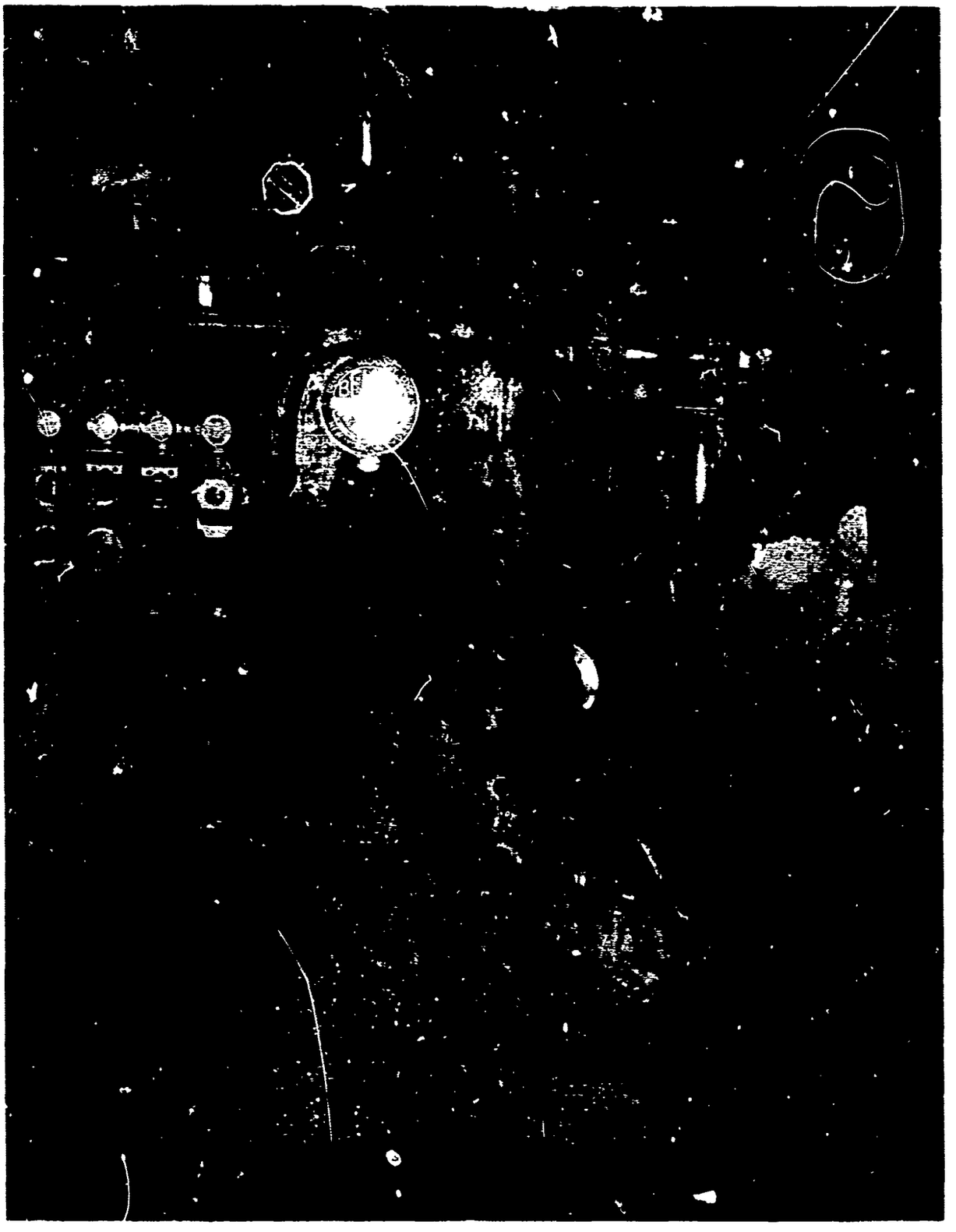
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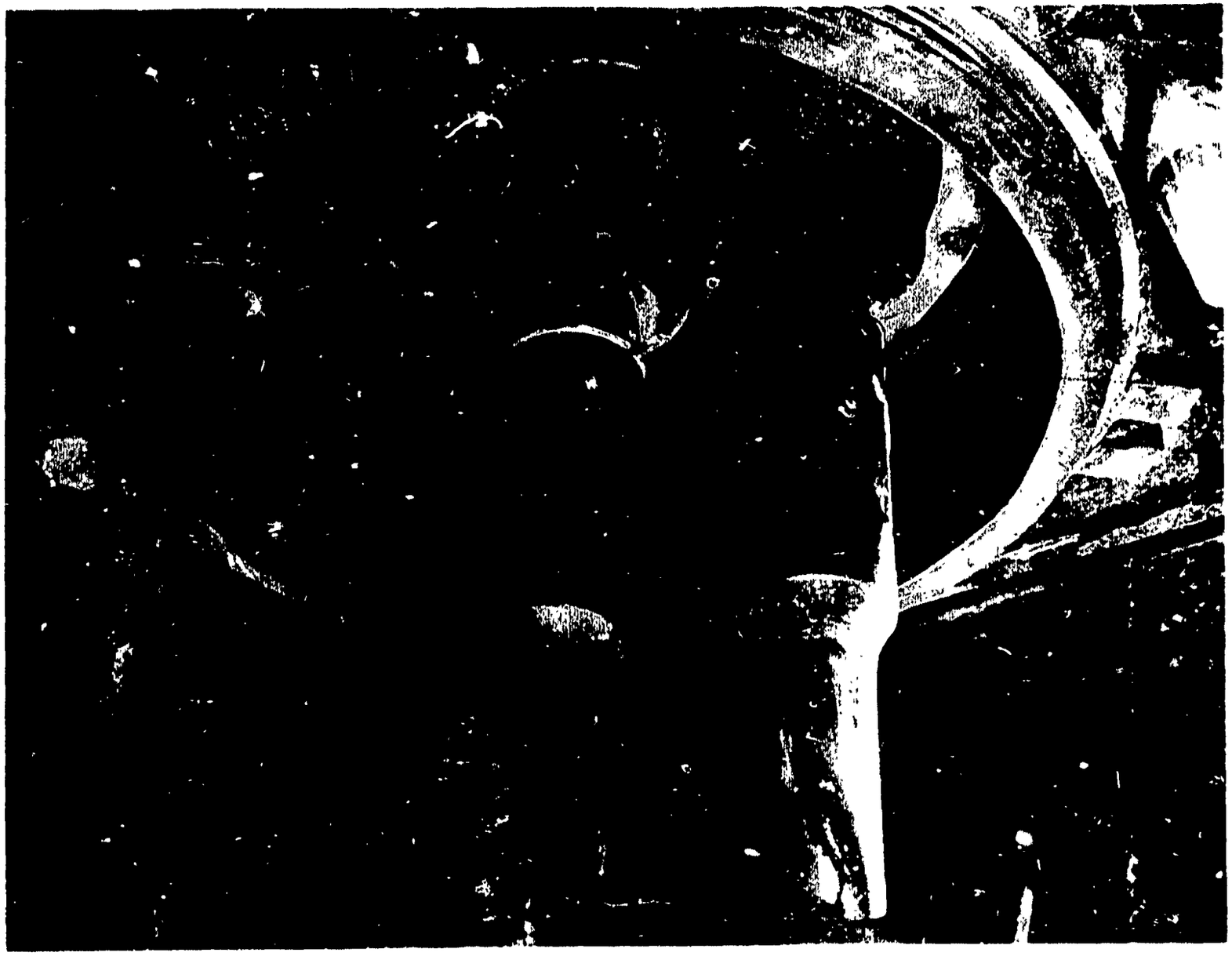
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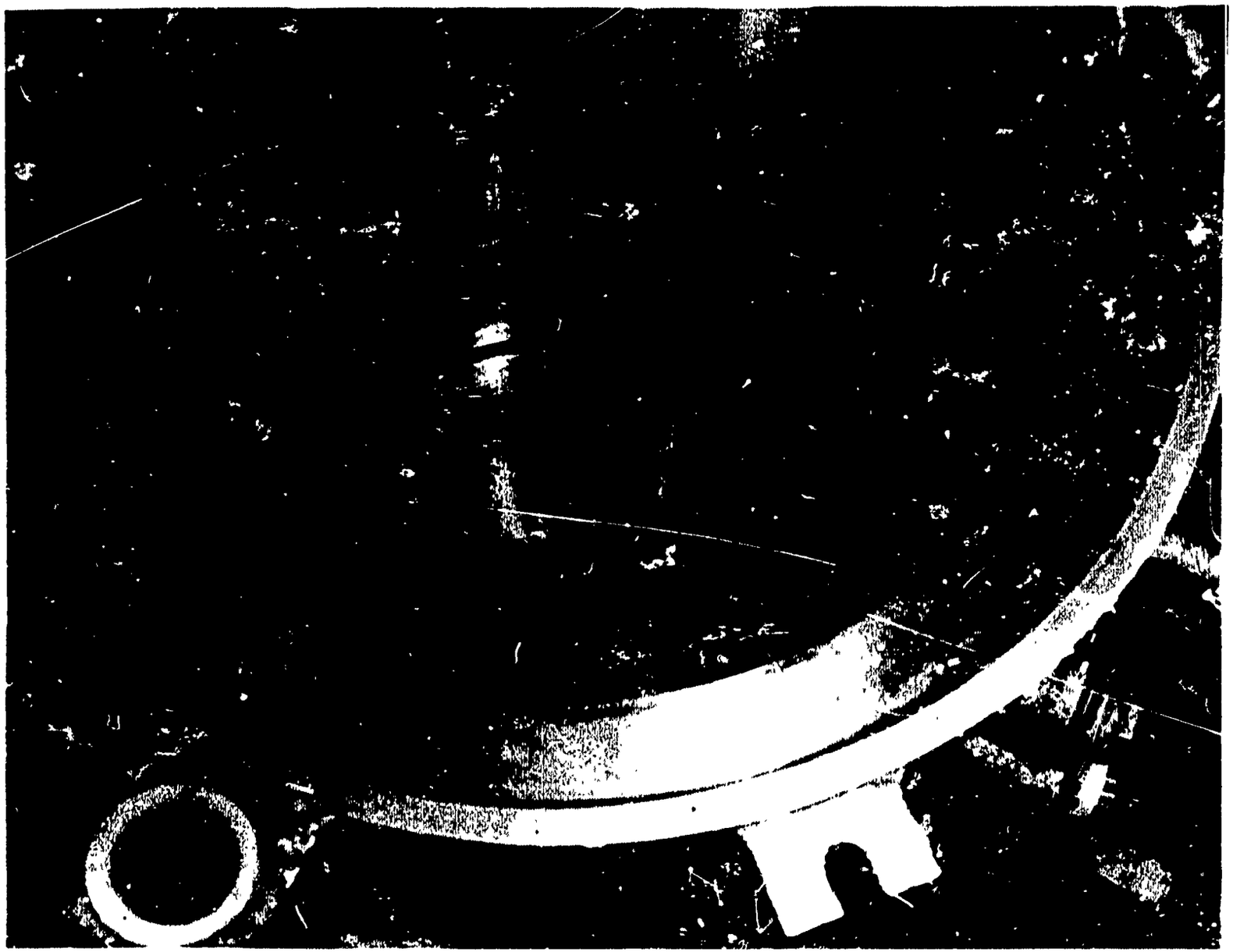
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ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 127

Explosion - Organic Vapors

Description: An employee was starting a direct coupled 1½-inch stainless steel centrifugal pump. An explosion inside the pump caused it to rupture and pieces struck the employee's leg. He received a comminuted fracture of the right leg, including compound fractures above and below the knee, and deep gashes and multiple contusions.

Cause: Investigation indicates that an explosion of organic vapors occurred inside the pump and/or connecting piping. The source of the explosion has not been definitely determined, but it is possible that the impeller of the pump came in contact with some foreign material.

Preventive Measures:

1. When the service of a centrifugal pump is to be changed, it must be flushed with water or nitrogen before being started. The same precautions are to be taken even though the pump remains in the same service if, in the opinion of the operator, there has been any possibility of the entrance of air into the system.

2. All operators are to be given verbal and written instructions concerning the correct way to start a centrifugal pump and the potential danger if a pump is run with valves in the discharge or feed line closed.

3. Signs are to be permanently attached to each centrifugal pump warning of the need to open the discharge valve before starting.

Reference Number of this Incident: L-73

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 128

Laboratory Refrigeration Explosions

REPRINT FROM OCCUPANCY FIRE RECORD -- LABORATORIES, COPYRIGHTED BY THE NATIONAL FIRE PROTECTION ASSOCIATION, REPRODUCED BY PERMISSION.

October 6, 1957 - Summit, New Jersey - $1,000.

A refrigerator which had supposedly been approved to provide some explosion protection was ruined by a mild explosion in this polymerization research laboratory. The volatiles stored in the refrigerator either reacted with each other or vapors were ignited by sparks from electrical equipment that had been left in the refrigerator. The watchman, though hearing no explosion, saw fire as he passed the laboratory. The fire was confined to the refrigerator and the surrounding floor. Although the building was protected by an automatic alarm system and a sprinkler system, prompt discovery of the fire by the watchman and prompt use of a carbon dioxide extinguisher extinguished the fire before either the sprinklers or automatic alarm system operated.

August 20, 1957 - Rochester, New York - $3,000.

An explosion in an ordinary, nonexplosion-proof refrigerator involved vapors coming from 24 beakers, each containing 150 ml. of pentane. A cloth towel covered the beakers. After the concentration of vapors entered the explosive range for pentane (1.5--7.8 per cent of volume) they were ignited by a spark from the exposed electrical temperature control located inside the refrigerator. The explosion badly damaged the refrigerator, ignited the refrigerator insulation, damaged a concrete block wall of the laboratory and smashed the wired glass in steel sash window behind the refrigerator. Laboratory glassware, supplies and instruments as well as some of the light fixtures were broken. Four automatic sprinklers within the area extinguished most of the fire. The remaining smoldering insulation was extinguished by the Rochester Fire Department with a pail of water. The Department had been called immediately by the watchman.

November 23, 1956 - Cambridge, Massachusetts - $10,000.

A student placed an open vessel of plastic material in the nonexplosion-proof, household type refrigerator. Flammable vapors from the open vessel accumulated in the refrigerator and exploded that evening when the interior temperature control sparked. Fortunately no one was in the laboratory. The refrigerator was demolished; 13 plain windows were smashed; 2 metal sash

windows were distorted; wooden benches, laboratory hood, desks, chairs, wiring, doors were damaged; laboratory instruments, glassware, reagents, and research test equipment destroyed. Smoke damage extended to several other laboratories and the hallway. Fire department extinguishment was prompt and efficient.

Summer 1954 - Indianapolis, Indiana.

An explosion occurring in an ordinary domestic-type refrigerator blew the glass out of all windows, cupboards and doors of the 12' x 20' laboratory and destroyed all glass laboratory equipment. At first it had been thought that the explosion involved vapor from an open beaker of ether in the refrigerator, but a more thorough investigation of the characteristics of the explosion led to the definite conclusion that the explosion occurred due to the formation of ether peroxide in the beaker.

February 27, 1950 - Newton, Massachusetts - $5,000.

Vapors from flammable liquids (ether and benzene) in open beakers in an 8 cubic foot non-explosion-proof, household type refrigerator exploded in a research chemistry laboratory in the basement of the 4-story fire-resistive building. A sparking contact on a thermostatic control in the refrigerator was the probable igniting source. Explosion damage to the refrigerator, windows and glassware comprised most of the loss. Neither of the students working within the laboratory was injured. Attempts to extinguish the fire with carbon dioxide extinguishers were thwarted by the heat and chemical fumes.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 129

Explosion of Pyrotechnic Flare During Testing

Description: While performing routine candlepower measurements of a pyrotechnic flare, a project engineer was fatally injured. The injury occurred from a door blown open by unexpected "explosion" of the flare. The operation was routine and all the safety precautions believed to be adequate had been taken. The incident was completely unforeseen and without precedence. On the day of the accident, the project engineer had delivered two flares to the photometric tunnel for candlepower and burning time measurements. The flare was fused as usual in the tunnel with loose starter mixture, firecracker fuse and an electric match. The terminals of the electric match were connected while the flare was sitting on the test stand. The project engineer and tunnel operator went to the instrumentation room to ignite and record the data from the burning flare. The door was closed and bolted with a steel bar across the entire width. The common practice used for initiation of flares for candlepower measurements in the photometric tunnel employed the use of a dry cell battery. The first try at initiation failed. The project engineer waited approximately 5 minutes and then entered the tunnel to determine the cause. Upon inspection of the flare, no apparent cause for non-ignition was noted. It was concluded that the dry cell was dead. A new dry cell was obtained and upon ignition, the flare exploded, collapsing the walls of the tunnel. The project engineer was standing near the edge of the door in the instrumentation room. The shock wave (or sudden increase in pressure) sprung the lock on the door. The swinging door struck the project engineer on the forehead with sufficient force to result in a fatal injury.

Cause: The extensive force generated by the deflagration of this flare had never previously been observed during local burning tests nor was it known of anything comparable to this being recorded at any other activity. An intensive investigation was conducted to determine cause for explosion of this flare. A review of the test work prior to the testing of the final flare failed to indicate that an explosive type action could be expected. Laboratory experimentation failed to uncover any significant factors which would tend to indicate detonation of the material (magnesium, sodium nitrate and laminac). The conclusion was ultimately reached that the explosion of the flare must have been caused by the physical makeup of the unit. It was hypothesized that the explosion was caused by the initial flame front traveling down either the sides of the case, down the center pin or a combination of both of these. As the flame front moved rapidly toward the base of the flare, pressure rapidly increased, thereby causing a rapid increase in the burning rate and in chain reaction fashion burning so rapidly as to cause the pressure to increase sufficiently rapidly to burst the sidewalls of the case before the composition could be ejected from the case. A limited number of tests were conducted with experimental units to verify or

disprove this hypothesis and these tests strongly indicate that the hypothesis is correct. The results tend to show that the center stud and the fact that the case was not lined did not necessarily by themselves provide the conditions for deflagration but a combination of these factors with others (such as a rapidly burning composition, fine particle magnesium, a low percentage binder and relatively low pressing pressure) led to the conditions which produced the explosive results.

Preventive Measures:

1. Use of the center stud is being eliminated wherever practical.

2. All steel cases will be lined even though they are being used for exploratory type work. (It has been found many times before that the flare case must be lined in order to provide proper burning at reduced temperature.)

3. The pyrotechnic tunnel was not designed to provide for an explosion. The walls surrounding the burning area in photometric tunnels should be designed for this potential with blowout walls, cheap in construction and readily replaceable.

Reference Number of This Incident: 1085

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 130

Explosion - Mixed Chloronitrotoluenes

Description: An 8'x20' horizontal tank reboiler containing mixed chloronitrotoluenes exploded, causing extensive damage to adjacent equipment and the adjacent 4-story brick and metal-sided building containing other equipment. Fortunately no one was seriously injured. An exothermic reaction was started which first opened the 10" pressure relief vent, but within about 30 seconds generated sufficient pressure to rupture the vessel, which was designed for a 50 psi working pressure. The operator, who was on the top floor of the adjacent building, heard the pressure relief blow and left the building by an outside stairway. He was about 150' from the building when the explosion occurred. The tank was ripped open and flattened. In addition to smaller missiles, a few pieces of pipe and other metal weighing up to several hundred pounds were thrown from 300 to 800 feet. A number of plant buildings within a radius of 500 feet suffered broken windows and minor damage. A fire in the adjacent building resulted from the spray of flaming unreacted material from the ruptured tank. The automatic sprinkler system inside the building, though damaged, held the fire in check until it was extinguished by plant fire-fighting personnel.

Cause: The explosion was apparently caused by the addition of caustic soda solution with the chloronitrotoluene feed to the still. The feed stream had been inadvertently contaminated with the caustic in a tank car used for storage purposes. Upon addition to the still, which was indirectly heated by an attached heat exchanger, an exothermic reaction was started which rapidly developed into a runaway pressure buildup.

Preventive Measures: Plant procedures for loading, labeling and sealing tank cars for intra-plant service will be studied and revised as found necessary.

Reference Number of this Incident: L-74

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 131

Ignition of Propellant Mix

Description: The exact cause of the fire was undetermined, but was assumed to involve the addition of Methyl Aziridinyl Phosphine Oxide (MAPO) into the unmetalized polybutadiene-ammonium perchlorate mixture. An excessive amount of MAPO was used. Past experience indicates that MAPO can ignite spontaneously at temperatures of from 160° to 230°F when it comes into contact with pure ammonium perchlorate. The mix in this instance was at a temperature of 176°F, and it is assumed that some of the ammonium perchlorate had not been thoroughly dispersed.

Reference Number of this Incident: 339M-1

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 132

Explosion - Lead Azide During Blending Operations

Description: An explosion occurred in lead azide jelly bag mixing unit at approximately 1:00 PM during blending operations at mix house. A chemical worker had charged the jelly bag with 7 pounds lead azide and ½% calcium stearate, using the remote control dumping device. He had activated the agitating motor and had left the building to attend to an adjacent disposal vat. A second chemical worker remained in the control room to monitor the mixing unit and to dump the batch when the counter showed the blending cycle to be completed. The mixing cycle was about 20% complete when the explosion occurred. No personnel were injured. Weather conditions outside of the building were warm, partly cloudy, humid and virtually no wind. Temperature was 91°F. The humidity of the building was controlled at 70%. The mix building was wood frame construction, with blowout walls and light roof. The entire portion of the building behind the reinforced concrete barricading wall was demolished (the two side walls, back wall and roof were shattered); a small crack was in evidence in the concrete barricading wall extending from the top of the entrance doorway of the blending room to the top of the wall; water and electric lines were damaged and require replacement; jelly bag blending and screening unit were destroyed.

Cause: Cause of the explosion unknown. No abnormal conditions had been noted by either operator in the blending building or the surrounding area. Equipment and static grounds in building were checked approximately 6 weeks prior to date of incident and no defective conditions were noted. The absence of explosions during the mixing of 300 batches of lead azide without calcium stearate prior to the date the incident occurred might indicate process change might have contributed to the explosion. Process change included increase of batch size from 3½ pounds to 7 pounds; the addition of ½% calcium stearate; the screening through smaller mesh screen.

Preventive Measures: Since the cause of the explosion could not be determined, all changes in the process made on the day the incident occurred will be eliminated. These are:

1. Discontinue use of calcium stearate.
2. Reduce batch size to 5 pounds.
3. Change size of screen from 108 to 50 mesh or less.

Reference Number of this Incident: 1096

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 133

Explosion - Detonator Charging Scrap

Description: Imperfect, scrap, or rejected detonators are collected during the shift in a stainless steel pail containing approximately one gallon of 3% solution of sodium hydroxide as a desensitizing solution. At the end of the shift, the pail is taken to a concrete pad at an adjacent disposal unit and enough sodium hydroxide is added to raise the percentage to 10%. At approximately 4:00 PM a chemical worker carried a pail containing between 250-500 detonators to the concrete pad, set it down, added sodium hydroxide, and started cleaning his equipment and removing special protective clothing when a detonation occurred in the pail. This pail had been placed beside three others which had been removed earlier in the day and treated with liquid and caustic. Components in the pail immediately adjacent to the exploded container apparently also detonated. The two other pails on the pad were blown some distance, but their contents appeared not to have exploded. The chemical worker was struck on the back of legs and body with flying fragments of stainless steel from the pail, and sustained some caustic irritation of the upper lip and right eye. The injuries were minor in nature and the injured was released after treatment at the first aid station; no lost time resulted. The injured had been wearing all required safety equipment including face shield, long-gauntlet rubber gloves and plastic apron during the performance of this work. He was removing these three items to hang in the chemical storage cabinet at the time of the explosion, and was standing immediately in front of the cabinet with the right-hand door open. A hole 8-10 inches deep was blown in the concrete pad and the concrete was broken for a radius of approximately 2 feet from the hole. Debris from the explosion was scattered over an approximate 100-foot radius and several fragments were blown into the door of a chemical storage shed which was located at the edge of the concrete pad.

Cause: In reviewing the operation, it becomes evident that an uncontrolled chemical reaction took place which, as a result of high temperature and consequent increased activity, produced an explosive mixture. The detonators are made waterproof; however, when placed in a 3% solution of sodium hydroxide, a chemical reaction is initiated with the aluminum detonator cup material. Eventually the aluminum container is dissolved and then a chemical reaction may be started between the sodium hydroxide and lead styphnate and/or lead azide of the detonator. The condition of any particular detonator will depend on how long they have been in the 3% sodium hydroxide solution. When flaked sodium hydroxide is added to change the concentration of the solution to 10%, three significant actions take place concurrently: significant amount of heat is evolved due to the heat of solution of sodium hydroxide; active foaming action takes place which results in a turbulent condition causing detonators to strike one another; should a sodium hydroxide flake land on an aluminum

detonator cup, a sharp temperature rise may take place over a very short period of time from heat of formation - temperature rises to over 200°F have been experienced.

Preventive Measures: The use of sodium hydroxide solution as a desensitizing agent has been discontinued. Scrap detonators are now placed under plain tap water and are being held for possible destruction at the explosive burning grounds.

Reference Number of this Incident: 1097

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 134

Explosion - Cyclotol During Melt Pour Operation

Description: Cyclotol was being re-melted in kettles on the second floor of the melt pour building and dropped through steam-jacketed draw-off legs to a manifold system on the main floor of the building. The manifold system is manually controlled by Hills-McCanna valves in a continuous pour operation. A powered conveyor services the manifold with a continuous flow of interconnected pouring funnels. Valves in the manifold are adjusted to fill the funnels to a predetermined level. When this level is reached, the next funnel is automatically placed under the pouring manifold. The operator on the second floor started operations in the melt kettles by turning on steam, processing the temperature charts, and placing enough cyclotol in the kettles to form a heel. A short time after placing explosives in the kettles, the employee discovered that he had not closed the valves at the base of the kettles. The explosives started to melt, thus allowing molten explosives to flow into the draw-off legs. The valves were then closed. On the main floor, several employees were preparing to start their operations. These employees noted that explosives from the previous day's operation had solidified in the pouring nozzles. Steam serving the manifold was turned on and attempts were made to clear the nozzles. This was accomplished by using a screwdriver and hammer (both of spark-resistant material). The screwdriver blade was bent and driven into the nozzle with the hammer. The screwdriver was then twisted in a circular motion to remove the explosives. This action was completed on two nozzles. A third nozzle was partially cleared, and molten explosives started to flow from it. The employees summoned their supervisor for assistance in stemming the flow of explosives. Approximately 4 minutes after his arrival, a detonation occurred. The operations being conducted could not be determined, but evidence indicates that the detonation occurred inside the valve rather than in the orifice of the nozzle. The supervisor and one other employee died as a result of severe injuries. There were no other injuries.

Cause: Exact cause is unknown. Probable causes:

1. Friction by undue force when using unauthorized tools.

2. Friction in the valve bonnet resulting from valve closure against hidden solidified explosives.

Preventive Measures:

1. Only those tools authorized for the operation and listed in standing operating procedures should be permitted in work areas.

2. Personnel working with explosives should be adequately trained to recognize inherent hazards associated with their operations.

3. No deviations from approved standing operating procedures should be permitted. (Failure to close valves prior to putting explosives in kettle.)

4. Supervision at all levels should review inspection procedures to assure prompt detection and correction of hazardous conditions. (Operational, maintenance and safety inspections did not reveal solidified explosives in the manifold orifice.)

5. Standing operating procedures should be prepared, approved and made available for operations involving the cleaning of contaminated equipment. (Periodic cleaning of the nozzle orifice was not included in the SOP.)

Reference Number of this Incident: 1099

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 135

Explosion - Acid Feed Line

Description: During the feed of mixed acid to a nitrator, an explosion occurred in the acid feed line. The force of the explosion shattered a rotameter tube, blew out a flange gasket, bulged a blanking disc in the feed line and caused glass to be blown into the face, eyes and body of the operator. The operator received superficial cuts on his face and body. Glass particles were successfully removed from his eyes, with no permanent injury. The glass did not originate from the rotameter tube since it was enclosed in a pressure casement. The glass is believed to have originated from a broken light bulb. The operator was not sprayed with acid. This nitration was the third batch of a series. The feed had been in progress for 1 hour and 50 minutes prior to the explosion. Prior to this series of batches, the feed system had been used to feed an organic liquid to another product reaction.

Cause: Investigation produced only a probable cause of the explosion. It is believed that a violent reaction resulted from contact with organic material retained in the asbestos flange gaskets, rotameter packing or in a dead-end section of the piping.

Preventive Measures:

1. This area will be designated a goggle area during all operations.

2. All flange gaskets, valve packing and rotameter packing will be changed from asbestos to teflon.

3. Piping has been modified to eliminate all "dead-end" sections as well as some common use.

4. When changing from one product to another, clean-out procedure shall include dismantlement of acid feed piping to insure cleanliness.

Reference Number of this Incident: L-75

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 136

Reaction Vessel Rupture

Description: An employee was preparing to transfer a reaction vessel (12"x2½") from a low temperature bath in a bench hood to a pressure reaction cubicle. A halogenated olefin had been introduced into the vessel and then nitrosyl fluoride was added. The temperature of the vessel was about -78°C. After a short time, when no pressure was observed, the employee started to remove the vessel from the bath and it ruptured. The employee received severe injuries to the lower abdomen and injuries to the hands.

Cause:

1. Using too large a sample of reactants which detonated, rupturing the reaction vessel.

2. The vessel was of an alloy that had loss impact strength at low temperatures.

3. The loaded reaction vessel required transferring from the hood to a cubicle.

Preventive Measures:

1. Experiments of this type will be loaded, reacted and vented using proper shielding and remote handling techniques to prevent exposure to any employee.

2. Supervision will make certain that the quantity of materials shall always be kept to the absolute minimum consistent with the extent of the knowledge of probable hazard.

3. A reaction vessel of proper design and metal composition will be used.

Reference Number of this Incident: L-76

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 137

Fire - Propellant Ingredients

Description: A fire occurred in Bay 8 at approximately 3:30 PM involving unmixed propellant ingredients (Mfgr. A PBAA binder plus additives, ammonium perchlorate and aluminum). There were no injuries and operations on a routine basis were started on the following day. A mix can containing 4750 grams of the unmixed propellant ingredients ignited while resting on a balance under the hood in Bay 8. This fire ignited a waste can containing waste papers and a box of gallon size sealright paper cartons which were under the hood-table in the bay. There were four operations proceeding simultaneously in Bays 7, 8, 9-Patio and 10 at the time of the fire. These were: Bay 7 - an operator was preparing live test motors for static test and disassembling motors with slivers from previous tests; Bay 8 - propellant ingredients previously weighed out were being placed in mix cans and weighed in total prior to being carried to Bay 10 for mixing; Bay 9-Patio - propellant ingredients were being preheated in the ovens outside of Bay 9 preparatory to being carried to Bay 8 for final weigh-up; Bay 10 - propellants were being simultaneously mixed and cast in Bay 10. At the time of the fire, 4750 grams of a propellant in which Mfgr. B PBAA polymer was used (rather than the Mfgr. A PBAA polymer) was being mixed. In addition, a mix can containing approximately 500 grams of Mfgr. B propellant was on the press following casting of two motors approximately 10 minutes earlier. At the time of the fire, the doors to Bays 9 and 10 were closed. The door from the hall to Bay 8 was open; there is no door between Bay 7 and Bay 8. The door between Bays 6 and 7 was closed and locked. Approximately 5 minutes prior to the incident, the operators left Bays 9 and 10 and then started simultaneously the operations of mixing in Bay 10 and final weighout in Bay 8. Bay 8 door was open while the operation was in process. A mix can containing preheated (175°) aluminum powder (760 grams) on the bottom covered with Mfgr. A polymer (817.2 grams) was placed under the hood. The curative (37.8 grams) was poured onto the polymer and the ammonium perchlorate (3135 grams) was poured on top of the curative. The mix can was approximately 95% full at this time. The hood fan was turned on for this operation but turned off for the subsequent final weighback. The filled mix can was placed on the balance and the final weight recorded on the mix sheet. After final weighout, the operators walked to the mix console in the hall 30 feet from the hood to see if the mix cycle in Bay 10 was completed. Approximately 3 minutes remained, so the operators remained in the hall preparatory to picking up the mix can in Bay 8 and carrying it to the mixer in Bay 10. The fire was observed at this time by the three operators from hall position. Fire losses consisted of the balance, the sealright containers, repair to the table and smoke damage.

Preventive Measures:

1. No further work on any PBAA polymers will be performed until the cause of the fire is established.

2. No paper products will be stored under the hood. The sealright containers will be stored in Bay 9 and brought to Bay 8 individually as required. The waste paper can will be stored away from the hood.

3. Large quantities of oxidizer (50 pounds or more) will not be stored in Bay 8. It will be moved to Bay 9. Since weighout is performed in Bay 8, working quantities of all propellant ingredients will be stored in sealed fire-resistant containers in Bay 8.

Reference Number of this Incident: ..77

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 138

Explosion - Flammable Solvent

Description: An employee was preparing to load acid into a trailer. The hose was in the tank and water was being loaded. When he put the metal gauge stick into the tank, an explosion occurred. The employee received moderate to severe burns on his face and right leg.

Cause:

1. There was approximately one-half barrel of flammable solvent and diesel fuel mixture in the trailer tank. An employee who had used the trailer the day before had failed to flush the tank.

2. The employee dropping a metal gauge stick into a tank containing a flammable mixture.

Preventive Measures: It has been determined that this flammable solvent can be pumped safely if properly handled. Therefore, any future pumping of this mixture must be approved by the Safety Department so adequate safety measures can be set up.

Reference Number of this Incident: L-78

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 139

Laboratory Explosion

Description: An explosion occurred in a laboratory, causing some damage to the vacuum line and minor injury to an employee (some small cuts on the upper arm from flying glass). The operation involved was the pumping out of recovered HNF_2 from a glass transfer tube by means of a water aspirator. There was approximately 300 cc of gaseous HNF_2 in the tube. The aspirator had been turned on and was functioning when the employee turned the stopcock of the HNF_2 tube to open it to the aspirator. Almost immediately afterward, the explosion occurred. The filter flask used to protect against a suck-back from the aspirator was also blown apart. This flask was in the hood some 10 feet from the HNF_2 tube. It is assumed that the HNF_2 explosion caused an overpressure in the aspirator line which burst the filter flask.

Cause: The cause of the explosion is not known. It is possible that there was organic vapor in the filter flask and therefore in the aspirator line which exploded when it mixed with the HNF_2.

Preventive Measures: In the future, more effort will be made to keep all the lines free of impurities.

Reference Number of this Incident: L-79

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 140

Laboratory Explosion

Description: An explosion occurred in a laboratory at 4:25 PM. The contents of a cold trap which was at -196° exploded, causing minor damage only and resulting in no injuries. The trap was believed to have contained some hydrazoic acid and acetonitrile. It had been warmed and cooled several times before the explosion. No immediate explanation is available.

Reference Number of this Incident: L-80

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 141

Ammunition Functioned When Dropped

Description: 105mm howitzer cartridges with fuze were being unpacked and repacked for the purpose of replacing unserviceable fiber containers and wooden boxes. After rounds were unpacked they were placed on a continuous belt power conveyor and repacked in a separate room. An armor plate barricade extended lengthwise for part of the length of the conveyor. The barricade served no purpose for this particular operation, but was used on previous operations. In order to prevent projectiles and cartridge cases from striking the edge of the barricade, a guide bar or sweep had been installed to deflect all items to one side of the conveyor. Apparently, as a result of the continuing impact of projectiles and cartridge cases against the sweep, the welds broke, allowing the sweep to become slightly elevated and projectiles and cartridge cases became wedged under and jammed against the sweep. After twelve projectiles and twelve cartridge cases had become jammed and wedged, a thirteenth projectile apparently overrode the pile and fell to the lead-covered floor, a distance of approximately 35 inches. The projectile functioned with the head of the fuze being imbedded in the lead sheeting on the floor. All three cannisters were ejected with two being ignited; one cannister was split open, apparently as a result of striking the armor plate dividing wall. The three cannisters struck the ceiling heater, and continued through the ceiling into the attic of the building where they were recovered. A hole in the roof of the building was presumed to have been caused by the base plate of the shell; the base plate was not recovered.

Cause: The power conveyor and associated equipment were inspected two days before the accident. The sweep or guide bar which was installed at the point of accident was visually checked and appeared to be in satisfactory condition. No specific check was made of the condition of the welds, but it is doubtful if any defects would have been noted; examination of the sweep after the accident indicated fresh breaks in the welds. On the day of the accident the foreman and surveillance inspector had checked the entire operation, including material on the conveyor, approximately 5-10 minutes before the accident; there was no indication of a pile-up of material. Subsequent tests of the rate of movement of the conveyor belt showed that accumulation of material at the sweep would have occurred in less than 5 minutes. Falling of the projectile from the conveyor to the floor was the direct cause of the explosion. The reason for the functioning of the fuze and/or projectile on a short drop cannot be ascertained until investigation or study of the fuze has been completed.

Preventive Measures: The sweep has been removed from the conveyor. In lieu thereof, a divider is being installed the full length of the conveyor; material will be placed on one side or the other of the divider.

Reference Number of this Incident: 1102

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 142

Deflagration in Loading Room During Cleaning Operations

Description: A low order deflagration occurred while employee was vacuum cleaning the loading room. He had removed all containers of explosives prior to the cleaning operation, with the exception of small amounts in the three bowls on the loading machine. Explosive ingredients being used were aluminum powder, magnesium powder and perchlorate, each in a separate container on the loading machine, and a mixture in the vacuum tank and manifold. A two-inch flexible hose runs from the vacuum tank, which is placed on the outside of the room, to the manifold. One-half inch hoses run from the manifold. Approximately three-fourths of the two-inch opening was closed by a build-up of dust which had set up and hardened. As this gave evidence of very little cleaning of vacuum equipment being accomplished, indications were that there was a build-up of dust between the base plate and one-half inch orifices leading from the manifold. Due to cyclonic effect of the vacuum on the metal particles in the explosive dust, static built up and ignited the dust in the base of the manifold. The base plate (which was welded or brazed to the manifold) and the screwed-on cap from the manifold were blown off. Burned areas on reinforced concrete wall indicated deflagration started at base of the manifold and continued through the two-inch flexible tube into the vacuum tank. The top of the vacuum tank was blown approximately 150 feet from the tank. The three bowls of explosive ingredients did not ignite. Two employees were injured - one suffered first degree burns over the hands and small areas of the face; the other sustained superficial abrasions and bruises of one arm during exiting from the building. Two sides of the loading room were constructed of 12-inch reinforced concr e. The wall between the operations area and the loading area was constructed of ho[illegible]rick, filled with cement and reinforcing rods, backed by 3/8-inch steel shielding on the loading area side. The brick separated in a portion of the wall and one-inch plastic shield cracked and split in several areas. The plastic sliding door through which operator removes items from platen was also cracked. The reinforced concrete walls suffered no damage with the exception of the burned area. Blowout panels of a paint room approximately fifteen feet from the loading room (on the same side and part of the building) were destroyed. This was evidently caused by a generation of gas and forced air being blown through the air conditioning ducts into the paint room. There was no glass breakage. Most missiles were projected within a 50-foot radius, with the exception of the top of the vacuum tank, which weighs approximately eight pounds and was found approximately 150 feet away.

Preventive Measures: A scheduled cleaning of vacuum tank, manifold and hoses after each shift, and a thorough grounding throughout the vacuum system.

Reference Number of this Incident: 1103

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 143

Explosion - Destruction Area

Description: An explosion occurred during destruction of various types of explosives-filled components (detonators, rotors and other explosives-loaded devices). Destruction was by burning in a locally-fabricated furnace consisting of a portion of an obsolete bomb casing into which was welded a metal pipe. This device had been in use for the past eight years. The items were not fed singly, but were dumped from a box at the top of the device. The furnace was located in an open field near an earth-covered metal firing butt (no longer used) which served as a personnel shield and for unpacking components. The items were removed from their packaging, placed in a cardboard box, and carried to the furnace. It is believed that the injured operator was about to place the box with contents into the chamber when the explosion occurred. The operator sustained serious injury to both eyes.

Cause: Initiation of one component, either by impact or friction, within the cardboard box which, in turn, caused other components to detonate.

Preventive Measures:

1. An appropriate destruction furnace should be constructed for destroying explosives-filled components such as rotors, detonators, delays and small primers.

2. An approved standing operating procedure should be prepared for destruction of explosives-filled components, and adequate safety inspections should be made.

3. All employees working with hazardous material should be trained for their specific assignments.

Reference Number of this Incident: 1106

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 144

Explosions and Fire - M80 Firecrackers and Bulk Blended Explosive

Description: An explosion involving blended powder for M80 firecrackers occurred in a production building at approximately 6:00 PM. The quantity of explosives in the production building could not be established. The explosion initiated the contents (packaged items, approximately 3968 pounds explosive) of two trailers used as a storage location approximately 70 feet from the production building; and two service storage magazines containing 150 pounds of blended powder each, located approximately 85 and 100 feet respectively from the production building. The trailers and storage magazines detonated high order. A low order explosion occurred in an aluminum powder storage magazine containing three 55-gallon drums, two of which were believed to be filled and the other partially full. Fire and minor low order explosions occurred in small temporary wood buildings throughout the area which contained undetermined quantities of miscellaneous fireworks in storage. Approximately 50 acres of wooded and grass area surrounding the explosion site was set on fire by ignited fireworks. After hand-mixing of M80 charge ingredients, the final blend is measured into 10-pound conductive containers and transferred to one of the two service storage magazines. One container at a time is carried to the M80 production building for loading and manufacturing of M80 firecrackers. The completed item is packed in approved containers and placed in the trailers. Production operations were accomplished on the day prior to the incident; however, no production work had been performed on the day of the incident. The night watchman was preparing to cut a vent hole in the ceiling of the M80 production building with a conventional saber-saw which was provided with a standard flexible cord and two-prong male plug. He had covered some containers of blended powder within approximately two feet from the location where he was working, with a pillow. When inserting the plug of the saber-saw into the female outlet, an explosion occurred. The night watchman was fatally injured and a volunteer fireman was hospitalized for treatment and observation. Numerous sections of concrete block were propelled to distances in excess of 1000 feet north and northwest of the point of explosion. The area in this direction is uninhabited and heavily wooded for distances of approximately one-half mile. Lighter weight missiles from the majority of the buildings, which were of temporary wood construction, fell within a radius of approximately 800 feet. Glass breakage was reported in three buildings at 7600 feet and one building at 5400 feet.

Cause: The cause of the explosion resulted from one or more of the unsafe acts and/or unsafe conditions listed below, of which items 2 and 3 are considered to be the primary causes:

1. Using unapproved type portable electric power tools in an explosive operating building.

2. Installation of unapproved electric outlets in Class II hazardous areas.

3. Failure to decontaminate the area before attempting to perform maintenance or modification to the building.

4. Failure to remove bulk explosives and/or completed explosive loaded items from the processing building prior to performing work.

5. Failure to establish and maintain explosive storage in accordance with appropriate standards.

6. Failure to maintain suitable fire breaks around explosive processing buildings and storage magazines.

Preventive Measures:

1. More frequent and thorough safety inspections by qualified individuals.

2. Specific safe practices designed for the type of operations to be performed.

3. Approved separation distances maintained between non-related explosive storage locations and activities.

4. Suitable fire breaks maintained around explosive processing and storage buildings.

Reference Number of this Incident: 1104

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 145

Fire - Solid Propellant Mixer

Description: A confined deflagration occurred within the bowl of a 300-gallon Baker-Perkins multi-wing overlap blade mixer. The installation, equipment and tooling were damaged extensively. No injuries were sustained. The facility (an automated batch weighing system) was assigned to the mixing of a 4300-pound batch of composite solid propellant when the incident occurred. The ingredients were weighed and fed into the mixer automatically. The mix had been prepared in accordance with approved standard operating procedures. Thirty minutes of the mixing cycle had elapsed when the incident occurred.

Cause: The incident, as concluded by an investigation committee, most probably was caused by propellant ignition induced by entry into the mixer of a foreign object. The most probable types of foreign object ignition sources, in the order of selection, are as follows: Sweco screen (tension nut and washer), tools, epoxy curing agent valve (clam shell), scale weights, and personal items, i.e., badges, pencils, pocket rulers, watch parts, etc.

Preventive Measures: The following corrective measures are being or have been instituted:

1. A more positive tool control for all personnel entering the mixer buildings.

2. A more positive personnel control in the mixing complex.

3. A thorough study of the Sweco separator for possible modification to improve the integrity and reliability of the unit.

4. Modification of the ABM electric circuits to confine the operation of the Sweco separator to the addition of oxidizer only.

Reference Number of this Incident: L-81

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 146

Fire - Solid Propellant Mixer

Description: A fire and subsequent pressure burst occurred in the Ko-Kneader section of the composite solid propellant continuous mixing facility. The fire propagated from the Ko-Kneader section to the associated equipment in the mixing room and subsequently to the analytical room and west exterior of the building to involve the propellant receiver containers. The facility (a completely automated system) was engaged in the qualification of composite solid propellant and small (5-inch CP) ballistic rocket motors. The ingredients were weighed and fed into the Ko-Kneader automatically. The operation had been conducted in accordance with approved written procedures. The incident occurred two hours and thirty-seven minutes after the operation began. The building, equipment and tooling were damaged. No injuries were sustained.

Cause: It was concluded that the most probable cause of the incident was heat of friction created by the entrapment of a foreign object between the outer edge of mixer screw flight and mixer barrel.

Reference Number of this Incident: L-82

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 147

Reaction - Water and Oleum

Description: Mononitro benzene was being sulfonated with oleum in a 750-gallon cast iron reactor having an open manhole. A leak in the internal cooling coil permitted water to enter the reactor. Reaction between water and oleum raised the temperature from 110°C to above 150°C. An explosion resulted damaging the top of the reactor. The reaction mass ended up outside and was mainly foamed carbon. A sample taken just before the explosion analyzed 11% water; all other components were normal. The rest of the sample was subjected to 165°C for one-half hour and with the same result as the plant batch. A laboratory mix containing no water was found to decompose at 190°C.

Cause: Water from the leaking cooling coil reacted with the oleum.

Preventive Measures: Coil will be replaced in the future on indication of serious reduction in wall thickness. An emergency dump line is to be installed to an outside sewer.

Reference Number of this Incident: L-83

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 148

Explosion in Nitroglycerin Spent Acid Storehouse

Description: An explosion occurred in a nitroglycerin spent acid storehouse when denitration occurred in the standpipe of a blowcase. The standpipe exploded and killed a worker instantaneously. From evidence found as to location and time, apparently the explosion occurred when the worker began to open the vent valve for the blowcase. The blowcase was filled between 2 and 2¼ hours prior to the accident and the vent valve on the vessel was opened and left in an open position. The blowcase was overly full, and the acid rose in the standpipe which was used for the intake and expulsion of air pressure. During its stay in the blowcase, some of the explosive oil must have become separated from the acid as there was approximately 100 gr. accumulated in the standpipe. The weather was humid, with rain and drizzle, on the day of the accident and the previous day. Although provided with a condensate trap, apparently water condensation accumulated in the vent line of the air pressure apparatus. It is likely that the water condensation came in contact with the acid and the acidic explosive oil which had accumulated in the pipe, and that the heat of dilution resulted in an increase in temperature which was sufficient to detonate the oil.

Preventive Measures: Improvements have been made in the piping arrangement in order to prevent water condensate seeping into the acid. The place of work has been changed from the previous location and has also been protected with a sheet steel protective wall. Separating instructions have been changed. Doors and windows in the spent acid storehouse must be kept closed, if danger exists when the air temperature falls below the temperature of after-separation. Transfer of spent acid to the blowcase is permitted only immediately before the time acid is to be moved for denitration and it is forbidden to overfill the blowcase.

(Foreign source)

Reference Number of this Incident: 1110

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 149

Explosion in Nitroglycerin Nitrator

Description: A small explosion originated in a nitroglycerin nitrator. The charge was just in the initial stage and was turned on for scarcely 5 minutes when suddenly, with a dull noise, brown oxides of nitrogen were discharged into the air from all the free openings of the nitration apparatus. The feed of the glycerin-glycol mix was stopped immediately. The initial temperature was 9°C; at the moment of explosion it was 17°C. Normal temperature of nitration is 26°C in winter and 28°C in summer. After the switch-off, the temperature did not rise but instead went down, and the discharge of brown vapors also stopped. Closer investigation showed that the air-pressure control functioned perfectly and that the condensate trap of the air-pressure gauge was emptied. Nothing indicated any abnormality.

Cause: Apparently the feed control valve for the glycerin-glycol mixture was opened too wide to permit quick return from initial temperature to working temperature, and as the excess quantity could not be handled, the surface acid exploded. (Finishing of the process - activating the charge - was carried out without incident and consequent separation took place normally.)

Preventive Measures: Personnel were instructed not to force induction at the beginning, but to permit the temperature to rise slowly.

(Foreign source)

Reference Number of this Incident: 1111

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 150

Explosion During Repair of Thermometer

Description: An explosion occurred during repair of a thermometer which came from a vat of explosive mixture. A mechanic experienced a serious eye injury. The thermometer, surrounded by a stainless steel casing, was screwed onto a vat of mixture for the preparation of Trialene (70% TNT, 15% hexogene, 15% aluminum). The collar of the casing broke and descended approximately 10 cm., filling with explosive. The thermometer was unscrewed and the explosive between the thermometer and casing was removed with a mixture of water and steam. After this operation, the thermometer was removed to the mechanical workshop in order to separate the casing from it. During the sawing operation, an explosion occurred. Material damage was limited to the thermometer and to the metal saw manipulated by the worker.

Cause: Although not visible from the exterior, some of the explosive must have remained between the thermometer and the casing.

Preventive Measures:

1. In a general way, every passage with a double inner side should be submerged in acetone to dissolve any explosive possibly imprisoned between the walls, before being repaired.

2. Such repairs should not be executed except when controlled by a qualified person.

(Foreign source)

Reference Number of this Incident: 1112

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 151

Explosion - Smoke Canister During Cleaning

Description: Excess paint was being removed from the outer surface of 105mm smoke canisters. The standing operating procedure required paint to be removed by use of a solvent; however, a mechanical, metal-brush buffer wheel was used to conduct this operation. While one of the canisters was being cleaned, it exploded. The operator cleaning the canister sustained multiple fractures and lacerations on both hands and a second operator, standing nearby, received dust contamination in both eyes. Property damage resulting from the explosion was minor.

Cause: Excessive heat from buffer brush caused contents of canister to ignite and explode.

Preventive Measures:

1. Mechanical buffer wheels (equipped with metal brushes) should not be used to clean pyrotechnic-filled items.

2. Operations should be conducted in accordance with standing operating procedures and deviations from SOPs should not be permitted without appropriate approval. (The standing operating procedure specified that a rag saturated with a solvent would be used to remove excess paint from the canister.)

Reference Number of this Incident: 1113

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 152

Explosion and Fire - Curing Complex

Description: An explosion occurred at approximately 12:45 PM in one building (Building 238) of a curing complex for an experimental casting area. The explosion initiated fires in other buildings in the immediate area, causing a second explosion 8-10 minutes later which resulted in the complete loss of the complex. No one was in the immediate vicinity; and there was no loss of life or lost-time injury, although 17 employees were sent to the plant dispensary and local hospitals for examination and treatment of minor conditions attributable to the explosion. The cure complex consisted of 4 buildings in line: No. 120 (1 bay), No. 121 (1 bay), No. 122 (2 bays, separated from each other by a reinforced concrete block fire wall), and No. 238 (4 reinforced concrete bays, Nos. 13, 14, 15 and 16). Buildings 121 and 122 were separated from each other by a reinforced concrete block fire wall. Building 265 (brine chiller, heating and air-conditioning units) was located immediately behind the complex. A dry house for ingredients (Building 31) was located 40 feet from and in front of the cure complex and was separated from it by a reinforced concrete block fire wall. It contained 6 bays. All bays in the cure complex were equipped with single-pass air blower heaters protected by Mercoid limit switches which, on override of the bay temperature, would shut down the blower and turn on a flue warning light on top of the building. Bay 10 was equipped with a circulating reheater and all cure bays had deluge systems actuated by fusible link heads. Cure temperatures in the bays could be programmed between 70°F and 140°F. The curing bays contained 3494 pounds of propellant in a total of 56 grains and assemblies, 8 to 180 pounds of propellant each. The adjacent dry house contained 1021 pounds of explosive ingredients in various states of drying. These weights were well below the authorized limit for the area (5300 pounds for the cure complex and 2000 pounds for the dry house - 7300 total). Only a small quantity of the explosives contributed to the two explosions. The majority of the propellant, assemblies and ingredients either burned, were recovered unburned, or were accounted for during the ensuing investigation. There were no active operations in progress in the buildings at the time, other than normal curing of experimental propellant grains, casting solvent absorption studies, and ingredient drying or storage. Personnel were in the area preceding the incident at the following times: (1) two explosives operators removed two castings from a grain cooling bay at 10:45 AM; (2) at 11:00 AM an experimental area casting foreman made a routine check of the cure house; (3) at 12:30 PM, just 15 minutes before the first explosion, two powder service operators picked up an empty nitrocotton drum outside of the dry house (No. 31). Nothing unusual

was observed by the operators at these times. The temperature log of the bays was recovered after the incident and indicated no abnormalities. The first explosion occurred without any forewarning. Examination of the area after the explosions and the subsequent investigation indicated that the first of the two explosions occurred in one bay of Building 238. The second, initiated by fire from the first, occurred in Building 121. Careful review of local work orders, log books, quality assurance record sheets, propellant composition records and casting records was made. Analytical examinations and tests of suspect ingredients, powder and liquid were conducted. These tests indicated that casting powder Lot 96 contained no resorcinol, a propellant stabilizer. One cast grain manufactured from this lot, was located in each of Bay 10 (Building 121) and Bay 14 (Building 238). Taliani tests were run on samples of propellant castings as well as casting powder lots. There were no unusual stability results with the casting powder; but, when mixed with casting liquid, the samples from Lot 96 ignited spontaneously after 22.5 and 44 hours respectively; castings with the same ingredients, except with resorcinol added, showed no tendency toward deterioration. Examination and identification of materials recovered after the explosion gave strong evidence that the grain manufactured from casting powder Lot 96 (which was located in Bay 14 of Building 238) was the initiating source. Therefore it was concluded that: the most probable cause of the incident was an exothermic reaction in an unstabilized propellant grain which was being subjected to curing temperatures.

Reference Number of this Incident: L-84

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20316

Explosive Incident Report No. 153

Propellant Fire

Description: A 2400-pound batch of solid propellant formulation was in the early stages of the mix cycle when flames were seen coming from the mixer. The burning inside the mixer evolved sufficient gas to force open the counterbalanced mixer lid. When the deluge activated, the force of the water splashed most of the burning propellant out of the mixer onto the station floor, where it was partially consumed. There were no personnel injuries, and little damage to the interior of the mix room.

Cause: Propellant and oxidizer residue was found in the crevice between the metal floor plate and the mixer wall. The sealing material had cracked, permitting contaminated solvent from the cleaning operations to seep inside, and the metal-to-metal contact from the slight vibration of the mixer ignited the residue. A split was also found in the gasket of the mixer lid. The pressure differential caused by 5 inches of vacuum inside the mixer permitted the propagation of the flame through the split gasket into the mixer batch. Contamination was also found on the mixer lid hinges, the hinge pin, and the bearings.

Preventive Measures:

1. That the standing operating procedure for mixing batches of propellant be augmented by including a detailed inspection of the mixer lid gasket to insure its good condition.

2. That the mixer and the metal plates around it be tightly sealed with a flexible material to prevent seepage of oxidizer and propellant residues into crevices.

3. That the mixer lid hinges be redesigned to move them to a position where they cannot become contaminated.

Reference Number of this Incident: L-85

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 154

Explosion - Counter Current Extraction Column

Description: An explosion occurred near the base of a counter current extraction column located in the west end of the process building of a nitroplasticizer production plant. The column was used to purify an aqueous solution of the potassium salt of 1,1-dinitroethane (K-DNE) by extraction with ethylene chloride. The explosion resulted in rupture of the column near the base and immediate discharge of the column contents into the process area. There was no fire following the explosion, no personnel injuries were sustained, and damage was confined almost exclusively to the extraction column and its associated piping and instrumentation.

Cause: Possible Cause Factors:

1. The most probable cause of the incident was the explosion of solid K-DNE (which was found to be present) in the extraction column with initiation occurring as the result of friction in the footbearing assembly at the bottom of the column.

2. The possibility of an unknown exothermic reaction involving the K-DNE cannot be ruled out, though no direct evidence was found to support this.

Significant Factors:

1. Crystalline K-DNE can get beyond the dissolver vessel during certain conditions of processing.

2. Deep, recessed foot-bearing housings lend themselves to accumulation of solid substances. The fluid purge of the bearing housing does not guarantee adequate nor uniform flushing of the recess.

3. There was no positive device to prevent downstream flow of undissolved K-DNE into the extraction column. An additional dissolving step may have been helpful.

Preventive Measures:

1. The recessed footbearing assembly is to be eliminated. The footbearing is to be redesigned so that the housing will be elevated above the column bottom by suitable brackets. In addition, the stainless steel set screw which holds the teflon sleeve on the agitator shaft will be replaced by a "Nylock" type teflon screw.

2. Install a filter to prevent K-DNE crystals from entering the extraction column. If this proves inadequate, an additional dissolver is recommended.

3. Barricade the dissolver pump and the recommended line filter.

4. Visual inspection devices are recommended for strategic places in the process equipment and the lines.

5. Modify the regularly-scheduled equipment washout procedure to include the extraction column.

6. Conduct laboratory investigations directed toward the improvement of process safety.

Reference Number of this Incident: L-86

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 155

Unintentional Burning of Solid Propellant Motor

Description: Eight rejected and scrapped solid propellant motor crates were dumped into the burn pit of the inert burn area. They caught fire immediately from the already burning trash in the pit. Approximately five minutes later there was a bright flash from the pit, followed by a loud explosion. Subsequent investigation disclosed that one of the crates had contained a live motor. The motor case ruptured, and the motor burned in a typical pattern for about five minutes. Seven men were in the immediate area at the time of the incident, but there were no personnel injuries, and very minor property damage. The motor did not become propulsive. Minor debris and several pieces of propellant were found in a radius of 200 feet from the final position of the motor case.

Cause: The cause of this incident was failure to inspect the interior of the crate before it was moved to the scrap crate holding area, followed by another failure to inspect the interior prior to loading it for transportation to the inert burn area.

Preventive Measures:

1. That precise instructions and procedures regarding the inspection and disposition of motor crates be written and enforced.

2. Additional motor storage facilities and space be obtained for the production line involved in this incident.

Reference Number of this Incident: L-87

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 156

Accidental Ignition of Booster Propellant Grain

Description: A booster propellant grain was positioned in a horizontal trim stand. Employees had just finished scraping and trimming off the mold release material, which comes off with ribbons of propellant that vary in length from a few inches to two or three feet, and in thickness from .010 to .060 inches. After trimming, these propellant scraps are gathered and placed in containers for disposal. The grain itself rests on three sets of aluminum rollers so it can be rotated for trimming and inspection. The booster grain involved was about to be inspected, and as the inspector started to rotate it, those present noticed flame coming from the middle set of rollers. The deluge system was actuated and all persons ran to the safety shelters. The grain was completely consumed. There were no personnel injuries.

Cause: The probable cause was a piece of propellant from the trimming operation becoming lodged between the roller and the roller support frame. It probably ignited from the metal-to-metal contact when the booster was rotated. An examination also disclosed that a bearing in the end of the roller was missing, which would have provided a lodging space for a strip of propellant.

Preventive Measures:

1. A new type of holding fixture be designed to eliminate the use of rollers in the trimming operation.

2. In the interim, the ball bearings in the rollers of the present fixture be replaced by pressed teflon inserts to prevent metal-to-metal contact.

Reference Number of this Incident: L-88

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 157

Explosion During Oxygen Cylinder Refilling

Description: In the set-up in the safety department for refilling Pneolator oxygen cylinders (21 cubic foot capacity cylinders), the larger oxygen cylinders from the supplier are used. Such cylinders are located on the outside of the building and connected by a 3000-pound tested stainless steel tubing running through the wall and to directly over a work bench, a distance of approximately 15 feet to the valve. The regulator is attached to the valve at this point and the regulator that had previously been used was approximately 6½ years old. The gauges were not operating properly and it was decided that a new regulator would replace the older one. A new regulator was ordered from the manufacturer locally and when the same arrived was taken directly from the packing box in which it arrived and placed on the valve. One hour previous to installation of the new regulator, the entire line leading from the large cylinder located outside the building was blown out as a precaution and to eliminate any foreign materials. This was done by opening the valve on the large oxygen cylinder and blowing out same. When the new regulator was tightened and in place, the gauge on the outside cylinder was opened slowly and oxygen was permitted to flow through the line and into the valve located inside the building which was closed. The inside valve was opened slowly and the gauge on the high pressure side of the regulator showed a pressure of between 2000 and 2100 pounds on the gauge. This was permitted to stand this way for approximately one minute at which time the screw valve was turned to permit oxygen to flow to the low pressure side of the regulator. When the screw valve had been turned clockwise about ¼ turn, a terrific explosion occurred and belching flames and molten metal spewed over the immediate area. Molten metal from three holes in the regulator was found as far away as 20 feet. A pad of unused matches with the cover closed was lying on a table approximately 8 feet from the explosion. Investigation revealed that all had been ignited within the pad and the cover was not even scorched. The safety director was turning the screw valve on the regulator and standing approximately 5° to the left of center of the regulator. The explosion blew one hole on the left side of the bell housing, another on the right and downward and another in the rear at the bottom of the flange. He received second and third degree burns on the right thumb and index fingers as this was the hand being used to turn the screw valve. His clothing was burned from hot metal. A safety inspector who had been outside to turn the valve on the large oxygen cylinder had just walked in the door approximately 15 feet away from the regulator when the explosion occurred. He was blown back out the door approximately 8 feet. (It might be well to note that nothing was attached to the outlet line of the regulator at the time of the incident inasmuch as they were only checking to see if the regulator was satisfactory.)

Cause: It is probable that either grease or oil had been permitted to enter the inside of the regulator accounting for the explosion.

Preventive Measures: A testing program has been introduced for all regulators, new or old. They will be placed in position on the line and oxygen will be fed from outside the building with no personnel permitted inside while the test is occurring.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-89

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 158

Gas Explosion

Description: The desired temperature of a sulfuric burner in a sulfuric acid plant had been reached (1800°F) by burning of a propane gas mixture. The gas burning equipment then was shut down by pushing two electrical control buttons which closed two 2½-inch and two ½-inch electrically operated valves. Following the closing of the gas valves, the main air blower that supplied combustion air for the gas was shut down. Approximately 10 minutes after the burner had been shut down, two men were requested to remove a blind flange from a 4-inch nozzle on the vaporizer cover. The vaporizer is a tank 6 feet-0 inches in diameter x 8 feet high located adjacent to the sulfur burner and connected by an 8-inch pipe. One employee was standing on top of the vaporizer and the other employee (injured) was standing on a stepladder alongside of the tank. His face was about level with the 4-inch nozzle. There was a sudden explosion and a flash of flame came out of the nozzle burning the injured on the face, neck and upper chest. In trying to get away, he fell and lacerated his knee.

Cause: Investigation revealed that failure to close the primary gas cocks was the cause of the accident. It is believed the explosion was caused by gas leaking past one or more of the electrically operated shut-off valves. A hot brick surface was present and when sufficient gas accumulated to produce a combustible mixture, it exploded.

Preventive Measures: A thorough review of operating techniques with all operators, particularly infrequent start-up and shutdown practices.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: I-90

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 159

Explosion - Lead Styphnate

Description: An employee was removing a beaker of lead styphnate (lead 2, 4, 6-trinitroresorcinate) from a laboratory oven. He grasped the beaker with his left hand and, as he turned, he apparently bumped the beaker on the side or bottom of the oven opening and a detonation occurred. The detonation propagated to the other two beakers in the oven and all three detonated. The man's injuries consisted of perforated colon, lacerations to arms, abdomen and hands and perforated ear.

Cause: The causes of the accident were:

1. Inadvertent mishandling of explosives.

2. Drying explosives in glass beakers.

3. Possibility of detonation from impact during handling while hot and dry.

4. Flaw in beaker from thermo effects.

Preventive Measures:

1. All ovens shall be equipped with upper limit temperature control and grounded.

2. Drying lead styphnate for the purpose of determining the average granulation size weight will be accomplished by weighing in water using a pycnometer.

3. Handling of dry explosives will be eliminated whenever possible and use of glassware will be minimized.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-91

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 160

Ignition - Flammable Vapors

Description: An employee was renewing the filter "heel" on the screen of a centrifuge. The old "heel" powder had been scraped off and the screen flushed with a vehicle. The fresh powder was stored in a leverpak with a polyethylene drum liner. Because the drum was nearly empty, the employee dumped the powder directly from the liner into the centrifuge. It was at this time that a flash occurred. The employee received minor and moderate burns to both arms, face, ears, and neck. Two maintenance employees who were standing by to close up the centrifuge received moderate burns on their arms as they assisted the employee from the area.

Cause: 1. High level of fumes inherent in process.

2. Possible static charge created by powder flowing from the polyethylene bag.

Preventive Measures:

1. Operator to wear aluminized jacket and hood with air supply.

2. Flushing with vehicle will be discontinued.

3. A grounded aluminum scoop will be used to apply fresh powder.

4. Additional grounding of centrifuge to be provided.

5. Use of polyethylene drum liners will be discontinued.

6. Block valves to be installed on centrifuge to limit vehicle fumes.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-92

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 161

Chemical Plant Explosion and Fire

Description: Trying to repair a leaky sight glass on a vessel under pressure was the primary cause for a chemical plant explosion and fire that resulted in 7 deaths, 2 critical injuries and property damage exceeding $4,000,000. The 85'x85' building with drying and packaging area attached contained 20 - 2,000 gallon reactors used in the manufacture of polyvinyl chloride (PVC). All electrical equipment was explosion-proof and the building was ventilated at 20 air changes an hour. One reactor had trouble with the 6-inch sight glass which had a light above it. The lead and asbestos gasket and sight glass were replaced and the vessel put on stream. The foreman noted that at 140°F and 140 psig the system was tight, but while the maintenance men were in the building to repair a valve on another reactor, they were asked to check the sight glass. A small leak was observed and a maintenance man tightened the nuts with an open end wrench (not a torque wrench). On the second round of tightening, a one-inch ribbon stream of water and vinyl chloride suddenly shot out and knocked the man down. He was bleeding from the face and escorted out of the building. Regular emergency procedures were started immediately, e.g., windows and doors were opened, steam to reactor shut, additions stopped, and the manual vent to the reactor opened. An operator was overcome by vapors and carried out. Five minutes later a tremendous explosion occurred, ripping the building to pieces. The contents of 18 reactors were dumped but there was very little fire in the building. The explosion wrecked the sprinkler system and the post indicator valve could not be reached. Pressure dropped to zero in critical locations. There evidently wasn't a sprinkler line loop on this area. A warehouse, laboratory and office building 150' x 800', was 60 feet south of the building. A wall was blown down, several small fires started and propagated along the roof. The roof caved in and the building burned several days, to complete destruction. The sprinkler pressure was zero in this area. The boiler and maintenance building 80 feet to the north, was extensively damaged and other surrounding buildings also were damaged to varying degrees. Windows in homes were shattered and some homes evacuated. Of the dead, one was found in the dryer room attached to the building. Four bodies were found outside, between the building and the warehouse, indicating that conditions had changed from emergency to evacuation within a 5-minute period. One fatality occurred in the boiler room, 80-100 feet away.

Cause: The investigators feel that the 6-inch sight glass shattered completely, causing a sudden build-up of flammable vinyl vapors which found an unknown source of ignition. Possibly glass fragments broke the ceiling lights.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-93

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 162

Explosion and Fire - Lead Azide

Description: At approximately 8:35 AM an explosion and fire occurred in a lead azide conditioning and storage magazine which resulted in death of a chemical worker. The building was demolished. The chemical worker and his co-worker were checking magazine bunkers to determine if heating systems were functioning satisfactorily, at the time the explosion occurred. Both men proceeded separately, with the chemical worker checking the lower level of buildings (which included the building in which the explosion occurred). His co-worker completed a check of a similar set of buildings and was waiting for the chemical worker at the time of the explosion. Two explosions were heard, one immediately followed by another louder report. The building was 8'2½" x 13'-3/12", with 10' ceiling and a 3'6" addition to the northeast corner for housing the steam reduction unit. The building was of semi-permanent type construction with concrete foundations and floors. It was not sprinklered or fire resistant. The exterior walls were of corrugated asbestos siding over a wood frame. The roof was of tar and gravel built up over wood decking. All interior walls and ceiling were of fiberboard. The building had a conductive floor, static electric grounding facilities, and steam and electric utility connections. Lighting was accomplished by a spark proof light mounted in the wall over the door. A ventilator was installed in the roof. The door was equipped with ground cables attached to the building ground system. A static discharge bar was installed just inside to the left of the door. 2-inch blanket insulation covered with aluminum foil vapor barrier was installed in the walls and ceiling. The hot water heating system and humidification control system located in the building were demolished, with the exception of the fin-type hot water radiators which remained largely intact. Other equipment in the building consisted only of a small metal table and metal shelves, all of which were completely demolished. A total of 20 pounds of lead azide was located in the building - 15 pounds in conductive rubber drying tubes and 5 pounds in pie cups. Interior temperature of the building was approximately 80°F, with relative humidity less than 10%. An inspection conducted approximately 3 months prior to date of the incident found all equipment to be properly grounded. The barricades effectively contained the explosion and were damaged only as a result of the fire. The barricade's wooden retaining wall was ignited along the top edges and fire spread down the wooden retaining walls before being extinguished. Debris was blown to a distance of approximately 400', with most of the debris (including wood and corrugated transite) confined within a distance of approximately 140' from the point of explosion.

Cause: Probable Cause -

1. Accumulated static electricity discharged from the body of the deceased to the lead azide, causing the explosion. (The deceased was wearing non-conductive rubber overshoes over conductive shoes.)

2. Lack of adequate supervision, through a system of positive controls, definitive instructions, and approved SOP's, allowed violations of safety regulations to exist and was a contributing factor to the explosion.

3. Condition of walkways leading to the building, which were not cleared of snow and which contained loose gravel, may have been a contributing factor to the explosion.

Preventive Measures:

1. The practice of wearing non-conductive footwear in and around buildings containing explosives be discontinued immediately.

2. A positive system of safety checks by supervision be established, to insure that employees are properly attired and equipped when entering explosive areas, and that these safety checks be made a matter of record.

3. Approved SOP's be established for all phases of explosive material processes, to include monitoring and conditioning operations.

4. Walkways in areas containing explosives be conditioned to eliminate the presence of loose abrasive materials, and be kept clear of any hazards such as ice, snow, or water.

Reference Number of this Incident: 1132

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 163

Tank Explosion

Description: An explosion and fire occurred at a research combustion and heat transfer laboratory, resulting in fatal injuries to an engineering test technician. Preparations were being made to test an oxygen propane torch intended for later use in the evaluation of flame resistant materials. Liquid oxygen at a pressure of 200 psig was to be run through a throttle valve and heat exchanger to furnish gaseous oxygen to this torch. The set-up utilized a nitrogen gas pressurized liquid oxygen tank facility constructed some two years ago for heat transfer testing, but which was not so used. The system had been secured against contamination during the idle period. On the day prior to the accident, the oxygen system was checked out with liquid nitrogen and the throttle valve was adjusted to give the proper flow rate to the torch. On the day of the accident, the propane system was flow checked and adjusted to flow rate. Then the LOX system was loaded, and at the time of the accident, nitrogen pressurization of the tank was in process. The crew was increasing nitrogen gas pressure in the tank in small increments to the intended level of 200 psig. The technician was viewing a tank pressure gage from a distance of about 10 feet and had just called out "150 psig" when the explosion and fire occurred. Positive evidence showed that the system was mechanically sound and that the tank was not over-pressurized with nitrogen. The deliberation and care with which the pressurizing operation was proceeding indicates that the nitrogen pressurization was only slightly above 150 psig. The tank was protected with a relief valve and burst diaphragm set to 1200 psig. After the incident, a loosely fitted dust cap on the relief valve discharge port was still in place, indicating that the valve had not opened. Subsequent testing of the valve showed it to be still in good condition and operating properly at its setting of 1150 psig. The burst diaphragm also was tested and burst at 1200 psig.

Cause: Probable cause of the explosion was the sudden generation of pressure due to reaction of the liquid oxygen in the tank with the material of the tank. This tank was made of titanium alloy. Examination of the debris showed extensive burning of the lower half of the tank; some fragments burned to a feather edge, and a portion of the tank bottom was apparently completely consumed by fire.

Comments: Literature search has not revealed any definite prohibition against the use of titanium for oxygen services; however, several references question such use and indicate that titanium is more sensitive to reaction with oxygen than with other common materials of construction, such as stainless steel or aluminum. Oxygen/titanium reactions have been noted on a number of occasions, usually as a result

of some triggering action. It was assumed the tank was suitable for liquid oxygen service because the specification under which it was purchased called for pressure cycle testing at -320°F and to 5000 psig pressure, a value several times the pressure at which the tank was to be used. It had been given a pressure test at 4500 psig and cleaned for LOX service just prior to incorporation in the facility. Contamination of the system may have been a factor in the triggering of the reaction between LOX and titanium because most such reactions noted have been the result of some triggering action. Careful analysis of the components of the pressurizing system, the tank remains, the downstream LOX flow system, the liquid nitrogen supply tank, the liquid oxygen supply tank, and the transfer hose do not show presence of contamination. Whether or not contamination played a role in the accident is unknown.

Preventive Measures:

1. Eliminate use of titanium in service with oxygen - liquid or gaseous.

2. Additional chemical and metallurgical tests are proceeding on one tank and certain of the LOX flow system components.

Reference Number of this Incident: L-94

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 164

Fire During Waste Disposal Operations

Description: A 250-pound metal drum of waste ammonium perchlorate was delivered to the burning ground in a ½-ton pickup truck for disposal. The material had been rejected due to the top section of the drum rusting, allowing the material to cake from moisture. The truck was parked alongside a designated pit which contained a quantity of dry solid propellant trimmings and approximately 300 pounds of wet propellant waste. Two employees tossed the drum over the side of the truck bed and allowed it to fall into the pit, a height of approximately 9 feet. When the drum contacted the bottom of the pit, ignition of the propellant trimmings occurred. The two employees evacuated the area, receiving only minor burns from the radiant heat. Damages to the pickup truck amounted to $700.

Cause: The most probable cause is impact of the propellant trimmings between the ammonium perchlorate drum and rocks or other objects in the pit bed.

Preventive Measures: More rigid handling and disposal procedures have been implemented and are being enforced.

Reference Number of this Incident: L-95

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 165

Fire - Propane

Description: A tractor-semitrailer transporting 7000 gallons of propane caught fire after an external hose broke or ruptured while in transit. The drivers were attempting to shut off the escaping gas when it ignited. The accident resulted in the death of one driver and injuries to three other persons. In addition to the vehicle, fire damage extended to a two-story frame house and four other motor vehicles parked nearby. The accident occurred in a mixed residential and business district. At the time of the accident, the weather was clear and traffic was moderate. The cargo tank was 33 feet long and seven feet, four and three-eighths inches in diameter, of frameless construction, with tank capacity 9526 gallons. The driver was accompanied by a driver-trainee. While at the shipper's plant, the driver attached the rubber hose from the propane cargo tank to the tractor fuel tank for the purpose of fueling the vehicle en route. He stated that the hose appeared to have sufficient length to permit the vehicle to turn without damaging the hose or connections. Excess slack in the hose was taken up by looping a piece of wire around the hose and through a hole in the fiberglass fender over the forward dual wheels of the tractor. The driver thought the wire would keep the hose from dropping to the wheels or binding, and the hose could move within the loop as necessary. Shortly after making a left turn (approaching the accident scene) there was a noise of escaping propane vapor. The driver stopped the vehicle, cut off the engine, and told the driver-trainee to shut the valve at the right fuel tank. The driver then attempted to reach under the cargo tank to shut off the hand control valve at the discharge line. When the driver-trainee touched the valve on the fuel tank, the vapors ignited, engulfing him in flames. He died five days later as a result of burns. The driver suffered serious, but less severe, burns and survived. The escaping gas continued to burn for approximately one hour and a half despite efforts of the city fire department, until the valve was finally shut off by an employee of the carrier, using protective clothing. Two bystanders were hospitalized from possible inhalation of fumes and shock.

Cause: Examination of the vehicle after the accident disclosed no defective mechanical condition with regard to the tractor which might have contributed to the occurrence; however, a modification in the external piping arrangement on the cargo tank definitely contributed to the accident. The tank was originally equipped with a three-inch discharge line located just aft of the landing gear, projecting from the center of the tank toward the curb side. This discharge line included an excess-flow valve at the other end of the line. The modification included the insertion of a T-joint between

the excess-flow valve and the manual control valve in the discharge line. Into this joint was fitted a 1¼-inch pipe and hand cut-off valve which provided for a hose connection. A 3/4-inch rubber hose had been connected between this fitting and a fitting on the right fuel tank of the tractor. This arrangement, which bypassed the main discharge valve, permitted fueling of the tractor directly from the cargo tank. The excess-flow valve in the cargo tank, which had a rated capacity of 250 gallons-per-minute, provided the required protection for the three-inch discharge line. The liquid flow capacity of the auxiliary fuel line, restricted by valve and connections, was much lower, rendering the excess-flow valve ineffective. Thus, in the event of failure of the hose between the cargo and fuel tanks, the only means for controlling the flow of propane was the single manually-operated valve off the main discharge line. No secondary excess-flow protection was provided. Pressure relief valves located at the top of the cargo tank functioned properly during the fire.

Preventive Measures: A number of accidents, some with extremely serious consequences, have occurred in recent months in the transportation of liquefied petroleum gases by cargo tank vehicles. The nature and severity of these accidents have shown beyond question the hazardous nature of this commodity if not properly handled. This accident demonstrates the prime necessity for more adequate measures for instruction and supervision of drivers who are entrusted with the operation of vehicles transporting these materials. Proper control of the practices of drivers is an essential element in the responsibility of carriers.

Reference Number of this Incident: 1133

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 165

Explosion During Preparing Rocket Motor for Shipment

Description: Part of the handling harness for a particular type of solid propellant rocket motor consists of a handling ring which is fastened by eight ½-inch x 1¼-inch bolts, four on each side of the ring. These bolts are directly opposite each other, and are point-to-point when drawn down tight. A motor was being prepared for shipment, and the employee was fastening the handling harness to the transport dolly by inserting these bolts. The back four were in position, and he was tightening one of the front bolts when there was a loud explosion, and the bolt was blown at the man's head. It struck the crown of his hard hat with sufficient force to penetrate the hard hat. Otherwise there was no damage or injuries.

Cause: Propellant residue trapped in the screw threads, despite precautions to prevent this from occurring. The rings are cleaned prior to each use. The process consists of scrubbing the bolt holes with trichloroethylene applied by an air-driven wire brush. This is followed by chasing the threads with a tap under water. Next is another cleaning with triclo and a stiffer bottle brush. After this the threads are inspected with the aid of a flashlight. The ring in the incident had gone through this process of cleaning.

Preventive Measures: The front and back bolts have been discontinued, and 3/8-inch through bolts are being used, thus eliminating the threads inside the ring.

Reference Number of this Incident: L-96

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 167

Ignition of Flammable Solvent

Description: An employee was pouring methanol into a five-hundred gallon reaction kettle through an open manhole to neutralize the drying agent of a drying operation. As he was climbing down the stepladder to get more methanol, the vapors in the kettle ignited, blew out the manhole and hit him in the face. The employee received flash burns to his face and upper chest.

Causes: Pouring flammable solvent into an open kettle with a possible ignition source. (NOTE: This procedure had been followed in small polyethylene jugs without incident. Adequate planning for transition to the larger vessel did not take place.)

Preventive Measures:

1. The general procedure will be reviewed and revised.

2. All future neutralization will be carried out by pumping the methanol into a closed vessel with oxygen excluded.

Reference Number of this Incident: L-97

Duplication of this report is authorized.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 168

Ignition of Solid Propellant Grain, Outdoors

Description: Ignition occurred during a special study involving the attendant drilling of flame passages (artificial voids) through the phenolic restrictor pad sleeve of a 91-pound uncased grain of cast ammonium perchlorate propellant. Two process engineers performed the operation. The flame passages were made with a Dremel high speed electric drill with a 1/32-inch diameter drill bit. The grain was positioned on a wooden cradle atop a flat aluminum cart. This assembly and the cart were secured against movement, in the event of ignition. One engineer was using the drill and the other engineer assisted in the operation. Upon drilling through the phenolic pad, the drill bit contacted propellant and ignition occurred. Both engineers immediately evacuated the location. The engineer using the electric drill sustained first degree burns on his left arm and right hand when the propellant grain ignited and suffered a hemo-arthosis of the right knee while evacuating the site. The other engineer was not injured. The burning grain remained in place and burned entirely.

Cause: The Dremel high speed drill bit penetrated the high density phenolic restrictor pad and was deflected into the propellant. Propellant ignition was probably caused by resultant friction.

Preventive Measures: The creation of the flame passages in grains is now accomplished by drilling holes in the phenolic restrictor pad sleeve and positioning wire mandrels in these holes prior to casting. These wire mandrels are easily removed, leaving the desired flame passages, after grain cure.

Reference Number of this Incident: L-100

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 169

Fire - Powder Buggies

Description: Fire destroyed three powder buggies and floor of a tram track. The unattended truck carrying three empty buggies was standing in bright sunlight on track away from any process building when flames were noticed. The fire was allowed to burn out with no further damage.

Cause: The truckers had placed three one-gallon glass containers, partially filled with alcohol, in one of the buggies to be used later in routine "clean-up" procedure on Gelatin machinery. They left the truck standing in bright sunlight. We believe the conditions were such that the position of sun and bottles were just right for a lens effect through the glass to concentrate sufficient heat on the surface of the buggy to start a fire.

Preventive Measures: Immediate removal of all glass containers from not only the explosive area but from the entire plant area, and prohibiting the use of glass containers for any purpose.

Reference Number of this Incident: 1136

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 170

Static Ignition of Sodium Hydride

Description: A hydrogen explosion occurred in a chemical process while solid sodium hydride was being charged to the still from a polyethylene bag. The still contained 750 pounds of reactant at 40°C and 6½ pounds of 50% oil-coated sodium hydride catalyst. The normal procedure used on the previous fifteen runs was to charge the reactant under vacuum, break vacuum with nitrogen to a positive pressure and maintain a nitrogen bleed on the still while the manhole was open and at all times while processing also. Air had not entered the still for the past month. In this instance, the operator (on this job only three days) attempted to pry open the manhole cover before the vacuum had been completely relieved and permitted air to be drawn into the still. He was immediately stopped and told to pressure the vessel with nitrogen before attempting to open the cover, and also told why this was necessary. After further pressuring with nitrogen, the operator opened the cover and a chemical engineer dumped the 6.5 pounds sodium hydride into the vessel from a polyethylene bag. As the chemican engineer was shaking out the last of the hydride, an explosion occurred shooting flames into the air, knocking off his face shield, and driving him and the operator back from the kettle. The flames continued to issue from the kettle and the chemical engineer told the operator to close the cover to prevent the fire from striking back into the kettle. He turned up the nitrogen flow to the kettle. Flames continued to spurt several feet from the cover. By this time, two other technical men arrived with fire extinguishers and took over. They used dry powder extinguishers until the flames ceased and then opened the cover, replaced the gasket, bolted the cover down and applied vacuum. The batch was then processed in the normal fashion.

Cause: The three ingredients of explosion were present. The hydrogen from the reaction, the oxygen apparently from a pocket of air drawn in during the premature attempt to open the manhole, and the spark probably from a static charge on the polyethylene bag. The chemical engineer was wearing rubber gloves, shoe rubbers and dacron and wool clothing at the time.

Preventive Measures: The succeeding batches were run with sodium methylate as a catalyst replacing the sodium hydride. However, if it becomes desirable to use hydride again, several changes may be made. First, the sodium hydride will be handled in static-proof bags. Second, the order of adding first and third constituents was reversed as catalyst does not react with the third unless first is present. Vessel is then closed after adding catalyst (second constituent) and the reactive constituent (originally first) is drawn into the closed still by evacuating it. This change may have some effect on product quality which will have to be investigated.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: I-101

Publication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 171

Explosion - Chemicals

Description: An employee was attempting to mix liquid chlorine and carbon bisulfide for use with infrared equipment to determine chlorine impurities. The equipment in use consisted of one cylinder containing liquid chlorine (30 cubic feet size), one 1700 ML metal pressure cylinder (400 psi test) containing 70 ML of carbon bisulfide and $\frac{1}{4}$-inch copper tubing with fittings to connect the two cylinders. The equipment was assembled in a ventilated laboratory hood. In addition, a portable 3/8-inch plastic shield with a lead base had been positioned in front of the equipment as splash protection against any liquid chlorine spill. An explosion occurred inside the 1700 ML cylinder as liquid chlorine was introduced. The employee received cuts across the back of his left hand and a possible broken bone in his hand near the index finger.

Cause: Employee failed to recognize the potential hazard of mixing liquid chlorine and carbon bisulfide in the presence of an iron catalyst (1700 ML cylinder). NOTE: The operation had previously been performed using glass-lined containers.

Preventive Measures:

1. Check lists and available technical data should be consulted before attempting experiments and/or routine laboratory operations.

2. The necessity of considering all safety aspects involved before proceeding with any operation will be stressed.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: I-102

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 172

Silver Complex Detonation

Description: Recently an employee received chemical burns to both eyes when the reaction he was conducting detonated throwing a silver ammoniacal complex over the laboratory. The employee was not wearing safety glasses even though they were provided. The reaction he was conducting was to prepare a silver ammoniacal complex as a part of his research assignment. He had added sodium hydroxide to a silver nitrate water mixture until the silver nitrate had precipitated as silver oxide, then he proceeded to add ammonium hydroxide. While adding the ammonium hydroxide the reaction heated, and a detonation occurred. Literature references on this reaction state that the reaction of ammonium hydroxide on silver oxide can cause the formation of fulminate of silver and the records show frequent detonations. The employee should have used the established alternative method which requires the addition of ammonium hydroxide to the silver nitrate water solution which can be performed with safety.

Preventive Measures:

1. Safety glasses must be worn by everyone in all chemical laboratories.

2. New employees should be advised of hazards which might be encountered in their work.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-103

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 173

Fire - Black Powder

Description: A fire occurred involving 80 pounds of black powder which was distributed in different rooms (5-pound maximum in any one place) during regular operation of safety fuse spinning machines. The fire apparently started in the basement of one room and quickly spread to the other basements fed by powder that sifted down through the floor around the machines onto the basement floor, ledges and underfloor machinery. It came up through these holes and around the edges of the floors. The raw core being made is very inflammable and was ignited. The fire traveled up the wooden powder tubes and ignited the black powder in the lofts. There were a series of muffled explosions before fire came into the fuse rooms and after it reached the lofts. Powder cans left by the powder carrier exploded in the lofts of the rooms where the largest percentage of windows were broken. All operating personnel were able to leave the area without injury, except one person who was slightly burned around the ankles. The building consists of separate rooms in a line. There is a 5-foot high basement below each room which contains the drive motor, shafting and belting for driving the machines in the room above. Each fuse spinning room contains two rows of spinning machines. Each machine has its separate supply of black powder stored in separate plastered huts in the loft above the spinning room. A funnel holds the black powder (approximately 3 pounds when full) and is fed through a tube that extends through the floor to feed the machine below. There are two louvered doors with screening on the inside of each door on the huts. The funnels are filled from the back side of the hut through a tube leading to the funnel and fitted with a cam-locked cover. Access to each loft is from a runway in front of the building. Access to the spinning rooms is from a runway in front of the building also. The only opening to all rooms is in the basement. (Years ago one motor ran all rooms with long belts. The openings between the rooms are bricked up except for a 3-inch opening across the top for steam and water pipes and conduits.) The building construction was 2-foot thick stone walls, wooden roof, wood floors covered with linoleum and ample windows. The sprinkler system functioned normally. Damage consisted of broken windows (121 panes replaced out of a total of 424), blistering of paint in parts of rooms and water damage to machines. Damage was confined to the building involved and missiles were confined in lofts. Weather conditions were fair - temperature 58° and relative humidity 42%.

Cause: Unknown - possibility that black powder waste was ignited from falling metal object in basement or from friction on a machine.

Reference Number of this Incident: 113

Publication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 174

Solid Composite Propellant Fire in Laboratory Mixer

Description: A 15-pound batch of ammonium perchlorate castable propellant was being mixed in a 2¼-gallon horizontal mixer. Upon charging the last propellant ingredient to the mixer, the operator left a 6"x½" stainless steel spatula in the mixer bowl. Propellant ignition occurred shortly after restarting the mixer. There were no injuries. The deluge system functioned efficiently. Damage was slight, the cell was lightly soiled and a sheet plastic burn-out panel in the weak wall burned out.

Cause: The propellant was ignited by the friction and force generated by a metal spatula entering into the mixing action.

Preventive Measures: Laboratory operating personnel must now certify in writing that a mixing cell is free of extraneous items prior to starting a mix. They must list the tools taken into a mixer cell and must account by signature for each of these tools prior to each starting of the mixer.

Reference Number of this Incident: L-104

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 175

Explosion - HNF Manufacture

Description: Two violent decompositions (fume-off) of nitrogen followed by explosions occurred during manufacture of hydrazine nitroformate. No personnel were injured. Loss of equipment was limited to one ice chest. Approximately 20 pounds of NF were involved in the incident. The initial decomposition occurred near the crystallization shed and involved one polyethylene bottle containing approximately 11 pounds of a 90% NF - 10% isopropanol solution. After the first explosion, the remaining 5 bottles of NF, one of which contained 10% isopropanol, were placed in the ice chest located near the operating area. The second explosion is believed to have been caused by the one bottle containing the NF - isopropanol solution. All of the nitroform involved had been previously frozen and was being thawed for an HNF reaction. The material was stored frozen and considered to be safe based on samples of frozen NF stored for approximately 1-1/2 years with periodic thawing. This material showed no signs of deterioration.

Cause: Subsequent investigation and tests revealed the following:

1. When nitroform is dissolved in isopropanol forming solutions wherein the concentration by weight of nitroform is 50% or greater, an exotherm is observed. This exotherm increases directly with the concentration of nitroform above 50% by weight.

2. Nitroform is very reactive with HNO_3 and its constituents some of which may have been present in the nitroform used at the time of the incident.

3. Nitroform is more stable when frozen and is stored for short periods in this state. The nitroform that was reacted the day of the incident with isopropanol was still partially frozen. In addition to the exotherm that is known to occur under the conditions of paragraph 1 above, nitroform goes into solution exothermically which may also have contributed to the incident.

Preventive Measures:

1. Prior to further reaction, all of the nitroform will be completely thawed.

2. The pH of the nitroform will be more closely controlled to minimize the possibility of HNO_3 or its products being present.

3. The mixing of nitroform and isopropanol will be done remotely with small amounts of nitroform being added to cooled, agitated isopropanol. The concentration of isopropanol-nitroform will not exceed 50-50 by weight.

Reference Number of this Incident: 1142

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 176

Fire - Propellant Line Operating Building

Description: Propellant samples were being cut on a No. 4 Cincinnati mill by remote control. When a sample has been cut, the mill operator enters the bay, unloads the specimen from the jig, cleans the chips from the mill table with a vacuum, runs the table back, and reloads the jig for the next cut. Eighteen such samples had been cut, and as the mill was started for the nineteenth cut, a fire was discovered at the machine. The deluge functioned and the operators ran to the safety shelter.

Cause: The exact cause could not be determined. Possible causes were:

1. Friction heat caused by the propellant holder rubbing against some brass spacing shims next to the propellant.

2. A foreign object in the sample holder.

3. Static discharge.

Investigation indicated that the cannister and hose of the wet vacuum collector pressurized to the point of rupture; in fact, the filter bag support and cannister lid were ejected during the fire. Unconsumed oxidizer found upon disassembly of the rotor housing indicated the fire did not originate within the moving parts of the cleaner. It may have started in the cannister where many metal parts were subjected to contact and minor vibration. A vacuum distribution plate had been scorched by flame, leaving various amounts of residue.

Preventive Measures:

1. Strengthen maintenance and housekeeping activities.

2. Take more care in the adjustment of the mill.

3. Locate the vacuum cleaner outside the building.

Reference Number of this Incident: L-105

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 177

Explosion of Contaminated Equipment, Machine Shop (Inert Area)

Description: An employee in the inert area machine shop was assigned to repair an air cylinder from a casting vibrating fixture, which had been received from one of the operating lines. It bore a properly signed "DECONTAMINATED" tag. He had some difficulty in removing a 4-inch bolt, so he gave it a tap with a hammer. There was an explosion which blew the bolt out, severely lacerating the employee's left index finger. He had to have plastic surgery on the finger, and lost a week of work.

Cause: Although the equipment had been decontaminated, it had not been disassembled before shipment to the inert area. Dry propellant residue had remained under the nut and in the threads of the bolt, which detonated upon impact.

There was considerable rust on the equipment, which made it difficult to recognize the residual propellant. Existing regulations require that equipment be completely decontaminated - including disassembly, if necessary - before shipment out of the explosive area. The regulations also require the receiving department to make a thorough inspection of such equipment to assure complete decontamination before attempting any work on it. Neither of these precautions had been followed.

Preventive Measures:

1. More stringent control and enforcement of the regulations.

2. No attempt should be made to repair such cylinders, since it is probably easier, cheaper, and definitely safer to replace them with new ones, and scrap the old ones for salvage.

Reference Number of this Incident: L-106

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 178

Accidental Ignition of Propellant

Description: An employee was just completing the job of fastening a grain of very fast burning propellant into the chuck of a lathe located in a machining bay of an operating line. The actual machining was performed by remote control, but the preparation and the removal after machining was done attendantly by the operator. At the time of the incident, his foreman was standing behind, and slightly to one side of the operator, watching him complete machining preparations. Two grains had been previously machined on this lathe, and the propellant shavings were contained in an aluminum scrap pan that was positioned under and between the ways of the lathe. The operator had tightened the jaws of the chuck with a specially-fabricated T-wrench weighing approximately 4 pounds. He accidentally dropped the wrench into the scrap pan (a distance of 38") and the scrap ignited, the flame propagating to the grain in the chuck, totally consuming it. Both men received serious first and second degree burns.

Cause: The impact of the falling wrench against the thin layer of propellant scraps in the metal pan ignited the propellant. This particular propellant has an impact sensitivity of 17 centimeters in the standard 2kg. drop test. The deflagration was so rapid that the deluge system heat sensor never reached activation temperature, although the system was manually activated from the control room.

Preventive Measures:

1. Devise a method of suspending the chuck wrench so that it cannot fall or strike an area contaminated with propellant fines, or the grain itself.

2. Install a scrap collection system to remove propellant fines to a safe location.

Reference Number of this Incident: L-107

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 179

Ethyl Acetate Tank Truck Explosion

Description: At about 1:45 PM, a tank truck being loaded with 99% ethyl acetate, exploded. The tank truck loader had started to load the truck at approximately 1:41 PM. Just before the explosion occurred, the loader heard what he described as a sizzling sound. He peered into the tank but could see nothing. He moved away but held an arm over the dome opening holding a wooden gauge stick. An explosion occurred and flames shot out of the dome opening. The loader's right arm and hand received second degree burns. He jumped from the top of the truck to the ground. Torn ankle ligaments and inner thigh muscle strain resulted. Investigation at the scene of the accident showed all grounding equipment to be in excellent condition. The hose used in loading was checked and found to have a resistance of less than 50 ohms from end-to-end. Questioning of personnel disclosed that regular grounding procedure had been followed by the tank truck loader. However, it was disclosed that static discharge had been heard before but not recognized as such. Static discharge had been seen jumping between the copper cup used to hold the thermometer and the loading pipe, at the start of loading. In all cases, 99% ethyl acetate had been involved. Practice of lowering the thermometer into the truck had been discontinued at the time the discharge was seen.

Cause: All evidence shows this explosion to have been due to free charge on the surface of the liquid. Discharge of sufficient energy resulted in ignition of flammable mixture.

Preventive Measures:

1. The pumping rate is to be slowed down so as to decrease turbulence and thereby cut down static build-up.

2. Bare No. 4 flexible stranded copper cable is to be used on the outside of the cloth filter to discharge [illegible]. Six to eight cables shall run from upper two-inch fitting to lower [illegible] inch cap and extend six inches beyond bottom fitting.

3. No ungrounded metal objects are to be inserted into tank truck during load-operations.

4. After loading has been completed, a three to five minute relaxation time shall be allowed before proceeding with taking of readings. Relaxation time should allow dissipation of any static charge.

Reference Number of this Incident: L-108

Duplication of this report is authorized.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 180

Fire - Benzoyl Peroxide

Description: An operator was preparing to make a special mix. He was weighing out 1.6 pounds of benzoyl peroxide into a large stainless steel beaker. As he picked up the beaker and turned away from the weigh station with it, the peroxide belched forth fire. The operator threw the beaker to the floor and quickly ran for a dry chemical extinguisher. With the help of the foreman who was close by, he managed to extinguish the blaze. By the time the operator reached the extinguisher, the peroxide had probably burnt itself up, but there was a small amount of methyl methacrylate in a pan underneath one of the pumps which was blazing. An investigation showed that the operator had rinsed out his beaker with methyl methacrylate prior to weighing out the benzoyl peroxide. Even though he shook the beaker out, no doubt there was a small amount left in it which polymerized rapidly in contact with the peroxide resulting in a local build-up of heat and ignition of the catalyst. In the past the laboratory has weighed out practically all the benzoyl peroxide for the department. The operator had not received specific instructions on how to weigh up and add the catalyst to this mix which was a comparatively new operation for him. However, supervision had assumed that it would be done in the way that the master mixes were made. The operator was astute enough to realize that the benzoyl peroxide should not be added to the mix in the dry form and was planning to slurry it with another ingredient. However, he did not understand the danger of rinsing the beaker out with methyl methacrylate prior to use. This is a standard cleaning procedure. This was the third time this particular operator had weighed up this mix. The first two times he had not been rushed, and presumably the methyl methacrylate had had a chance to evaporate from the beaker prior to weighing up the benzoyl peroxide. The third time he was running late, and by his own admission, there was practically no delay between the time he cleaned out the beaker and weighed up the catalyst.

Preventive Measures:

1. A special beaker shall be used for weighing catalyst only.

2. More training will be given on the hazards of benzoyl peroxide.

3. The benzoyl peroxide sheet in the Hazardous Chemical Manual will be revised to reflect more accurately the nature of this material.

4. All other places in the plant which handle benzoyl peroxide will be studied to see that safe handling procedures are used at all times and that personnel are properly instructed in the hazards.

Explosive Incident Report No. 180 - Cont'd

Reference Number of this Incident: L-109

Duplication of this report is authorized.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 181

Fire - Solvent Storage

Description: A fire occurred in a drum storage yard in which 800 steel drums (55 gallon) containing solvents and adhesives and three underground storage tanks containing some 36,500 gallons of solvents were housed. Most of the drums were stored in a horizontal position. The underground tanks were dual compartmented, horizontal steel tanks. The pumps to these tanks were located in pits (below ground level) adjacent to the tanks. The pits had interconnecting drains to a concrete covered sump at the south end of the pump pits. The switches to the pumps were located on an adjacent building wall. The source of ignition has not been determined. Stories of eye witnesses concerning the point of origin differ between a drum or drums several feet from the pump houses. There was no activity in the yard at the time of the fire nor was there any electrical energy to the pumps. There were no transfers being made at the time. This being shift change time would substantiate the above conditions. A remote possibility of vandalism was discussed; however, no one was observed inside or outside the fenced area at the time. Approximately 450 of the drums plus three pump houses and equipment were destroyed. The three underground storage tanks containing solvents were also affected and may be abandoned from further use. The estimated property loss, including the bulk solvents, was in excess of $100,000.

Cause: 1. Excessive storage of flammable solvents and adhesives.

2. Pump pits were known to have accumulations of solvent vapors due to leakage of the pumps.

3. Drums stored horizontally lost their entire contents when ruptured, which added to the spread of the fire. Close stacking of the drums also contributed.

4. Underground storage tanks were not equipped with approved flame arrestors. Vapors flashed and blew off fill caps and possibly contaminated the material.

Preventive Measures:

1. A clear space distance from drum storage to buildings of at least 50 feet should be maintained. This clear space should also be free of other combustible material accumulations.

2. Reduction of present inventory levels and controls on maximum levels to be permitted.

3. A method of cooling drums during high temperature weather conditions should be provided.

4. Horizontal versus vertical drum placement in accord with cooling and handling practices should be investigated.

5. Equipment should be provided for the application of mechanical air foam extinguishment for this class of fire.

6. Approved type flame arrestors and vents should be provided in bulk flammable liquid storage tanks.

Reference Number of this Incident: L-110

Duplication of this report is authorized.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 182

Explosion - RDX

Description: At approximately 1:17 PM, an explosion occurred in Bay G in a single action pelleting press containing approximately ½-pound RDX. There were no personnel injuries. The production operator activated the pelleting presses in Bays G, H and I by remote electrical control at approximately 1:10 PM, and observed the starting of each press through viewing port of mirrors in 12-inch reinforced concrete dividing wall. At approximately 1:17 PM, the operator turned off the pelleting press in Bay I and then entered the bay to obtain RDX pellets for check weighing. The operator had just entered Bay I when the explosion occurred. Immediately after the explosion, the operator turned off electrical controls to presses in Bays G and H, telephoned alarm to fire department and proceeded to perimeter gate of Line to meet fire department. Construction of the building involved consists of 12-inch reinforced dividing walls, hollow tile walls, and wood frame roof construction. Damage to the building was confined to wood frame roof of Bay G, celloglass enclosures opposite Bay G, the press, and the 12-inch reinforced concrete wall was pitted. There was no structural damage to the hollow tile walls or other portions of the building. Most of the missiles from the press were confined in Bay G and the celloglass enclosure opposite Bay G. Missiles from the wood frame celloglass enclosure were confined to a 30-foot radius outside the building involved. One piece of the shoe from the press was found approximately 96 feet to the south and east of Bay G. Four other pieces of the hopper, shelf and table were found 20 to 42 feet south of Bay G.

Cause: Cause of the explosion is unknown, and no abnormal conditions previous to detonation were noted by operator in the press building or surrounding area. The press was rebuilt before installation. The base of the press was substantially installed with four anchor bolts. Lower and upper ram, and powder shoe were adjusted. Punches and dies were magnafluxed and otherwise completely checked before installation four days prior to date incident occurred. Operational tryout of machine was conducted. The press is thoroughly cleaned and adjusted every day of operation. Investigation reveals the press operations were being conducted in the normal manner and there was no departure from approved current standing operating procedures. Continuing effort will be made to determine cause of explosion.

Reference Number of this Incident: 1146

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 183

Steam Pot Used as Flask Holder Spells Fire Hazard

Description: A chemist set a 22 liter flask containing 12 liters of a filtrate on a steam pot as a holder for the flask and left the laboratory. The filtrate contained diethyl ether and benzene. Although the chemist did not wish to heat the filtrate, the steam valve connected to the steam pot was in need of maintenance and was leaking.

A second chemist, shortly afterward walked past the flask and also left the lab. He claims he did not smell ether or benzene when he passed the set-up and no one else was in the laboratory.

"A minute or so later" an explosion and fire occurred opening the explosion vents and 10 sprinkler heads.

Cause: It is believed that the steam vaporized some of the ether and benzene releasing the vapors into the room where they reached a source of ignition such as an arching Powerstat or an electric mantle. A Powerstat was located 4½ feet above the floor and about 5 feet from the flask.

Preventive Measures:

1. Defective equipment and services should be reported and repaired immediately.

2. Hand rubber flask holders should be used instead of steam pots.

3. Sparking devices should not be used in the vicinity where flammable solvents are handled unless they are suitably protected to prevent the sparks from becoming a source of ignition.

Reference Number of this Incident: L-111

Duplication of this report is authorized.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 184

Functioning of Propelling Charge Primer

Description: In a Demilitarization Building in the Ammunition Area, at approximately 0949 hours, a propelling charge for 4.7" gun M1 was accidently dropped which, in turn, caused the cartridge case in the fiber container to strike a protruding coupling on the conveyor. As a result, the primer functioned, resulting in serious injury to one employee and minor injuries to four others. Structural damage in the amount of approximately $200.00 resulted therefrom. The explosion was directly contributable to the coupling of the conveyor which acted upon the propelling charge primer as a large firing pin. Had this conveyor coupling been adequately covered by some protective device, it is extremely doubtful if the cartridge case or primer thereof would have functioned. Approximately 18,600 rounds of the same item had previously been handled on this line with no difficulty. It is ironic to note that this particular demilitarization operation would have been completed on the day the accident occurred.

Two individuals, at a great risk to their own personal safety, returned to the building following the accident and extinguished a fire which could have spread and involved additional quantities of the same material.

All personnel had been diligently following good safety practices as reflected in SOP changes made as difficulties had been encountered.

Cause: The protruding coupling on the conveyor acted as a large firing pin when struck by the propelling charge primer.

Preventive Measures:

1. That all sharp edges and protruding devices be protected during all explosives operations with specific emphasis on the couplers of roller conveyors and like items which can act as a firing pin on ammunition primers.

2. That closer observations be made when setting up operations to include, where appropriate, adequate safeguards.

Reference Number of this Incident: 1148

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 185

Explosion - Composite Propellant

Description: At approximately 1600 hours, a composite propellant physical properties test slab under laboratory cure exploded. The samples are slabs six (6) inches x six (6) inches x sixty-eight/thousands (0.068), containing eighty (80) grams of propellant. The samples are prepared by placing the propellant between two stainless steel plates and putting the plates into a press under one hundred ten (110) psi at three hundred sixty-five (365) °F for twelve minutes. The press used for this work is an RDX press modified to protect the operator by the addition of boiler plate around three-fourths of the perimeter of the press. To activate the press, the operator controls pressure with a jack inserted through the "face" of the boiler plate shielding. Once the desired pressure and temperature (controlled by a valve adjacent to the press) have been reached, the operator is free to perform other duties for the twelve minute curing period. On the day of the incident the slab had been placed in the press and the operator was attending to paper work at an adjacent desk when an approximately thirty (30) gram section of the slab exploded. The concussion blew the operator off his chair but did not injure him. The operation was shut down and authorities were notified.

Probable Cause: The mix was a more viscous batch than normal due to a micro-atomized Ammonium Perchlorate (AP) grind. It seems probable that the AP was not homogeneously distributed throughout the sample and being sensitive to pressure; it exploded.

Preventive Measures:

1. The operation is being relocated. The controls are being remoted from the press and placed behind an existing bulkhead and the press vented to the outside atmosphere. The existing press shield will be retained in addition to the remoting of controls and operator.

2. The remaining propellant from the malperforming slab will be subjected to viscosity determinations, SPG, differential thermal analysis, drop test, microscopic analysis and comparison in all the foregoing tests with propellant from the same mix.

Reference Number of this Incident: L-112

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 186

Laboratory Fraction Collector Explosion

Description: A commercial laboratory column chromatography apparatus was being used to collect automatically fractions from a column. The developing solvent was cyclohexane, which contained a small amount of ethyl acetate. The system had been in operation overnight, and 2,500 ml. of the solvent had been collected, leaving approximately 200 ml. in the reservoir at 8:30 a.m. when two explosions occurred. Fortunately, no one was in the laboratory. People in rooms 60 feet across the courtyard from the laboratory reported seeing the room enveloped in a ball of flame which quickly subsided. A staff member from an office connected to the laboratory quickly extinguished several small remaining fires with a carbon dioxide extinguisher. Only a small amount of glassware (the chromatographic assembly) was broken. Glass shrapnel from the solvent reservoir was scattered throughout the laboratory. Other damage was slight.

Cause: The explosion was attributed to the ignition of flammable vapors by a spark from the electrical controls on the sampling device. The evidence in this case, did not indicate any liklihood of solvent overflow or spillage in the apparatus, but rather that solvent vapor accumulated to an explosion level in the enclosed portion of the fraction collector and an explosion was set off by a spark from the open electrical equipment. The second explosion presumably was that of the solvent reservoir.

Preventive Measures: All chromatographic operations using atomatic fraction collection in conjunction with flammable solvents were immediately suspended until corrective measures had been taken. Although a small outlet through the wall of the fraction collector base had been provided by the manufacturer to remove solvent fumes, this seemed inadequate. An exhaust system was devised using a small squirrel cage blower driven by a shaded pole motor. Solvent vapor is vented into the hood by means of a flexible hose attached to the outlet of the blower. One-inch holes were cut through the walls of the collector box at locations which would allow a sweep of air through otherwise dead spaces and across open electrical switches. For efficient air flow, the metal dust cover which protects the collecting tubes should be in place. This equipment modification serves to remove not only flammable vapors, but also non-flammable though toxic vapors.

Reference Number of this Incident: L-113

Duplication of this report is authorized.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 187

Explosion While Introducing Chlorine Into Vaporizer

Description: The injured was working in the building that houses the chlorine vaporizer. He was introducing chlorine into the vaporizer. Assisting him was the First Assistant, and a new employee who was currently undergoing training. As the chlorine was being inducted into the vaporizer. the inlet line in the top ruptured violently.

The chlorination procedure consists of routing 20 lbs. of chlorine from a chlorine cylinder-within-a-cylinder type with the chlorine injected into the inner section. The annulus space between the inner and outer cylinders contains a steam coil (15 psig steam) immersed in continuous flowing water for vaporizing purposes. During vaporization the chlorine pressure normally reaches a maximum of 100 psig. The chlorine vapor is pressured into the Reactor catalyst bed using nitrogen, then the complete system is purged with nitrogen. At the time of the inlet rupture, chlorine was being introduced into the vaporizer. The chlorine cylinder had been used for previous chlorinations and was nearing depletion. A weight measurement taken after the rupture showed 13.5 lbs. of chlorine had been removed from the chlorine cylinder. Water had been opened to the vaporizer but the steam to the coil had not been commissioned. Seconds before the rupture it was noted that the chlorine pressure was 60 psig.

When the rupture occurred the injured was in a kneeling position on the floor. He was adjusting the flow valve in the inlet line which is located just above the floor. At the same time, the First Assistant was standing close to the injured with his back at a 45° angle to the vaporizer, but with his left side closest to it. He was checking the balance of the scales and the new employee was standing close to the west doorway observing the procedure.

When the inlet ruptured, a part of the elbow in the small section of the line struck the First Assistant on the inside of his right arm just under the arm pit, to inflict a slight laceration and a bruise. The fragmentation after striking the arm caromed off and entered the right side of his coveralls to travel across his chest and emerge out at the front of his coveralls. This action caused him to fall to the floor, he then crawled out through the west door.

The injured, who was kneeling at the time, suffered a ringing sensation in his ears, as did the other two men. This sensation lasted for more than 48 hours. A peculiar aspect of the incident was that all three persons indicated they observed no odor or effect from escaping chlorine.

Cause: Immediately following the accident, a sample of the pipe fragment, along with samples of black deposits which were ejected when the line ruptured, were analyzed and the following results noted:

1. A metallurigical examination indicated that the physical condition of the pipe would not account for the rupture.

2. Analyses of the pipe fragment and ejected vaporizer deposits were as follows:

a. Metal Fragment - inside coated with Ferric Oxide (normal corrosion product) - some organic material - some carbon.

b. Black Solid Deposit Ejected - carbon - finely divided - 20% - organic material - polymer of some sort - long chain - 50% - water + HCL Ferric Chloride - 30%

c. Black Liquid Deposit Ejected - Xylene + Finely suspended carbon

3. On the basis of these analyses, it was concluded that the rupture was the result of a spontaneous reaction between chlorine and hydrocarbon. This reaction, which does not require the presence of oxygen, is accompanied by a rapid rise in temperature and pressure. In this reaction carbon is formed similar to the deposit found after the rupture. The possibility also exists that some hydrogen could have been present which reacts violently with chlorine to give a temperature and pressure rise. There was no evidence of leakage from the water/steam side of the vaporizer to the chlorine side under pressure testing.

4. A possible reason for the absence of free chlorine could be that it was all consumed in the chemical reaction.

Preventive Measures: In order to obtain a mixture of hydrocarbon or hydrogen and chlorine in the vaporizer it is necessary to have a leak back from the reactors. At present the chlorine vent and purge lines tie into the reactor vent system, and although it would be necessary to have leakage through several valves, the possibility exists. To eliminate this possibility, the chlorination vent and purge lines are to be routed separately to the vent scrubber drum.

At present after chlorination is completed, the vaporization and injection system is purged with nitrogen and then bottled up by closing valves. It is recommended that, in the future, this system be blocked off from the reactors after each chlorination by blanking. Also the system will be purged with nitrogen before and after each chlorination.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-114

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 138

Accidental Firing of Third-Stage X-248 Rocket Motor

Description: On April 14, 1964, at approximately 9:30 a.m., the third-stage solid propellant motor of the NASA DELTA space research vehicle inadvertently ignited in Building 4-1540F in area 39, known as the Spin Test Facility.

The third-stage motor (X-248 Rocket) had been mated to the orbiting solar observatory (S-17) spacecraft, and preparations were made throughout the morning for a spin balance test. Present at the time of ignition were eleven personnel.

A polyethylene protective dust cover, which encased the spacecraft, had just been rolled down over the spacecraft and third-stage motor. Shortly after this covering, motor ignition occurred. The assembled motor and spacecraft broke free and struck the ceiling, breaking off the spacecraft. The motor traversed across the ceiling and came to rest in the northwest corner of the building. Three personnel sustained fatal injuries, three were seriously injured, requiring extensive hospitalization, four others received minor injuries, and one other was uninjured.

Cause: It was concluded that the most probable cause of the accident was electrostatics. The discharge path for the electrostatic charge was found to be spacecraft, attach fittings, suppressor paddles, squib case and spark to squib bridgewires which were grounded. It was found that potentials up to five thousand volts, with an average from a thousand to two thousand volts could be generated by the polyethelene bag covering the spacecraft, and that a man could conceivably induce three thousand volts upon touching the spacecraft. Actual squib firings in the accident configuration were produced with one thousand volts.

Reference Number of this Incident: 1156

Duplication of this Report is Authorized.

ADDITIONAL INFORMATION - ASESB EXPLOSIVES INCIDENT REPORT NO. 188

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON 25, D.C.

April 23, 1965

IN REPLY REFER TO:

Colonel Leland S. McCants, USAF, Chairman
Armed Services Explosives Safety Board
Washington, D. C. 20315

Dear Colonel McCants:

This is to confirm our recent conversation regarding general distribution of a report of investigation of the X-248 rocket motor accident at Cape Kennedy on April 14, 1964.

The NASA investigation of the inadvertent ignition of X-248 motors has been completed. A review of the data assembled as a result of this investigation indicates that the electrostatic test program conducted by the Cornell Aeronautical Laboratories uncovered some facts of broad general interests. It explained the cause for both the Tulsa and the Eastern Test Range incidents, proposed a solution, and demonstrated the adequacy of such a solution. A written and a film report have been prepared summarizing this activity.

In the interest of assuring adequate distribution of the information uncovered pertinent to safe design and handling of explosive ordnance, NASA is making the Cornell written and film reports available to departments and agencies of the Federal Government and to those in industry who may be interested in the data developed as a result of the investigation.

To assure general distribution of the report and film it is requested that the ASESB assist in this by informing the military and those shown on the ASESB Distribution List for summaries of explosive accidents and incidents, of the availability and procedure for obtaining a copy of the Cornell Technical Report, "Electrostatic Ignition of X-248 Rocket Motors," and the film report of the activity.

The report or the film or both may be obtained by submitting a request to the NASA Safety Director, Code BY, National Aeronautics and Space Administration, Washington, D. C. 20546. The report may be retained by the requesting activity--the film is available on loan. Due to the limited number of copies of the film available (8) there may be some delay experienced by the requesting activity in receiving the film. In view of this it is urged that the requesting activity arrange for immediate showing on receipt of the film and that it not be retained for more than one week. Requests will be honored in the order received.

Sincerely yours,

G. D. McCauley

G. D. McCauley
Safety Director

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 189

Explosion - Experimental Fluorination

Description: An experimental fluorination was being conducted in a 304 stainless steel one liter round-bottom flask. The flask was fitted with a paddle-type agitator, a straight-tube reflux condenser, a thermocouple well and a gas inlet tube. The system was placed in a laboratory hood and protected by a ¼-inch plastic shield. After cooling the reactor to -50°C and the condenser cooling medium to -70°C., introduction of the fluorination mixture was commenced. Progress of the reaction was checked every half hour by a technician trained in handling experimental fluorinations. The addition of about 160 g. of fluorine proceeded over a 10-hour period uneventfully. At the end of this period there was a sudden explosion without any warning as the technician reached into the hood to test for excess fluorine at the top of the condenser tube. Although his hand was protected by gloves and the starch-iodide test paper was held with a 10-inch forceps, the force of the explosion caused a severe hand injury. Subsequent examination of the remnants of the apparatus by explosives experts indicated that the explosion occurred in the vapor phase.

Cause: A new route to the preparation of perfluoropropyl hypofluorite was being investigated. The reaction was expected to proceed through cesium perfluoropropoxide. This had been prepared the previous day, the apparatus cleared with argon, blanketed with nitrogen and cooled. The fluorination mixture was approximately 50/50 fluorine and nitrogen. Literature studies had indicated that the reactions could be handled without undue hazard, but quantities were kept low and the apparatus was shielded. Investigations subsequent to the explosion indicated the possibility of a small amount of water being introduced due to the low temperature. Water could be expected to convert some of the perfluoropropionyl fluoride (used in primary reaction) to the propionic acid, a precursor for an acyl hypofluorite. (It is well known that perfluoroacyl hypofluorites are explosive).

From the structures that may have been present in the reaction mixture it is possible that the following potentially-explosive types of compounds could have been formed: bis (perfluoroalkyl) peroxides, bis (perfluoroacyl) peroxides and perfluoroacyl peresters. The explosion may have been initiated by the grinding effect of the agitator paddle on nearly dry solids in the flask, following extended sweeping with nitrogen.

Preventive Measures: Scouting ~~experiments involving~~ fluorine should be kept to 25 grams maximum, and should be conducted in blast-resistant hoods. Manipulations should be done with extension devices from the outside of the barricade. Fluorinations on a larger scale than 25 g. should be carried out by remote control behind an appropriate steel barricade in buildings constructed for this type work, outside the laboratory building.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: I-115

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 190

Explosion-Silver Oxide

Description: A chemist attempted to dissolve 3 moles of silver oxide, prepared 24 hours earlier and held in a sealed flask as a water slurry, by addition of ammonium hydroxide. Dissolution did not occur as expected and addition of hydroxide was continued, necessitating transfer of the slurry from a one-liter flask to a five-liter stainless steel can. As manual stirring continued a muffled explosion sufficiently violent to distort the bottom of the can occurred, blowing the slurry throughout the room and spattering the four workers present. The wearing of safety glasses by all of these employees and of rubber gloves by the chemist, plus prompt use of the nearby safety shower and eye-wash fountain, avoided a major injury, although all suffered chemical burns. Continued "pops" and "bangs" from the area indicated a persistent hazard, and personnel experienced with explosives were called upon for assistance. Spraying with slightly acid sodium chloride solution from behind a heavy steel shield successfully decontaminated the room and equipment by converting the silver oxide to chloride.

Cause: Although it is known that certain silver complexes present explosion hazards the reaction which here occurred is not understood. Similar procedures, without the 24 hour holding period, had been carried out without incident. No formation of hazardous compounds was expected, and holding in water was regarded as extra protection. Possible reactions leading to explosive compounds are formation of silver fulminate from reaction of catalytic action of the metal can, or silver imide formation.

Preventive Measures:

1. Do not attempt similar non-standard silver compound reactions until better understanding has been achieved and/or better protective arrangements established.
2. Broadly review the literature on hazardous silver compounds, and supplement with experiments if feasible, to establish better guides for undertaking reactions in this field. Make sure that the technical staff is fully informed of the conclusions.
3. When reacting more than one mole of ammoniacal silver nitrate use a metal container, and wear face mask, rubber gloves and rubber apron. Do not hold such a solution more than one hour.

(REPORTED BY THE MANUFACTURING C[illegible]'S' ASSOCIATION, INC.)

Reference Number of this Incident: L-1[illegible]

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C., 20315

Explosives Incident Report No. 191

Explosion Within Glovebox Disperses Contamination

Description: Ignition by unknown sources of a methanol-air mixture led to an explosion within a glovebox line in which 17 grams of plutonium 238 were being processed. No one was injured; however, the explosion pressurized the boxes and caused a total of six gloves to be torn from the ports.

Plutonium oxide discharged from the open gloveports and spread throughout operating areas of the building. Swipe specimens (40 sq. in.) indicated loose contamination ranging up to 4×10^6 d/m. Contamination cleanup costs approximated $33,000.

All employees in the room were wearing half-mask respirators at the time of the explosion. Three of these men had completed a glove change on a box on the other side of the room just before the explosion occurred. During glovebox changes, it is standard procedure for all personnel in the room to wear respirators.

The clothing and external body surfaces of three employees were contaminated. Body surface contamination readings (using commercial alpha survey meters with 55 cm^2 windows) varied from 100 to 1,300,000 c/m. Decontamination of these individuals was effected with little difficulty. These same three men also had initial nose swipes ranging from 44 to 10,000 d/m indicating internal contamination. The three were treated with DTPA. On the basis of previous experience and an analysis of blood, fecal and urine samples, it is roughly estimated that the plutonium body burden for two of these men is less than 10% of the permissible amount and less than 50-75% of the permissible amount for the third individual.

Preventive Measures: Steps taken to prevent recurrence of similar incidents include the following actions:

1. Use of flammable solvents within gloveboxes has been prohibited.
2. A complete reevaluation is being made of the area ventilation system with respect to control of airborne plutonium.
3. Self-closing hardware will be installed on emergency exit doors. (NOTE: It is thought that doors left open by evacuating employees contributed to contamination spread.) A program has been initiated to reinstruct existing employees as to standard operating and emergency procedure requirements.
4. A permanent "Hazardous Chemicals Committee" has been formed to maintain a continuing review on the use of chemicals within the building. Gloveboxes afford a commonly used means for working with hazardous

materials under conditions preventing their escape to external areas. Fire and explosion constitute the most common serious threat to glovebox integrity. A Chicago Operations Office contractor is currently making an intensive study of the most effective methods for detecting and suppressing glovebox fire and explosion hazards. Results of this study will be published in the fall of 1965.

U. S. Atomic Energy Commission Case History

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-117

Duplication of this Report is Authorized

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 192

Nitrogen Compressor Explosion

Description: A four-stage reciprocating compressor was used to recycle high-purity nitrogen gas from the low-pressure distillation column to the high-pressure distillation column of a nitrogen liquifaction facility. The Cellulube 550 lubricated compressor normally took suction at 15 psig and developed a maximum discharge pressure of 3,000 psig. The compressor was equipped with appropriate pressure relief safeguards.

Prior to the explosion, the operator noted that the third-stage safety relief valve was "blowing." The entire plant was shut down to permit the removal, inspection and replacement of the third-stage inlet and discharge valves. When restarted, the second-stage relief valve began to "blow" immediately. After again shutting down the compressor, the third-stage suction valve was "inspected for the correct direction of flow and found to be reversed." It was shortly after this error was corrected and the compressor restarted that the explosion took place. Subsequent investigation established that the third-stage suction valve had indeed been installed properly but that the discharge valve had been installed in a reversed position.

The explosion ruptured the compression jacket and projected metal fragments up to 160 feet from the building. Witnesses reported seeing a "brilliant flash" at the compressor. There were no injuries. Property damage is estimated at $16,000.

Cause: With the third-stage discharge valve in a reversed position, compression of gas within a closed volume would, theoretically, have permitted attainment, during a single cycle, of a gas temperature approximating 1310°F and a pressure of about 16,800 psig. These conditions in the presence of some oxygen from air introduced during compressor maintenance, exceeded the autoignition temperature of the compressor lubricant and resulted in the explosion.

Recommendations and Conclusions: Prior to the accident, no standard procedures were in effect to substantiate that a compressor was in operable condition following conduct of maintenance work necessitating exposure of the compressor interior to the atmosphere. To prevent recurrence of similar incidents, the investigating committee recommended:

1. Operations Test: A 20-psig, high-purity gaseous nitrogen purge line should be installed to the suction line of the nitrogen compressor. The suction and discharge valves in the piping to the compressor, and the first, second, and third-stage discharge blow-down valves should all be closed. With the 20-psig purge valve open, the fourth-stage discharge

blow-down valve should be checked for positive flow to indicate that the compressor valves are in the correct position. Should a valve be inadvertently installed in the reverse position, there will be no flow from the fourth-stage discharge blow-down. After this test has been completed, the purge flow can be closed by a valve and the compressor made ready for startup.

2. Maintenance Test: After maintenance has been completed, the compressor fly-wheel should be turned by hand a minimum of two revolutions to be assured that no obstructions exist in the machine. All compressor discharge blow-down valves should be opened during this test.

3. A similar test procedure should be established for the air compressor. However, instrument air should be used as a purge gas in lieu of high-purity nitrogen.

4. An oxygen analyzer should be installed on the suction line from the low-pressure column to the nitrogen compressor. Should the oxygen concentration in this gas stream exceed a pre-set level, the compressor suction should be automatically valved to an independent high-purity nitrogen supply until this condition no longer exists. A pre-set level should be determined to allow for automatic operation and yet prevent an enriched oxygen stream (greater than 21%) from being pumped by this compressor.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-118

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 193

Leaking Natural Gas Follows Water Main

Description: While mechanic was in an enclosed water-meter pit to make routine readings and inspection, an explosion occurred. The source of the explosion was natural gas which had followed the water main some 50' from a leak in a gas main. The source of ignition has not been determined -- possibilities include smoking (employee's pipe and lighter were found on the pit floor), the open contacts of the float switch on the water siphon pump, and the heat lamp which was found broken after the incident.

Preventive Measures: Standard practice for vessel entering has been revised to require gas testing before entering any size or type of vessel regardless of use or location.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: CH-1061

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 194

Explosion - Hydrogen Gas

Description: Following the termination of a process utilizing hydrogen, an open air explosion occurred in the vicinity of the hydrogen gas vent stack. The explosion caused severe damage to several buildings in the proximity of the facility and slight damage to walkways, small beams, and cabinets in the vicinity.

Cause: During the normal process, cold gaseous hydrogen is vented through a vent stack into the atmosphere. Normally hydrogen is bled through a piping system and into the atmosphere for approximately 45 minutes at which time the process is completed.

During this particular occasion, an unusually calm weather condition (no wind) prevailed. It is theorized that this calm weather condition failed to disperse the hydrogen gas as rapidly as usual. This gas accumulated in the atmosphere overhead and was then ignited by an unknown ignition source, creating the explosion.

Preventive Measures:

1. Venting or bleeding of hydrogen gas will be accomplished only when a sufficient amount of turbulence exists to disperse the gases.

2. Studies to determine the relative advantages of burning vent-gases versus releasing gas only during conditions of predetermined wind velocities will be continued.

Reference Number of this Incident: 1149

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 195

Explosion and Fire - Hydrogen Gas

Description: While several technicians were working in a test cell, a violent explosion occurred above an adjacent test cell. Some of these technicians working in the vicinity of the blast received minor cuts, bruises, and burns. The explosion caused major shock damage to surrounding buildings, fixtures, cabinets, equipment, etc. The bellows in an overpressurized hydrogen system were severely damaged.

Cause: Liquid hydrogen was unknowingly admitted into a suction line during checkouts of the system. Vaporization of the liquid hydrogen in the warm suction line generated a pressure greater than the burst pressure of a bellows section in the line. The bellows ruptured and hydrogen gas was expelled into the atmosphere and ignited in an open air explosion.

Recommendations:

1. Modify procedures to effect better control of all vents.
2. Re-side and install vent and relief valves of adequate capacity to accommodate such a situation.
3. Provide electrical interlocks to prevent flow of cryogenic fluids into any system prior to opening the system vent valves.

Preventive Action: Recommendations listed above were complied with prior to the reactivation of the test cells.

Reference Number of this Report: 1150

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 196

Explosion of Nitroglycerin-Ethylene Glycol Dinitrate (NG-EGDN) during Emulsification

Description: An unexpected initiation of 50/50 nitroglycerin-ethylene glycol dinitrate (NG-EGDN) occurred during an attempted preparation of an emulsion of glycerol in NG-EGDN using ultrasonic irradiation with Branson S-150 Sonifier. The amount of explosive involved was 135 grams. The Sonifier, remotely controlled, had been in operation about 7 seconds when the explosion occurred. This operation had been performed for approximately 3 months during which time about 20 batches of liquid explosive mixtures, consisting mostly of NG-EGDN, had been emulsified without incident, although this is the first time glycerol was used for the dispersed phase. Damage was slight except to the transducer head and viewing periscope that had been built into the wall. The operation was being conducted in a hazardous operations bay with 12-inch reinforced concrete walls on three sides with the fourth side formed by two large doors which were open at the time of the incident. The seat of the explosion was about 12 inches from one wall adjacent to a 6 x 8 x 1-inch safety glass window of a viewing periscope. Although no damage at all occurred to the concrete or steel, the window was completely destroyed as well as the lower mirror of the periscope. There was additional slight damage to lighting fixtures and the glass panels in the doors in the rear of the bay. There were no injuries to personnel.

Cause: The precise cause is not known. In the process of cavitation by ultrasonic irradiation the liquid is subjected to severe agitation and to rapid and localized temperature rises. Under these conditions the explosion of nitroglycerin is not entirely unexpected, although more violent treatments in the past, even with pure NG-EGDN, have not resulted in explosion and rough calculations of stress levels and temperature rises based on the assumed total energy input preceding the explosion (200 calories), and peak power flux density (120 watts/cm^2), indicate that explosion threshold levels (assumed to be of the order of 1 kilobar peak pressure or 200°C temperature rise) should not have been attained. It is possible that the glycerol, having a high viscosity, absorbed all the energy in a small volume, permitting a large local temperature rise.

Preventive Measures: Smaller samples and more effective protection of equipment will be employed in the future.

(REPORTED BY THE EXPLOSIVES RESEARCH CENTER, BUREAU OF MINES)

Reference Number of this Report: L-119

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 197

Explosion - Explosive Bridgewire Detonator (Approx. 0.518 grams PETN)

Description: Normal operations for the 130 volt no fire test of the explosive bridgewire detonator are as follows; The detonator is plugged into the test circuit and placed into a partially plywood lined armor plate box for the test. The door to the box is secured, and the test voltage is applied to the detonator for five seconds. A timer automatically cuts off the power after five seconds. The operator waits thirty seconds, then opens the door, removes the detonator from the box, and unplugs it from the test circuit.

The operation as described above had been performed in a different cell; however, due to special equipment installed in this cell it was required for other tests, so the detonator test was moved to cell No. 1. The only difference in the set-up was an extension cord into which the test set was plugged. Six hundred sixty-four detonators were tested without incident. After completion of the test cycle on the six hundred sixty-fifth detonator the operator opened the door to the box and as he attempted to unplug the detonator an explosion occurred.

The operator performing the test lost the distal phalanx of the right ring finger, has unknown injury to the remainder of the right hand, and shrapnel wounds in the left thigh.

Investigation:

1. The test equipment used incorporates the use of a polarized circuit (one side grounded) and only the hot wire is switched.

2. The extension cord into which the test set was plugged was wired in such a manner that polarity was reversed. This allowed a flow of current through the neutral wire of the test equipment and into the lead wires in the armor plate box. The lead wires were hot when the detonator was plugged in prior to the test and when disconnected after the test.

3. Normally, this condition would have resulted in a short and a fuze failure. However, a malfunction in the test equipment allowed 127.5 volts of AC current to be applied to the detonator at all times (approx. 45 seconds) except during the 5 second test cycle. When the test cycle switch was pushed, the detonator was de-energized.

4. Inspection and test of extension cords indicated that 9 of the 14 available for use at the building were wired in such a fashion to reverse polarity. Further inspection revealed that the male plug incorporated in the extension cords had reversed terminal identification..

EI No. 197 - Continued

5. The test set arrangement when originally assembled was checked prior to commencement of testing. When the set was relocated to another test cell, the assembly was not rechecked prior to resuming testing.

Corrective Action:

1. The detonator test equipment is being redesigned and will include switches on both sides of the circuit with both sides of the circuit grounded when the switches are open, and an isolation transformer to protect the operator from accidental electrical shock.

2. Microswitch interlocks are being installed on the armor plate box so that the chamber cannot be energized when the door is open.

3. A test instrument is being designed and will be built so that operators or mechanics can check the polarity of electrical circuits.

4. Testing assemblies will be checked prior to operation and rechecked when relocated or reassembled to insure proper operation.

5. The polarity of all circuits is being checked. Circuits with reverse polarity will be corrected.

6. All electrical items which do not conform to the requirements of the National Electric Code, NBFU No. 70, Oct 1962 are being removed from service and no additional equipment of this nature will be obtained.

Reference Number of this Report: 1160

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 198

Train Derailment - Explosion and Fire

Description: On 18 May 1965 at approximately 1630 hours, NPR Train No. 603 with sixty-nine cars in tow was proceeding West at 62 miles per hour. Approximately 1.3 miles West of town (Gold Creek, Montana), 40 of the 69 cars were derailed. The derailment occurred on the main line track, adjacent to a side track in an area bounded on the North by US Highway 10-12 and on the South by the Clark Fork River. At the time of the investigation, it was assumed that the derailment action was initiated by a loose wheel on one end of an axle causing the wheel on the opposite end of the axle to break. The density of broken, cracked and split railroad wheels and trucks made positive identification of the particular wheel or axle most difficult.

Of the 40 railroad cars derailed, 6 were carrying military ordnance items. No fire, exposure to fire, or explosions occurred in train cars no. 20, 21, 23 and 24 which were transporting HE and Illuminating Ammunition. The damage sustained in these cars was limited to that caused by the forces of the derailment. Fire and explosion damage was observed in cars no. 41 and 42 which were transporting 155mm, M3 propellant charges. The physical damage observed is indicative of low order detonations, fire and impact destruction. One-half of a wheel was found in car no. 42. It has not been determined whether the broken wheel or the derailment was the action which initiated the fire and resultant low order explosions of several M3 propellant cans. With one exception, all M3 propellant cans were in, on, or adjacent to cars no. 41 and 42. The one (1) M3 propellant can was recovered on the highway at an estimated distance of 200 yards from train car no. 41. No casualties resulted from the destruction of the M3 propellant.

Cause: The derailment occurred as a result of an undue force exerted upon the speeding train (62 MPH), i.e., broken wheel or axle.

The force of impact caused the cars and their undercarriage to become disengaged and at least one half ($\frac{1}{2}$) a wheel forceably entered an M3 propellant car (no. 42).

Fire was initiated at the approximate time of impact in one or both of the M3 propellant carrying cars. Simultaneously, impact or spontaneous ignition caused one or more of the M3 propellant charges to explode (instantaneous conflagration). The examination of the residue provides ample evidence that a high order detonation did not occur.

EI-198 Continued

The fire was sustained in the two train cars (41 and 42) with the M3 propellant acting as the fuse. The M3 propellant ignition temperature was achieved in sequential order and in occasional "hot spots" the detonating temperature of the compressed propellant was obtained providing for an erratic pattern of explosion.

The fire continued until the "fuel," was exhausted, resulting in the loss of 4824 charges, propelling, 155mm, M3, Lot No. BAJ-63541-57.

Primary Damage in the area was due to the derailment and was limited to railroad property, rolling stock and cargo.

Secondary Damage; loss of military cargo. M3, propelling charges was due to derailment, fire and explosion.

Secondary Damage; damage to 155mm projectiles illuminating M118 and M118B1 and 105mm projectiles, HE, was due to derailment with no damage due to fire or explosion. Damaged ammunition requires surveillance inspection and renovation (in part) prior to re-shipment.

Reference Number of this Incident: 1161

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 199

Metallic Uranium Explosion

Description: A technician received thermal burns on his face when an explosion ejected burning uranium turnings and chips from a stainless steel beaker. Safety glasses undoubtedly saved his eyesight.

Prior to the accident, the technician had received 3½ kilograms of depleted uranium chips and medium to fine turnings and observed that this batch was well matted and the turnings were finer than prior batches. (Smallest cross-section 0.001" x 0.008".) He separated the turnings into three approximately equal batches, and placed each in a 4-liter stainless steel beaker. After an initial hot water rinse, the metal was degreased in trichloroethylene, drained and again rinsed in hot water. It was then covered with hot water. The beakers were then transferred to a hood where concentrated nitric acid was added until the resultant 4-6 normal pickling solution was within an inch of the beaker tops. The metal was permitted to react for about 30 minutes, after which the beakers were removed from the hood and flooded with cold water.

The chips and turnings were not as bright as desired so the pickling procedure was repeated. The beaker was then placed in a sink. When the technician started to turn on cold rinse water, the beaker "exploded", ejecting burning metallic fines and nitric acid solution about the room. The technician, temporarily blinded by the flash, was taken to the dispensary. He sustained first degree thermal burns over his entire face, as well as "spot" acid burns.

Samples of debris ejected from the beaker, of fine turnings remaining in the beaker, and of V-shaped turnings from an unpickled portion were all analyzed spectrographically. None showed the presence of uranium alloys or abnormal contaminants.

Cause: Page 169, Volume VIII-5, "Chemistry of Uranium" (National Nuclear Energy Series), states that "Since nitric acid or nitrogen dioxide can react with uranium with explosive violence, it is necessary to add finely divided uranium to nitric acid in small portions to avoid accidents."

Other sources indicate that formation of an explosive material during pickling of uranium had been reported previously and that presence of fluoride ion tended to inhibit the formation of explosive coatings or residue. In this incident, the contractor believes that either nitrogen dioxide was generated and that it reacted with the uranium to produce an explosion, or that an explosive coating was formed on the uranium.

Preventive Measures: The following recommendations are suggested to protect personnel from these hazards during uranium pickling:

(1) A safety shower should be available in the immediate area.

(2) Waterlines should be so located as to eliminate unnecessary handling of this material during pickling operations.

(3) Uranium scrap considered for pickling should be restricted to larger chips and turnings. The fines are particularly hazardous and should be segregated for special handling.

(4) As mentioned previously, it is thought that the presence of fluoride ion tends to inhibit the formation of an explosive coating; therefore, the use of ammonium bifluoride should be considered. Use of inadequately mixed or excessively strong nitric acid should be avoided. Only sufficient acid should be used to perform the operation.

(5) Personnel performing uranium pickling operations should wear the following protective equipment: (a) Nitrometertype (full-face) face mask; (b) Rubber bib-type apron; (c) Rubber gloves.

(REPORTED TO THE MANUFACTURING CHEMISTS' ASSOCIATION, INC. BY THE U. S. ATOMIC ENERGY COMMISSION)

Reference Number of this Report: L-120

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 200

Americium Shipping Container Explosion

Description: A shipping container, holding 5 grams of americium (Am^{241}) in aqueous chloride solution, exploded in an unoccupied room. The general alarm was sounded by the health physics monitor and the building evacuated. The container had been closed for 3½ months prior to the explosion.

The above accident caused contamination of the room in which the explosion occurred and the loss of about 2.5 grams of americium. There were no injuries or radiation exposures.

Cause: It is not known whether the container failed due to a chemical explosion or a slow pressure buildup. Either case is theoretically possible.

Preventive Measures:

(a) Avoid shipping a radioactive solution presenting radiolytic gas hazards if practical; a dry oxide is safer.

(b) If a solution must be shipped, use an adequate pressure vessel such as the currently recommended plutonium nitrate shipping container; provide a vent valve for pressure release.

(c) If a solution must be shipped, vent the container immediately before shipment and after receipt.

(REPORTED BY AEC TO THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: L-121

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosive Incident Report No. 201

Dryer Explosion

Description: Trays of a granulated product wet with alcohol were placed directly in a recirculating electrically heated dryer. A short time later the flammable vapors reached the explosive range and presumably were ignited by the thermostatic control or the heating elements. The dryer was completely damaged, many windows were broken and considerable glassware in a nearby laboratory was shattered by the shock wave. Damage is estimated at $17,000 but fortunately no one was injured as the explosion occurred during a rest period.

Cause: Operating instructions called for placing the wet material in a humidity controlled, air-conditioned room overnight in order to evaporate most of the solvent prior to placing the product in the dryer. The air in this room is not recycled. This incident clearly illustrates, however, that it is hazardous to use any equipment with ignition sources in processing flammable material. It should be noted that even single pass air-conditioned rooms can be unsafe for handling flammables.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: L-122

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 202

Peroxide Detonation

Description: Fifty ml of mother liquors from a hydrogen peroxide oxidation reaction was being concentrated in a rotary vacuum evaporator. Approximately five minutes later there was a typical severe peroxide type detonation which destroyed the 100 ml glass flask and shattered powdered and broken glass throughout the laboratory.

Cause: Although it has not been determined why the aqueous ethanolic mother liquors detonated, it is believed that the peroxides in the solution were concentrated to the critical point. All vacuum operations should be shielded to protect laboratory personnel from flying glass in the event there is a detonation or the glassware breaks or implodes while under vacuum.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: L-123

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 203

Perchlorate Detonation — Flame Testing

Description: A detonation occurred recently in a sintered filter funnel containing $[Co(NH_3)_5(H_2PO_2)](ClO_4)_2$. This complex had been precipitated from solution, then washed with ethyl alcohol and diethyl ether, and air dried on the sintered filter funnel.

The chemist attempted a test for sodium and carried a small amount of the sample on a platinum wire to the burner in the isolation room. This test was unsatisfactory, so he took the whole sample (estimated 10-20 grams) in the funnel into the isolation room.

The chemist was uncertain whether the wire which he dipped into the complex before the explosion was hot or at room temperature. At this stage, the chemist was holding the glass funnel in his left hand. The introduction of the platinum wire (hot or room temperature) may have caused the cobalt compound to detonate.

The detonation completely disintegrated the funnel and caused serious injury to the man's hand. The chemist was wearing safety glasses, and from their appearance, there is no doubt that the glasses saved him from permanent blindness.

Preventive Measures: This incident is worth reporting, because information on the hazards of this type of compound is limited, and other people may attempt to flame test similar compounds for sodium.

It must be emphasized that flame testing with a platinum wire should be done with extremely small quantities of any compound to prevent the possibility of a disastrous reaction.

(REPORTED BY THE US ATOMIC ENERGY COMMISSION THRU THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: L-124

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 204

Fire & Explosion in Sewer Line

Description: Sparks from welding on a pipe line ignited flammable vapors coming from the main plant sewer line. This line runs from north to south. Subsequent explosions occurred at five manhole covers north and south of the initial explosion. Fire in the sewer was extinguished with a hose from the foam truck and two 2½" fire hoses with fog nozzles. Two mechanics received minor burns.

The welding work was started at about 8:30 a.m. and was properly authorized by production supervision with a Work and Flame Permit. Welding proceeded up to approximately 10 o'clock. At 10:10 a.m. an operator started charging the recovery still by applying vacuum to the system.

Cause: Benzene vapors were evolved, not condensed completely, and were drawn into the wet vacuum pump. This discharged water and condensed benzene to the sewer and was undoubtedly the source of the flammable vapors which ignited from the welding spark at 10:20 a.m.

Preventive Measures:

1. The recovery still will not be charged by vacuum. Addition of recovered material to the still will be at such a rate as to condense any benzene vapors.

2. Flame work will not be authorized in the vicinity of sewers unless special precautions are taken; such as continual flame testing, covering open manholes with tarpaulins, standby fire brigade personnel, and shut down of operations up-stream where required.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of This Report: EI-204

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 205

SO_3F_2 May Be Explosive

Description: A recent incident which occurred during the handling of fluorine-fluorosulfate may be of interest to researchers working with fluorine-containing oxidants. A by-product (largely SO_3F_2) from the preparation of $S_2O_6F_2$ was distilled into a cold, clean and dry steel cylinder of about 500 ml capacity and of a strength suitable for storing gas at 135 atmospheres. The cylinder was warmed almost to room temperature when it exploded with a violence indicating a chemical explosion and not just a rupture from gas pressure. (At room temperature the vapor pressure of SO_3F_2 should be less than 10 atmospheres.) No previous case of explosive decomposition has been uncovered. (Private communication - Prof. G. Cady, U. of Wash.)

(REPRINTED FROM THE CHEMICAL PROPULSION NEWSLETTER, CPIA)

Reference Number of this Report: L-125

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Explosives Incident Report No. 206

Cylinder Explosion

Description: A one-quart size L.P. type cylinder used for handling pyrotechnic chemicals was hooked up for routine washout which consists of a nitrogen purge to expel any liquid, followed by a naphtha or kerosene wash, then a methanol wash. The cylinder was open to vent and for relief but when the wash out was partially completed, the cylinder exploded violently. These wash out procedures are remote and done behind a barricade - thus no injuries occurred.

Cause: No firm conclusion can be arrived at since tests were run on the wash out materials and they were free of water or contaminates. It is suspected that somehow methanol contacted the contents before the naphtha wash and then reacted with the methanol. This points out the value of strict operating procedures and adequate safety devices and equipment for this type of operation.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of This Report: EI-206

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 207

Explosion - Nitric Acid in Contaminated Tank Car

Description: In preparing to load an "empty" tank car with 64% nitric acid, caps were removed from the dip filling pipe and the other two pipes in the dome. The foreman looked through these pipes with a flashlight and could see the bottom of the car. No material or liquid of any kind was visible in the car. He then inserted the 1½" size filling pipe into the 2" opening that contained the dip pipe. This would have allowed the car to be vented through the second 2" opening and the 3/4" opening while it was being filled. There was a safety valve with about a 2" opening mounted on the fourth pipe in the dome of the car. The loading pump was never started. However, the filling valves were opened and the level of acid in the storage tank was high enough to allow acid to flow by gravity into the tank car.

The foreman estimates the explosion occurred not more than three to five minutes after the filling line valves were opened. A blowing-hissing sound at the dome of the car was the first indication that something was wrong. The foreman was at the car checking the acid strength from a chart when he heard this noise. He then saw a white vapor blowing from the vents in the dome of the car. At this point, the foreman immediately sent the operator to close the valves at the acid storage tank located approximately 300 feet away. By this time, the blowing and hissing sound had increased alarmingly. The foreman, sensing that he was in imminent danger, ran. The tank car exploded as he ran around the corner of a building. After the explosion, the foreman quickly closed the valves at the acid pump.

Cause: Based on the findings of the investigation, the following chain of events probably occurred:

1. A small amount of alcohol was in the car when it arrived.
2. Nitric acid (64% HNO_3) drained from the loading line into the car (although the pumps were not in operation).
3. This mixture started the conversion of alcohol to acetaldehyde. Vapor was evolved as the reaction mass heated and acetaldehyde fumes filled the vapor space.
4. The reaction increased to the ignition temperature of the acetaldehyde-air mixture.
5. Detonation of acetaldehyde-ethanol-air mixture occurred and the tank car exploded.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC. FROM AEC)

Reference Number of this Report is: EI-207

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Explosives Incident Report No. 208

Ignition of Acetone Vapor by A Spark Caused by Static Discharge

Description: An operator was tipping cyanuric chloride from a drum with a polythene liner into a vessel containing acetone, via the manway. The operator was wearing newly laundered polypropylene overalls, rubber boots, and P.V.C. gauntlets.

There were reports of a flash and a bang with the operator being flung backwards, and cyanuric chloride plus shredded polythene liner from the drum, were sprayed throughout the plant. There was no resultant fire. The operator suffered extensive burns of his right forearm and from the effects of cyanuric chloride in his eyes, nose and mouth.

Cause: After full investigation, the most likely explanation was that the explosion was caused by a flammable concentration of acetone vapor in air, in the area of the manway of the vessel, being ignited by a spark caused by the discharge of a high potential due to personal static electricity. The operator recalled that he put his hand in the region of the open end of the drum and the manway to assist the emptying of the contents of the drum, and that the explosion occurred at that particular moment.

Preventive Measures:

1. Use overalls of cotton (NOT synthetic fiber).
2. Use conductive shoes (NOT rubber).

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC. FROM THE QUARTERLY SAFETY SUMMARY OF THE BRITISH CHEMICAL INDUSTRY SAFETY COUNCIL)

Reference Number of this Report: L-125

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Explosives Incident Report No. 209

Explosion of Potassium Metal

Description: From the time of World War II, several drums of potassium metal (in brick form) had been left in stock. It was decided to dispose of them and sell the potassium for laboratory use. A special bench, covered with a thick steel plate, was set up in the open yard and two operators were assigned to removing one brick at a time, putting it on the bench without delay, cutting it with a knife into cubes as quickly as possible, and finally placing the cubes into smaller bottles filled with an inert solvent. The operation, which was of an emergency character only, and not intended as a standard procedure, was performed on a sunny, dry day and usual precautions, as when working with sodium emtal, were taken. During the handling, a terrible, unexpected explosion took place. As a result, two operators lost their lives on the spot before help could arrive. The steel plate and bench were scattered all over the yard, and a deep hole was blasted in the ground.

Cause: The exact development of the accident could never be established for lack of witnesses. The concensus of chemists was that an oxide or peroxide of potassium was formed during the long storage under the protecting liquid, which then initiated the ignition.

It has been reported that hitting the potassium with a hammer is dangerous and results in its ignition, and that dry potassium ignites spontaneously on longer exposure in the air due to the oxidative formation of an easily flammable mixture of metallic potassium with its oxides. It has also been mentioned that old, oxidized potassium metal is to be handled with the greatest precaution due to its oxidation to KO_2, which is a very strong oxidizing agent reacting, e.g. vehemently also with potassium metal itself.

Cutting even small amounts of potassium in the air on filter paper or destroying scraps of it with commercial alcohol should be avoided. Experience shows that it is better stored and handled in dry xylene (minimal surface oxidation and discoloration) than in kerosene (petroleum, naphtha). It should always be cut under a layer of xylene in a porcelain dish or mortar, the oxidized surface cut off, the scraps transferred without delay into a beaker containing xylene, the freshly-cut potassium removed by forceps into a tared beaker containing xylene, and the weighed potassium then introduced into the reaction mixture. Scraps of potassium, covered with xylene, should be immediately decomposed in a hood by adding tert.-butyl alcohol (not methyl or ethyl alcohol) gradually, at such a rate as to keep the reaction under control and until all the potassium has reacted. A sheet of asbestos or steel to cover the beaker in case the liquid catches fire should always be kept at hand.

EI-209 (Continued)

Why does the "explosion" of potassium occur with greater ease and violence than that of sodium? We may assume that an ignition, whatever its origin, breaks up the adjacent area of the hot, liquid potassium metal and scatters it as a spray in the surrounding atmosphere, where the metal evaporates, mixes with atmospheric oxygen, and detonates. All these steps occur in a minute fraction of a second and the phenomenon is somewhat similar to the gasoline explosion in an automobile motor. Also, because potassium has a lower m.p. (63°5-97°5°C.) and b.p. (779°-892°C.) than sodium, it is consequently evaporated and atomized faster than the latter.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC. FROM THE QUARTERLY SAFETY SUMMARY OF THE BRITISH CHEMICAL INDUSTRY SAFETY COUNCIL)

Reference Number of this Report: EI-209

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Explosives Incident Report No. 210

Peroxides

Description: While an employee was connecting lines for unloading a vinylidene chloride tank car, an explosion occurred in a piece of two-inch pipe about 18 inches long. The employee was temporarily deafened.

This pipe was normally connected to an inert gas supply to maintain an inert atmosphere in the car during unloading. As the pipe touched the tank car fitting, the explosion occurred.

Cause: Investigation revealed that there was a coating, apparently of vinylidene chloride polymer, on the inside of the pipe. Literature on this kind of polymer discusses the possibility of peroxide formation and indicates that such peroxides will catalyze polymerization. Literature references also state that this polymer, containing about 15% of peroxides, is known to be unstable and subject to detonation.

Preventive Measures: Such residues can be flushed and made inactive with hot water. Phenol-type inhibitors will reduce or stop oxidation and polymerization, but the best precaution is to avoid exposing vinylidene chloride to oxygen. All equipment used in handling vinylidene chloride should be kept under an inert atmosphere. Small fittings, pipe nipples, etc., should be thoroughly washed with hot water after each use.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: EI-210

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Explosives Incident Report No. 211

Explosions of Propellant Containing Ferrocene Derivatives

Description: It has been brought to the attention of the ASESB that explosions have occurred in propellant formulations using ferrocene derivatives as burning rate catalyst. These explosions have resulted in deaths and injuries and occurred after mixing had been completed and while the mixer was being emptied prior to casting. Attempts to duplicate these accidents in laboratory size batches have, insofar as the ASESB is aware, been unsuccessful. In each case the same propellant formulation had been processed previously without incident.

Cause: The definite cause of these explosions has not been established. However, the most probable cause is believed to be the heat of friction between the mixer sidewall and spatula while scraping through a mixture of ammonium perchlorate/sublimed recrystallized ferrocenes. Tests have shown that this mixture is considerably more sensitive to friction than the propellant mass.

Reference Number of this Report: 1167

Duplication of this Report is Authorized.

NOTE: This report was referenced in the CPIA Chemical Propulsion Newsletter, Volume 2, Number 3, March 1966 as ASESB Explosives Incident Report No. 206.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Explosives Incident Report No. 212

Fiber Drum "Grounding" Not Effective

Description: Two operators were loading a drum of black roll stock chips into a mixer containing solvents and two drum loads of black roll stock. While one was in the process of raking the chips from the drum (using a brass fork) into a brass funnel in mixer opening, a flash and explosion occurred at the mixer opening, throwing him 6 ft. against a wall, and the other employee 25 ft. in the opposite direction. The first employee sustained a bruised hip and first and second degree burns of the face and wrists; the other, only minor injuries. All standard procedures were being followed, including having the funnel grounded to both the mixer and fiber drum metal ring. The flash from the mixer ignited the contents of an overhead 500-gallon solvent storage tank about 20 ft. from the mixer.

Cause: The probable cause of the explosion at the mixer was the discharge of static electricity from the chips (as they were being emptied from the drum) which passed over or through the brass funnel. There was a ½ in. opening in the cover of the solvent tank through which a 1/8 in. cable was inserted for a float gauge. It is believed that the solvent vapors around this opening were ignited by the original flash.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: EI-212

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Explosives Incident Report No. 213

Explosion - Solid Propellant in Igloo Type Magazine

Description: M9 mortar propellant in metal kegs (ICC 13), packed two to a wooden crate, was stored in the 80-foot igloo at the ammunition plant. A total of 183,950 pounds of propellant was stored in the igloo. This amount included bulk propellant in containers and propellant in increment bags for mortar ammunition. The crates were hand trucked from the magazine across a loading platform into a 1 1/2-ton van truck spotted at the igloo dock. The propellant was to be transported to a process building for transfer into intra-plant containers. The van truck normally backed to the front of the igloo loading dock which was approximately 40 inches above grade. One crate (two containers) was placed on a two-wheeled hand truck in the igloo and transported over a magnesium platform that was attached as a tail gate to the van truck. The crates were stacked three high in the front section of the igloo.

The igloo was provided with integrally mounted air terminals. The last continuity inspection was approximately five months prior to the explosion.

Three powder handlers were assigned to pick up 1200 pounds (24 crates) of M9 propellant at the igloo and transport it to the process location. The three handlers had been assigned to this type of operation for one, four, and six months, respectively.

During the handling operation at the igloo, an explosion occurred. The three powder handlers were killed. Forty-five minor injuries were sustained, primarily as a result of glass breakage at various locations throughout the plant. Crater - 30 feet deep by 150 feet diameter.

Property damage, including the complete destruction of the igloo, its contents, and the van truck, amounted to $630,286. Miscellaneous damage to other government property totalled $200,000 which consisted mainly of broken glass and overhead doors which were damaged by the shock wave following the explosion. There was no substantial building damage reported on or off the plant. Miscellaneous damage off post was estimated at $40,000.

There were several persons who claimed they saw lightning prior to the incident. The local U.S. Weather Bureau reported overcast skies, light rain showers, and no thunderstorm activity. The weather station is located approximately 15 miles from the ammunition plant.

EI-213 (Continued)

Causes: Exact cause - unknown.
Probable causes:

a. Ignition of the propellant by impact or friction during the transfer operation.

b. Lightning.

Recommendations:

1. Newly hired or transferred employees handling explosives should be thoroughly trained and familiar with the specific safety rules that apply to their jobs.

2. Supervisors should assure themselves that all employees in their area of responsibility are properly trained, and that they understand and follow the Standing Operating Procedures.

3. Work locations should be carefully inspected to correct and to detect unsafe acts and conditions.

4. Explosive limits should be carefully analyzed at all operating and storage locations. The maximum amount of explosives permitted in any location should not exceed that specified in the Quantity-Distance Tables.

Reference Number of this Incident: ES-19

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C., 20315

Explosives Incident Report No. 214

Decontamination of Mixhouse Condensers

Description: Incident occurred in small decontamination oven, during cycle when decontaminating mixhouse condensers along with other materials. Temperature had been slowly increased for two hours according to SOP and the materials had reached 375° when small explosion occurred. Temperature of material being decontaminated was to be brought up to 450° and held for four hours. Except for one piece of equipment, contents of the oven were to be salvaged. Oven is heated by hot gases piped in from Butane burners.

There were no fatalities, no disabling injuries, no minor injuries. Damage to the oven and one piece of equipment amounted to $720. There will be no curtailment to production.

Cause: Even though the mixhouse condensers had been partially decontaminated by steaming for some time, it is believed there still remained enough contaminating nitroglycerine condensate, nitroguanidine, etc., to cause the blow. Also, the condenser that blew could have developed a leak between the inner and outer jacket, affording a cache for the explosive materials.

Action: A more thorough inspection will be made of materials to be decontaminated and when necessary, each item will be given a preliminary decontamination by chemicals, etc., prior to placing them in the decontamination ovens. In addition, an engineering study will be initiated to devise an oven with more venting and with blowout section.

Reference Number of this Report: 1176

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Explosives Incident Report No. 215

Cryogenic Laboratory Explosion

Description: An explosion occurred in a liquid hydrogen dewar used for tensile testing of metals at liquid hydrogen temperatures. The dewar had a double wall vacuum insulated bottom, with a cylinder shaped polyurethane foam top. The foam was two inches thick coated inside and out with a vapor barrier of plastic. Venting of hydrogen was through a two inch diameter hole in the side of the foam. The dewar was located in a test cell which was separated from the control room by a common wall. The common wall and two side walls of the cell were constructed of a double layer of cross laminated 2" x 6" t&g planks. The fourth side was open through four door panels. The ceiling was metal lined and vented out through the roof through an exhaust duct equipped with a remotely driven fan.

Operating personnel had completed a 40 hour test run and were in the process of terminating the test. Boil-off of liquid hydrogen was being accelerated by the use of two electric heaters mounted in the bottom of the dewar. Liquid level sensors indicated about two inches of liquid hydrogen were still in the dewar when a violent series of explosions occurred. The dewar was completely shattered and dispersed by the force. One room wall (an outside wall) was moved three feet from its original position. The other two room walls were moved 16" - 18" by the blast. A heavy protective door between the control room and the test cell was torn from its casing and blown about 10 feet into the control room. There were four operating personnel in the control room but all escaped without injuries.

Based on analyses of the forces required to deform the dewar vessel, the dewar baseplate (1" thick steel), and damage to the walls, it was concluded that a detonation occurred in the dewar which was equivalent to approximately 1/4 pound of TNT. This was followed immediately by a gaseous dispersion of the remaining hydrogen into the air and a vapor phase explosion resulted which caused the severe damage to the walls of the cell.

Causes: Tests of the electric heaters used in this test to accelerate the boil-off proved that ignition of hydrogen above the pool could be attained in an open dewar. It was concluded that air had back diffused into the dewar through the vent hole in the polyurethane foam top. Another possible source of air leakage may have been cryopumping of air through the porosity of the foam. This mixture of air and hydrogen was enhanced by the length of the test run (40 hours) where previous tests did not exceed 4 hours. The resulting mixture of air and hydrogen was ignited by the high surface temperature of the heaters.

EI-215 (Continued)

Corrective Actions:

1. Heaters and potential ignition sources shall be designed and tested so that surface temperature does not exceed 400° F in ambient air, and will not arc or spark under cryogenic or ambient conditions.

2. Hydrogen dewars and similar test equipment will always be provided with a vent stack and a positive pressure relief valve which will release the hydrogen in a safe location.

3. Foam insulation will not be used when in contact with air on one side and cryogenic hydrogen on the other side.

Reference Number of this Report: L-127

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Explosives Incident Report No. 216

Explosion - Green M18 Grenade Mix

Description: On or about 0825 hours, 25 May, an in process batch of mix for Green M18 Grenades, located in a cubicle during sifting operations, exploded. An employee located outside the cubicle with the upper hopper vibrator and sifter in operation, and another employee, evidently engaged in pushing a batch of ingredients toward the adjoining cubicle, were killed. At the time of the explosion a hetrogeneous mixture of Green Smoke IV ingredients was present; however, the explosion is not directly attributed to the ingredients of Green Smoke Mixture IV itself, but to the conditions to which it was subjected.

The baffle in the sifter had the capability of working free from the sifter bowl during operations. Some sifters of the same types received and subsequently used had gaskets around the base of the baffle while some did not. Some operating sifters of the same type did not have dustproof covers over the drive shaft mechanisms. The lack of an adequate gasket around the periphery of the sifter screen allowed for the accumulation of ingredients which were subject to friction thereby increasing the probability of ignition.

There existed a discrepancy in the marking of ingredient containers. Containers did not reflect the name or symbol of the ingredient contained therein.

Defective hoppers were being used in the mixing operation. Cracked welds were found upon inspection.

Extensive sandblasting operations were carried out on the north side of the building the day prior to the explosion while the south side of this building was in operation. Winds were blowing from the N-NE at approximately 12 MPH. Sand and grit have an adverse affect on the operation, since small quantities of either can create the necessary friction to cause fire or explosion. Lab analysis revealed grit and sand in some of the ingredients stored in the building, and in Batch #2 Green. The sifting, weighing, charging of hoppers, final sifting of ingredients from hoppers to final mixing operations are all being carried out in this building. All mix operations were being carried out on the south side of the building due to repairs required as a result of a fire which occurred earlier in the year on the north side. The wall separating the involved cubicles was constructed of hollow tile, not reinforced concrete.

On occasion, personnel performing duty at the WP Plant were pulled for duty at the mixing and blending building without accomplishing a change of clothing or safety shoes. There was no evidence of a physical security survey being performed at the building in question. The crew on duty at the time of the explosion consisted of 1 supervisor and 6 operators. The crew was not fully aware of the explosive nature of the ingredients. Training emphasized the possibility for fire.

Three buildings and equipment contained therein were damaged as a direct result of the explosion.

Cause: It appears that the explosion was due to mechanical deficiencies in the sifter and was initiated by friction created in the sifter bowl by movement of the components during operations. This force was transmitted simultaneously to the ingredients in the lower hopper and to the surrounding dust particles.

Recommendations:

The Board of Investigation recommended the following:

a. Retraining of supervisors and operators on the explosive hazards, as well as fire, involved in the mixing, blending and filling of these grenades.

b. Re-emphasize the requirements for keeping ingredients free of cross contamination.

c. Provide properly marked containers for all ingredients during all phases of operation.

d. Implement procedures to insure that stored ingredients cannot become contaminated by grit, sand, and other foreign materials.

e. Conduct a continuing comprehensive inspection of all hoppers used in the operation to determine cracks, holes and other defects.

f. Conduct comprehensive tests in coordination with other appropriate organizations to determine the suitability of the large (2" stroke) hopper vibrator in supporting this operation.

g. Insure that good housekeeping practices prevail and operations are given full consideration prior to initiation of sandblasting or construction operations which may cause contamination of ingredients and machinery by foreign materials.

h. Provide controls such as covers for all open hoppers during operations to reduce the amount of dust particles suspended within the cubicle air.

i. Provide reinforced concrete walls between and adjacent to cubicles where hazardous operations are conducted.

j. Consideration be given to the placing of the necessary controls for the sifting operation within the blast proof corridors.

k. That the Operating Directive be updated to provide for a more suitable storage of mix and safe area for operators.

l. Comply with Operating Directive as written.

m. Implement safety measures to insure that personnel pulled from the WP Plant area are free of contamination prior to working in pyrotechnics operations.

n. Provide covers for all hoppers in use to reduce the possibility of contamination.

o. Consideration be given to the development of other formulas and methods of mixing ingredients in an attempt to reduce sensitivity.

p. Continue the use of the present green smoke mixture. Implement new mixing procedures to insure that chlorate is not added to the other ingredients until the final blend if this method is determined feasible for production.

q. Consideration should be given to the weighing of each ingredient in a separate cubicle.

r. Prior to continued use of the sifter, comprehensive tests should be conducted and coordinated with other appropriate organizations with modified versions emphasizing the stablizing of the baffle in the upper bowl.

s. Consideration should be given to providing a gasket around the sifter bowl screen to prevent the accumulation of ingredients between the screen and flanges of the bowl. Modification of the sifter bowl should consider a system for inspecting the screen and contents without removal of the upper bowl.

t. Insure that all sifters are equipped with dustproof drive shaft covers.

u. That the first line supervisor closely monitor all operations under their supervision to insure compliance with current operating instructions.

v. Stress the development of new mixes for smoke filling with less sensitivity.

w. That consideration be given to providing separate facilities for blending operations.

x. That a physical security survey of the building be performed and of other facilities to be utilized in similar type operations.

Reference Number of this Report: 1184

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

EXPLOSIVES INCIDENT REPORT NO. 217

Fire & Explosions at Explosives Plant

Description: Flames were noted coming from a semi-trailer containing 30,000 pounds of surplus military smokeless powder immediately after the lunch period (at about 12:25 P.M.) by a three-man magazine crew loading seismograph explosives into another semi-trailer at loading spur located about 100 feet away.

No one had been near the smokeless powder trailer and no tractors had been in the magazine area for several hours prior to detection of fire, although yard foreman had opened trailer and visually inspected it earlier that morning.

As the men ran from the area one went to the Box Factory to alert personnel there and then reported the fire to the telephone operator in the plant office.

Flames became white hot and shot out in all directions as more smokeless powder ignited. Escaping gas pressure propelled some of the boxes from the semi-trailer, and these fell to the ground nearby and split open, the spilled powder igniting instantly.

Semi-trailers parked nearby caught fire; one "melted" in the intense heat, according to an eye witness. Empty and partially loaded semi-trailers parked at the loading spur tram track about 100 feet away then caught fire.

Fires burned for about twenty minutes, during which time most of the plant personnel were evacuated from operating buildings by the Powder Line Foreman, or by the Powerhouse emergency fire whistle.

Six detonations occurred in the magazine area between approximately 12:47 P.M. and 1:05 P.M. These detonations destroyed magazine facilities and left craters where three dynamite magazines, a fuse magazine and several loaded semi-trailers had formerly been located. The first detonation occurred at the magazine parking lot involving several semi-trailers loaded with dynamites and NCN (nitro carbo nitrate). Detonations caused missiles to fly in all directions and fires were started in some locations approximately 3,000 feet from the magazine area.

One loaded dynamite magazine and all of the semi-trailers loaded with NCN in the NCN trailer parking lot (a different parking area) survived the explosions and other than being badly battered by blast damage, did not burn or detonate.

In all, about a million pounds of explosives were consumed by fire or explosion in the magazine area in less than one hour.

Since power lines entered plant through one corner of magazine area, power was lost immediately after the magazine area explosions, and other utilities a short time later.

Small fires were noted in the woods on the perimeter of plant after detonations occurred in the magazine area, and as supervisors checked operating buildings to be certain that all personnel had been evacuated, they noted fires at or near several Powder Line Buildings.

Within two hours after magazine area explosions, minor explosions occurred at a small stub house located on the Powder Line, and on a tram car containing cased Vibronite S primers at the Primer House.

Minor fires had been noted at the NCN House earlier, but apparently were controlled by the building and porch area sprinkler systems while water supply was available. But at 3:45 P.M. packaged material on semi-trailers at this location detonated. (Material in process inside building did not detonate.)

Later an explosion occurred at a Talley Mix House located about 3,000 feet from magazine area.

During the night - about 14 hours later - an NG Neutralizer Building containing 9,000 pounds of NG detonated.

A charge of NG, left in Separator when men received word to evacuate buildings, was drowned without incident early the next morning. Temperature of the NG-spent acid was 76° F. prior to drowning.

Cap magazine was destroyed by blast damage from explosions in magazine area and caps were scattered all over the magazine area. Some of the caps exploded like fire crackers during the afternoon and night. Two small depressions were found in cap magazine concrete foundation the next day, apparently where fuse caps and MS connectors had been stored.

A shallow crater was found later at the former location of the fuse magazine, indicating that a detonation had occurred at that site.

Missiles caused fires which destroyed Dope House, Shell House, Soda Storage Building, Box Factory, Combined Shops and some other safety area buildings. Remaining buildings had major structural damage.

Missiles caused fires at the following Powder Line Buildings which burned without exploding in spite of the fact that most contained nitroglycerin explosives:

Nitrocotton House
Gelatin Cartridging House (2)
Pneumatic Pack House
Bohlman Cartridging Building
Cutting Out House

Powerhouse, Crystallizer and grained nitrate of ammonia storages were damaged both by blast and by fire; very little - if any - grained nitrate actually burned.

A partially unloaded carload of nitrate of ammonia prills was observed burning and fuming in Safety Area several hours after magazine explosions occurred, but the fire apparently extinguished itself during the night as most of the wooden floor of railroad car burned, and prills flowed out on the ground.

Area had experienced hot weather with little or no rain for several weeks prior to the incident.

Because brush fires had occurred on perimeter of plant property near the established fire lanes, the initial phone call reporting the fire to telephone operator was interpreted to mean that another brush fire had been discovered. Hence, upon getting notification, Labor Foreman assembled a fire-fighting crew and went to magazine area with mobile fire-fighting equipment. Crew actually started fighting grass fires at edge of magazine area before plant manager arrived on scene and ordered evacuation of the area.

Five lost-time injuries occurred as the result of the fires and explosions, one fatality and four relatively minor injuries.

Fatality occurred to a veteran magazine area employee who retreated some distance away, but did not actually evacuate the area, although he warned others to do so. Apparently, he thought he was at a safe location and wanted to watch the fires burn. We have no explanation why he remained so long in the vicinity.

He escaped area - alone - several hours later - and was taken to a hospital, where he died the following night of internal injuries caused by missiles.

Three of the four injuries occurred as the result of blast or missiles (elbow laceration, severe leg abrasion, fractured rib and ruptured ear drum).

The magazine man (eye witness) who turned to look at the burning smokeless powder trailer (from a distance of 100 feet) received moderate second degree burns of back, arms and neck and was hospitalized for two weeks. He was not wearing standard powder uniform when incident occurred, and was essentially naked from waist up.

A good many employees were given first aid for minor cuts, etc., and there were a few cases involving minor shock, nervousness, etc.

Magazines which exploded were of brick construction covered with asbestos shingles or asbestos roofing material; all were barricaded to the eaves, with earth piled directly against magazines. Magazine which survived was built about 40 years ago - of 2 x 6" hardwood (laid flat) and covered with heavy corrugated galvanized metal sheets.

The NG Neutralizer and Tally Mix House which exploded were built in U-shaped offsets in a solid limestone wall, and had Repauno type barricades at each side to supplement the solid limestone barricade at rear of the U. Buildings were open at the front, with only a tram line between them and the creek.

Other Powder Line buildings (other than Stub House, Nitrocotton Building, etc.) were of standard wooden construction with asbestos roofing, with single revetted barricades on three sides and Repauno type barricades at the front.

The general layout of the Powder Line followed the contour of the limestone cliff along the creek, with about half the line at a right angle to the other half.

The U-shaped limestone barricades behind the Neutralizer and Mix House (which detonated) were scarred but otherwise undamaged. The Repauno barricades disintegrated.

Barricades at the buildings which burned were intact except the wood facings were partially or totally destroyed by fire.

A heavy trailer axle was thrown 3,500 feet. Other missiles were thrown up to a distance of 3,000 feet.

Glass breakage occurred to a distance of about 5 miles; major structural damage occurred to a distance of about 1-1/2 miles.

Cause: Spontaneous ignition of the smokeless powder is believed to have occurred, but exact cause of the fire is not known.

Reference Number of This Report: EI-217

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

EXPLOSIVES INCIDENT REPORT NO. 218

Finishing Press Explosion

1. On 3 January 1967 at 2302 hours local time an explosion occurred in No. 2 finishing press.

2. The press contained a charge of three (3) powder blocks of double base casting powder mix. Each block weighed 61 pounds for a gross weight (including the solvent) of 183 pounds.

3. The press had operated satisfactorily on the first two charges of three blocks of casting powder. The press was then charged with the third charge of three blocks from the same mix. The press was started and run through the cycle until it started to build up pressure and at this point the press was placed on hold and the pressure build-up warning whistle sounded. The press was again started and the pressure increased slowly as usual and at 900 psig the press moved into extrusion speed and continued to build up pressure until it reached 1900 psig when an explosion occurred. Extrusion of propellant from the press had started prior to this incident as approximately 2 feet long strands of propellant had extruded from each die.

4. After the incident it was determined that the main cylinder rupture disc had ruptured and allowed the ram to retract from the press cylinder. This allowed the powder to be blown from the press cylinder and released the pressure. Approximately 1/3 (20 pounds) of the bottom block of powder remained unburned and had dropped back inside the press after the pressure had been released. There were small pieces of burned and unburned powder scattered about on the second floor and all four (4) walls were spotted from unburned powder that had been blown from the press. The amount of this powder was estimated to be 20 pounds. The total amount of powder consumed in the press fire was estimated to be 140 pounds.

5. After the die plate - lower platen assembly was dismantled it was found that the shear ring supporting the die plate had started to fail. The rupture disc supporting the lower platen hydraulic system did not fail. One-half of the fiber seal ring was found in the press when the platen was lowered and was found to be eroded from fire and pressure. The other half had been consumed by the fire. The stainless steel screen had been ejected from the press and was found on the second floor and it had been burned in several places indicating that it had been in the press. The press cylinder, ram head and the die plate had erosion marks caused by the fire. All evidence indicated that the fire started in the area of the die plate junction with the bottom of the press basket. Clearance between the ram head and the press basket prior to the incident had been recorded at a minimum of 0.012" at the top and 0.014" at the bottom of the basket.

6. There were no injuries to any personnel.

7. The damage included 140 pounds (dry weight) of propellant valued at $224. It has been estimated that repairs to the die plate and press basket will be approximately $2500 and that repairs to the roof, explosion proof lights and repainting will be approximately $2300 for a total cost of $5024.

8. On 17 May 1966 an explosion occurred in the No. 2 Finishing Press and on 5 December 1966 an explosion occurred in the No. 1 Finishing Press and these two incidents have been reported. This incident of 3 January 1967 was the third explosion to occur in these types of finishing presses since their installation in 1965. An AdHoc Committee of station personnel was formed to review all three incidents and to meet with representatives of the manufacturer to consider possible changes or modifications to the presses that could be made to prevent future incidents of this type. After all three incidents were thoroughly reviewed it was the consensus of opinion of the AdHoc Committee that the areas of trouble causing the ignition of the propellant were:

a. The mating surface area between the bottom of the press basket and the die plate. This die plate is held in place by the lower platen assembly.

b. The area where the screen covers the dies. The opinion of this AdHoc Committee was based on the determination that each ignition started in the bottom of the press basket adjacent to the aforementioned areas. It was also the opinion that item (a) was the most logical of the two areas to cause the ignition since screens have been used in similar presses without causing ignition.

9. Several mechanical tests were run using inert material to determine if there was any relative motion between the lower platen - die assembly and the press basket. It was determined that there was lateral motion occurring in the amount of 0.007" to 0.010". It then had to be determined whether all of this motion occurred in the lower platen - die assembly or if some motion could be attributed to the press basket. It was determined that the major portion was occurring in the lower platen - die assembly. Shims were installed between the press basket and the press housing to prevent the lateral motion of the press basket. It was a known fact that propellant had been extruding between the two metal surfaces, namely the bottom of the press basket and the lower platen - die plate assembly. This had also occurred in the former presses where the die plate had been held against the press basket by a ring clamp. It was felt by the committee that this lateral motion of the lower platen - die assembly would be adequate to ignite the propellant. It was also determined that this relative motion occurred when the hydraulic pressure on the ram was in the range of 1800 to 2200 psig where normal extrusion of propellant starts and it was in this pressure range where the incidents occurred.

10. After these determinations were made the committee discussed the possible solutions for the problem. It was felt that there were three possible solutions:

a. Pin the lower platen - die plate assembly firmly in place. Since the area where the die plate mates with the press basket was the prime suspect, it

was felt that after raising the platen assembly in place it could then be pinned to eliminate lateral motion. It could not be firmly fixed in place, for example, by means of welding as it is absolutely necessary to be able to lower this platen assembly to remove the die plate for cleaning and/or for replacement. A consultation was held with the manufacturer who stated that this was not feasible as once the pins (even if they were tapered pins) were in place and hydraulic pressure which is in the range of 500 to 600 tons was applied to this assembly, pins would become so thoroughly fixed that they would be impossible to remove.

b. The installation of a suitable gasket between the lower platen - die plate assembly and the bottom of the press basket. It was believed that propellant would still flow into the area, however, the gasket should prevent a softer surface and hopefully would eliminate ignition of the propellant when the lateral motion occurred. Various gasketing materials were tested in the Machine Shop under pressures of 500 to 600 tons and it was determined that a neoprene gasket material 0.32" thick would be the most suitable. The question still remained as to whether this gasket material would prevent any escape of gas or vapors that are normally entrained in a block and escape during the compaction cycle and thus allow adiabatic compression of these vapors with resultant ignition. The dies are normally plugged with propellant after the first charge and thus are not a means of escape for vapor and gases. The committee felt that the propellant which had been extruding between these two surfaces was acting as a gasket. If this were a fact, then the substitution of a neoprene gasket for propellant would not present a problem. To verify this, blocks of inert (dummy propellant) were extruded through the press and then the press basket was sealed at the top and pressurized with nitrogen. The tests indicated that the propellant had acted as a gasket as the nitrogen pressure within the press basket remained constant for a period in excess of 10 minutes. It was therefore the opinion of the committee that a gasket could safely be installed between these two metal surfaces.

11. On 30 January 1967, the No. 1 Finishing Press which had been damaged in the explosion of 5 December 1966 was placed back into operation. The neoprene gasket was installed between the lower platen - die plate assembly and the bottom of the press basket. The press was first checked out on single base propellant and then further checked out on a double base propellant formulation. It operated quite satisfactorily and accordingly it was put into service.

Reference Number of This Report: EI-218

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

EXPLOSIVES INCIDENT REPORT NO. 219

Explosion Involving 105mm H.E. Projectiles With Fuze MTSQ M564

Description: While tightening a fuze with the air-driven wrench, an explosion occurred in the operating bay. Operations in the bay consisted of removing wire seals from fuze boxes, removing fuzes from boxes, applying Pettman cement to fuze threads, seating fuzes into projectiles by hand, tightening fuzes with air-driven wrench, and inspecting fuzed projectiles.

Eleven of the twelve people working in the bay died as a result of this explosion. Two seriously injured people were hospitalized. One of these worked in the bay where the explosion occurred and the other was in an adjacent bay. Thirteen minor injuries were given first aid treatment and released.

Discussion: Damage to the operating building consisted of roof sections (over the bay where the incident occurred) being blown off, and of several of the metal screen sections (used for protecting skylights) being dislodged. These sections fell into the bay. The 1/4" thick metal plate on which the conveyor belt rode, was ripped open. A small crater measuring 1 inch deep and 12 inches in diameter was formed in the concrete floor directly beneath this opening. Most missiles were contained in the bay. All bay doors were blown off their hinges.

The explosion ignited combustible material in the immediate area. The fire spread through the conveyor wall opening into the bay on the north side of the bay involved. (Note: The building runs north and south.) The Fire Chief, after learning that at least one person was still alive in the bay, erected a deluge nozzle on the east side of the building on the top of an embankment. Water from this position was directed into the area where the fire was burning. It should be pointed out that the Fire Chief knew this was a Symbol 4 building, however, since people were still in the building and there were no further explosions occurring, the decision was made to fight the fire. This decision probably saved the building from further damage. Estimated property damage is $23,000.

The RPM required to arm the M564 Fuze is 1,000. Test subsequently conducted with a similar type wrench showed that it was possible for the wrench to attain a speed in excess of 1,000 RPM. The SOP did not contain any information as to the speed with which the air-driven wrench could be operated safely. The wrench involved was recovered. Information on this wrench indicates that it was rated for 2800 RPM.

EI-21 (Continued)

One projectile detonated high order. This detonation caused one adjacent projectile to explode low order. Spacing of projectiles on the conveyor ranged from close proximity to approximately 10 inches.

The one person who survived this explosion stated that he heard those removing fuzes from their packing boxes remark to the bay leader that some of the fuzes had loose booster cups.

It is believed that safety personnel were not aware of the information contained in the Procurement Production Package or the Description of Manufacture for the item involved. Information was not available (at the time this abstract was being prepared) if the above documents had been received at the installation. In general, the Procurement Production Package contains safety limitations and precautions relating to production equipment and facilities involving hazardous material that must be incorporated into the manufacturing procedures; the hazards which may be presented by the material; identification of known and probable hazards and documented evidence of known hazards and any specific information generated during local tests and evaluation which may have an adverse effect on safety relative to manufacturing, handling, storage and shipping of the material.

Causes:

1. Exact Cause - Unknown.

2. Probable Causes:

a. Sudden acceleration of force to the fuze being tightened by the air-driven wrench to cause the cocked firing pin to function while the booster mechanism was in an armed condition. (In order for this to occur, there would have to be a faulty firing pin and an armed booster in the fuze.)

b. Initiation of the tetryl booster pellet due to friction between the threads of the booster cup and fuze body or between the top of the bare tetryl pellet and the bottom of the metal housing containing the booster mechanism.

c. Striking the nose of the fuze with the air wrench with sufficient force to function the M50 detonator while at the same time the booster mechanism was in an armed condition. In this case, the fuze would have had the point detonating detent safety mechanism missing and the booster mechanism would have to be in an armed position.

Recommendations:

1. Fuzes that can be armed by centrifugal force should not be screwed into projectiles with air-driven devices that impart sudden acceleration to the fuze. Fuzes should be hand inserted or devices should be fabricated that impart a slow rate of acceleration during operations.

EI-219 (Continued)

2. During the manufacturing of fuzes, precise control of the operation should be maintained. Specific instructions should be given to inspection personnel to assure that fuzes are assembled in accordance with written specifications and that all aspects of such specifications are complied with.

3. Whenever a possibility exists for bare explosives pellets (such as contained in booster cups) to come into contact with other metal parts of booster assemblies, onion skin paper should be used to separate the pellets from the exposed metal.

4. Conveyor belts should be marked to indicate the required separation distances between projectiles on the belt. Projectiles should be placed on the conveyor in a horizontal position.

5. Operations should be arranged so that the least possible number of personnel are exposed to the hazards involved.

6. Prior to starting loading and assembly operations for any hazardous item, the Procurement Production Package should be thoroughly reviewed. All applicable safety information contained in the Package should be incorporated in appropriate sections of the Standing Operating Procedure.

Reference Number of This Report: EI-219

Duplication of this Report is Authorized.

OPERATIONAL INCIDENTS

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 1

SO_2 Tank - Suffocation

Description: In a continuous process, raw materials enter neutralizers and the resultant mass flows into a steamer where the mass is sparged with steam and then flows into a finisher. Wet SO_2 gas is evolved from the neutralizer and the steamer and headers carry this gas to the acidifiers and through coolers to the department. Condensate from the headers and coolers is returned to the steamer. The department was shut down and the neutralizers and steamer washed out. Repairs and inspections of the neutralizers and header system were made during the day shift. The SO_2 headers were open at several places and washed. Work in the steamer was delayed because additional washing of this tank was necessary. The department crude room foreman signed the field inspection of the tank entering permit for the steamer, leaving it in the drawer of the crude room chief operator's desk. He then left the plant to take his wife to the hospital. The permit was put in place sometime prior to the shift change (4:00 PM); however, by the time the tank was entered, work on the header system was complete and the blind ends and previously-removed spools were back in place. The large diaphragm valves in the header were closed as were valves in all header drain lines except one which has no valve. A laborer entered the tank (for final cleaning before repairs by shop personnel) at approximately 4:40 PM. He used a ladder for descent. The manhole is small ($10\frac{1}{2}$" x $10\frac{1}{2}$") and required entry with arms overhead. The ladder was then removed from the tank to allow passage of a bucket. He reported that conditions were hot but tolerable to his watcher and to the middle shift chief operator. After about 8 buckets of sludge were removed, the laborer called for the ladder and said that liquid sprayed on him and that the SO_2 was bad. The ladder was not lowered because the laborer (choking) immediately climbed up the air hose. The watcher grabbed him but lost his grip due to slipperty gloves and SO_2 coming out of the tank and the laborer dropped into the tank again. On climbing up the air hose again, the watcher got a good grip on him but could not get him through the manhole. At this time, another employee came up the stairs and quickly sizing up the situation, assisted in working the laborer"s shoulders through the manhol e and helped lay him on the grating floor. The laborer was apperently unconscious and gagging. The shift supervisor pulled his tongue forward and removed mucous from his mouth to clear breathing passages. The night superintendent arrived shortly thereafter, administered oxygen and took him to the dispensary on a stretcher. From there, he was sent to the hospital for observation. Who attached the tank entering permit to the tank has not been determined. Witnesses established that it was on the tank at 3:00 PM and when entry was made. The source of SO_2 gas and the liquid has also not been determined, but its source was probably the SO_2 header system.

Cause: The primary cause of this accident was that tank entering permit procedures were not strictly followed. The permit was signed prematurely. Wrist harness was not worn by person entering the tank. Piping conditions changed

between inspection and actual entry. Also noted during this inspection was that valves closed for the shutdown were not tagged.

Preventive Measures: It is recommended that tank entering and tagging procedures be thoroughly reviewed with all supervisory and hourly personnel.

Reference Number of this Incident: OI-1

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 2

Chlorine Leakage

Description: Chlorine gas escaped into the shop work area through a ruptured gasket in the safety disc flanged holder. Two men working in the area suffered respiratory irritations from the gas. Prompt action by the shop foreman and a maintenance mechanic in evacuating the area prevented more serious injuries. Prior to the incident, the main steam supply line to the area had been shut off for maintenance repairs. As a result, the chlorination operation was interrupted since there was no heat available for the chlorine vaporizer. The operator shut off the chlorine vapor feed valve at the chlorinator and the steam valve at the vaporizer. Approximately one hour later, the maintenance work was completed and the main steam supply restored. The operator opened the steam valve at the vaporizer to preheat the vaporizer before resuming the chlorine feed flow. Within five minutes, the gasket failed and a large release of chlorine filled the area. The operator immediately shut off the cylinder valve while the mechanic notified the foreman and helped evacuate other personnel. The system is protected by a safety disc and safety valve in series with each set at 275 psi. Investigation showed that the safety disc had blown from the pressure developed in the system. The pressure could not release, however, through the safety valve because the safety valve discharge line was plugged at an elbow. There is doubt that the safety valve was in good order since a subsequent test showed it did not release until under a 600 psi pressure. Consequently, the safety disc gasket ruptured and the excess vented into the shop.

Cause:

1. The chlorine system should have been completely shut off during the steam shut-down period. The operating instructions did not cover the steps to be followed in the event of interrupted service.

2. The safety disc apparently leaked causing corrosion of the safety valve seat which prohibited discharge of the safety valve at 275 psi.

3. The safety valve discharge vent was plugged. Inspection procedures for detecting such conditions were inadequate.

Preventive Measures:

1. The procedure for shutting down the chlorine feed for short periods will be rewritten to include purging of the line.

2. The log sheets for the process will be revised to provide for recording the pressure in the safety disc-safety valve assembly on each batch.

3. A new two-inch vent has been installed to replace the one-inch line and periodic inspections of the complete vent line will be established in accordance with Safety Standard for Inspection of Pressure Relief Devices.

Reference Number of this Incident: OI-2

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 3

Aniline Poisoning

Description: An order was submitted by production to repair the condenser on a reactor. The condenser had three small holes in the side of the shell about two-thirds of the way down. The mechanical repair order was passed on to the maintenance foreman through the planner. The foreman checked the job site and requested the operator to drain the condenser so the repairs could be made. When the mechanics arrived at the job site to perform the work, they found that the condenser had not been drained. One of the mechanics went to the control room to request the operator to drain the condenser. The operator told the mechanic that the condenser had been repaired in the past (without having to drain it) by using metal screws. The injured attempted to repair the condenser in this manner, but was unsuccessful due to the material flowing from the holes. (While attempting to repair the condenser, the injured's cloth gloves became saturated and were discarded. The other mechanic suggested that rubber gloves be used, but the injured believed that they would have been of little use due to the location of holes which allowed the material to spill out onto his arms.) Being unable to make the repairs, the mechanics notified their foreman that it would have to be drained. The maintenance foreman requested the production foreman to have the operator drain the condenser. The injured felt that there was aniline in the spillage since he had encountered a tingling sensation in his hands. Being smoke-break time, he went to the area shop while the condenser was supposedly being drained. After smoke-break, the mechanics and foreman returned to the building. The production foreman was at the building instructing the operator to drain the condenser. The injured mentioned to the production foreman that he thought he had been exposed to aniline. The production foreman sampled the material and informed the injured that there was aniline present. The mechanics proceeded to repair the condenser after it was drained. After the repair was completed, the mechanics entered the control room. By this time, the injured showed evidence of aniline toxicity by the change in his complexion. The production foreman sent him to the dispensary for treatment.

Cause: Exposure to aniline liquid and vapors due to:

1. Lack of protective equipment (rubber gloves).

2. Lack of proper preparation of job site.

3. Lack of knowledge of contents of spillage. (Poor communications between responsible persons.)

Preventive Measures:

1. Production to inform Maintenance of hazards of process when submitting request for the work by:

a. More information being submitted when an order is called in so the mechanical repair order will "spell out the hazards of the job."

b. The maintenance foreman and production foreman should discuss the job line-up to insure the equipment is prepared for the work when working on process equipment.

2. The building to publish a notice of the hazards of their department and present to Maintenance so a review can be held with the mechanics.

3. Maintenance foremen to insure proper protective equipment is used by the mechanic when working on process equipment.

4. Re-issue the data sheets on toxic chemicals issued by the July-August 1960 Safety Committee. These are to be used as reference sheets by all foremen when exposure is likely.

5. Review with plant personnel the fundamental rules for working with chemicals as issued by the Safety Committee.

6. This investigation is to be discussed with all plant personnel so proper action can be taken through better design, operations and maintenance to prevent an occurrence of this type from happening within another department in the plant.

Reference Number of this Incident: OI-3

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 4

Fatal Accident While Operating Tow Tractor

Description: A sandblast leadman was fatally injured while operating a 4,000-pound capacity tow tractor in a non-operating storage warehouse. He left his work area to obtain extra glass face pieces for sandblast helmets. He entered an adjacent non-operating warehouse, and for reasons unknown, proceeded to operate an electric tow tractor. While operating the tractor in the poorly-illuminated warehouse, he turned sharply to the left and was pinned between a depressed gun tube of an anti-tank vehicle and the rear motor frame of the tractor. The front part of the tractor, from the driver's seat forward, passed under the gun tube. Adequate clearance, however, did not exist to permit the raised rear part of the tractor and operator's body to pass under the gun tube. The operator apparently was unable to stop the tractor, or did not see the gun tube. Death resulted from compression of the chest area.

Cause:

1. The employee was not experienced in the operation of this type vehicle.

2. The employee failed to see the gun tube due to poor illumination.

3. The operator attempted to make a sharp left turn at an excessive speed and lost control of the tractor.

Investigation of the accident revealed that the fatally injured employee did not possess an operator's permit. His position did not require that he operate a powered industrial truck. Examination of tire skid marks indicated that the tractor was started with the motor excessively accelerated, causing the wheels to spin on the warehouse floor. The tire marks further indicated that the operator attempted to make a sharp left turn while traveling too fast. At the time of the accident, the building was not in use and the overhead lights were not turned on. This condition resulted in poor illumination. Several hours prior to the accident, the employee involved in the accident had questioned a licensed operator concerning the operating controls of a tow tractor. He had also operated a piece of materials-handling equipment in the building where sandblast operations were in progress.

Preventive Measures:

1. Only authorized personnel shall be permitted to operate powered materials-handling equipment.

2. Operators shall be carefully selected, thoroughly trained, and required to pass an operating test before they are permitted to operate powered materials-handling equipment.

3. All prospective operators should undergo a physical and mental examination, given by a qualified medical examiner, to determine that they are physically capable of performing their duties.

Reference Number of this Incident: OI-4

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 5

Acid Release When Tank-Truck Cover-Clamp Failed

Description: A truck driver was unloading his third tank load of 60° Baume sulfuric acid during the middle shift. (A second driver had already unloaded three truckloads of the same material.) He followed the customary procedure of connecting the 3" discharge line from the truck to the line going to the storage tank. He connected the air supply to the 3/4" air connection on top of the truck. He turned on the air supply, observed that the pressure gauge indicated 22 psi. After one or two minutes, he entered the truck cab to work on his log sheet. He had just picked up the log when he heard a "rumbling" from the tank that resembled the sound made when live steam is discharged into the bottom of a tank of water. It was quickly followed by a vibration or chattering noise and then a loud bang. He started to leave the cab, but stayed in when he discovered acid spraying down heavily in the area surrounding the truck. When the acid stopped falling, he went to the air supply shed and turned off the air. He called the shift superintendent, who thereafter called in the materials handling supervisor. A 30' x 60' area around the truck was wet with acid, some laying in sizeable puddles. The driver estimated that 150 gallons had come out. The hinged loading nozzle cover was open, but the swing bolt assembly was laying in the roadway some 40' away, torn off at the weld. The level of acid in the truck was about 12" below the top. The following facts were established during the investigation: (1) The air supply system was functioning properly, the relief valve relieving at 28 psig. There was no evidence of excessive moisture in the air supply. (2) The vent on the storage tank was open. (3) The storage tank had previously had 60° acid in it, and all of the loads of acid transported during the evening of the accident analyzed 60°. (4) The circulating pump was valved off, and there is no reason to believe it could have inadvertently been started up. (5) The manhole cover and loading nozzle cover showed considerable corrosion; the weld that failed particularly appeared corroded. (6) There was no evidence of failure to follow approved procedures.

Cause: The cause of the accident was the failure of the loading nozzle cover hold-down mechanism, probably due to inadequate design and a weakening by corrosion.

The committee considered the possibilities of a violent reaction from contaminated or mixed acids or the introduction of water. It considered the possibility of a hydrogen explosion set off by a static charge. None of these possibilities seemed likely in view of the conditions. The most likely explanation is the simplest, that the loading nozzle swing bolt failed first on one weld, causing air release and chattering, followed by failure of the other weld. The blowing open of the cover was followed by the sweep of air out of the opening. At the same time, the acid in the 6" pipe line flowed back into the tank under its 12 or 15 psi static head causing enough surface disturbance to let a sizeable amount of acid be carried up into the air. It should be noted that the 2" lead rupture

disc on the manhole did not rupture. The exact rupture pressure of this disc is not known as it is cut from lead sheet on demand. This disc does fail occasionally at normal or slightly above normal blowing pressure. The lack of failure in this case tends to verify the weakness of the cover clamp.

Preventive Measures:

1. Expedite completion of approved project for the installation of facilities to allow use of a pump for acid unloading.

2. Alter the loading nozzle cover on the two acid trucks to include three swing clamps 120° apart.

3. Investigate to see that ICC regulations in regard to pressure testing of trailer tanks are being complied with.

4. Determine the proper thickness of lead for the rupture disc. Provide this information to the shift superintendents.

5. Although not directly related to the accident, install a properly drained concrete pad at the tank truck loading spot.

Reference Number of this Incident: OI-5

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 6

Ammonia Spray from Pump

Description: Two employees were changing a valve on a pump. After the inlet and discharge valves were closed, to isolate the pump, the men proceeded to pull the cover plate. As the cover plate came loose, ammonia sprayed on the men. One employee was burned on the shoulder and the other was burned on the neck.

Cause:

1. The pump contained residual pressure.

2. One of the men was not wearing a face shield.

3. The men failed to check the pressure in the pump.

Preventive Measures:

1. A vent line is being installed on the discharge line of the pump to insure venting of residual pressure.

2. To make venting more positive and to insure that no liquid ammonia remains, the pump will be run idle to vaporize the material while it is being vented.

3. Face shields will be mandatory to supplement safety glasses with side shields.

Reference Number of this Incident: OI-6

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 7

Acid Spray

Description: A quantity of glacial acetic acid had collected in the sump pit. The injured, a pipefitter who had been working on another unit, was asked to help hook up the discharge line on a positive displacement pump to be used to recover the acid from the pit. One end of the 3" suction line, equipped with foot valve and positive screen, was placed into the sump. It was intended to recover the acid via the 3" intake of the displacement pump coupled to a 2" line into the suction inlet of a residue pump. Using a 3" by 1½" reducing bushing, a 1½" nipple, a 1½" by 2" bushing and a 2" hose boss fitting, the 2" acid hose was coupled to the displacement pump, the gasoline engine was started and the pump put into operation at 10:30 AM. At 12:15 PM it was shut off for lunch period. On restarting the pump at 1:00 PM, the motor started and then stopped. On restarting and with the pump speeded up, the diaphragm ruptured. Acid sprayed on the injured and two other employees.

Cause: It is assumed that the displacement pump, prior to luncheon shutdown, was operating with reduced suction possibly caused by foreign material fouling the suction line screen. Once the obstruction dislodged, the pump, which was not equipped with a pressure release system, attempted to operate with a 3" suction intake against a 1½" discharge, rupturing the diaphragm.

Preventive Measures: Instructions have been issued that should it be necessary to reduce the discharge side, the suction side must be equally reduced and at no time will the use of a diaphragm pump without a pressure release system be compounded with another pump. A diaphragm or positive displacement pump (without a pressure release system) must be able to discharge a quantity of liquid equal to the quantity of intake and without restriction. Should it be necessary to use an additional pump or pumps, the diaphragm pump shall be discharged into an open vessel or other container in such a manner that no back pressure is produced.

Reference Number of this Incident: OI-7

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 8

Acid Splash

Description: An "outside" acid truck driver was splashed with 20° beume hydrochloric acid about the face, eyes and chest. The accident occurred on top of the truck platform as the driver was disconnecting the hitch on the acid hose delivery line. At the time of the accident, the man was alone in the area of the unloading station. He made his own way, a distance of approximately 100 feet, and was placed under a safety shower by the employees.

Cause: The truck driver violated the plant rule that outside drivers neither connect nor disconnect to company storage tanks. The acid is unloaded from the tank truck by blowing with air. The driver disconnected the transfer hose before the air pressure had been completely vented. Although the transfer line valve was closed it was faulty, permitting residual acid to spray out when the hose was disconnected. The driver was not wearing goggles.

Preventive Measures:

1. The purchasing and traffic departments have notified the carrier to insist that their truck drivers observe the plant regulations.

2. The operating personnel in this area have been reinstructed that outside truck drivers are not to handle any of the unloading equipment.

3. This review is being circulated to plant supervision to show the hazards which result when "outside" truck drivers do not comply with plant regulations.

Reference Number of this Incident: OI-8

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 9

Acid Spray

Description: Pipefitters had just completed the unloading of a tank-car load of sulfuric acid 93% into one of the storage tanks. A warehouseman who looks after stocks of cylinders of compressed gases and keeps close watch over plant stores of sulfuric acid and whose work normally consists of weighing off sulfuric acid into carboys and drums, proceeded to refill empty carboys that were on hand. He placed one of the empty carboys on the scale under the tank valve. Shortly after the acid started flowing into the carboy, there was a puff of brownish smoke and acid was sprayed up and out from the carboy and directly into his face. A pipefitter who was standing nearby helped the warehouseman into a nearby building where he quickly flushed his face as he removed his goggles. He then changed clothes and reported in at the dispensary. Although he received numerous superficial burns about his face and neck, none of the acid got behind his goggles and his eyes were uninjured.

Cause: Someone had violated the safety rule in using the carboy for chemicals other than sulfuric acid.

Preventive Measures: Sample taken from the broken carboy and spectrographically analyzed was inconclusive. All manufacturing departments have been reminded again of the rule concerning use of carboys as containers for materials other than the material indicated by its label.

Reference Number of this Incident: I-9

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 10

Battery Explosion on Fork Lift Truck

Description: A fork lift truck was reported as not having any electrical power to the switch and would not operate. An employee was assigned to trouble shoot and make the necessary repairs to put the unit back into operation. His first step was to determine if he had good mechanical connections at the battery posts. To do this, he placed the blade of a large screwdriver in the split of the battery cable on the negative post, and tried to turn the cable to check looseness. As he did this, there was an explosion, rupturing and blowing out the top of the negative post cell; this sprayed him with broken pieces of battery and battery acid (sulfuric acid). At the time of the explosion, he was looking directly down at the battery post with his face being only about 18 inches from the terminal.

Cause: The battery acid became low in the cells which built up hydrogen gas in the void space in the battery cell. When the employee twisted on the cable connection, it caused a spark which ignited the hydrogen gas coming from the filler cap.

Preventive Measures:

1. Always check to see that the liquid level in the battery is to the full level.

2. Use only a short tool to check the battery connection. With a short tool, possibility of grounding to the body chassis will be minimized. Whenever possible, a non-metallic tool should be used to do this job.

Reference Number of this Incident: OI-10

Publication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 11

Eruption of Hot Caustic from Repulper Vat

Description: The cook pump feeder on a washer repulper started to come loose and hooked on the cook pump impeller. Shear pins in a coupling sheared and stopped the pump. The drive motor and reduction gear continued to operate and the chute filled up. The level of stock came up into the repulper vat causing the repulper to kick out. The washer was shut off and the repulper was already immobilized. The supervisor asked if steam had been shut off but did not say whether he meant No. 4 or No. 5 chute. As steam had been turned off on the No. 4 chute, he was advised the steam was off. Believing it could be safely unplugged, the workman started toward their area to start unplugging. At this time, a rumbling noise was heard from inside the repulper. Three of the men turned and started to get out of the area, but one man was prevented by pipes and valves in the way. The fourth man, not hearing the warning, made no attempt to get out of the way. Immediately following this loud noise, hot caustic stock and steam erupted from the repulper vat.

Cause: Had the steam lines been turned off properly, this accident probably would have been prevented. It is believed the steam could have heated up the stock and built up enough pressure to blow the stock up through the repulper. It was found that pressure in the line between the cook pump and the refiner mixer could cause the cook pump to rotate backwards which could have contributed to the blow-back.

Preventive Measures:

1. Control valves have been installed on the steam lines to No. 4 and No. 5 washer.

2. A plugging switch on the cook pump will ring a bell if the rotor stops.

3. A back-stop braking arrangement has been installed to stop the cook pump from rotating backwards.

4. Valve has been moved so that workmen will not be trapped.

5. Each man has been instructed on safe procedure and the procedure has been written into the bleachery log book.

Reference Number of this Incident: OI-11

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 12

Acid Spill

Description: A level control flow chamber had been blocked in and turned over to maintenance with a warning that the inlet block valve to the chamber might leak. Maintenance carefully broke out both unions in the piping down stream of the valve and no leakage was evident. They then broke out the flange at the valve and found the valve plugged with process solids. While they prepared to install a blind flange on the valve, the plug blew out causing a spill which was stopped after about 10 minutes, when an operator drove a wooden plug into the valve outlet. The operator was treated in the dispensary for a minor chemical burn caused by the acid in the process spill.

Cause: Inability to completely close a block valve as a result of process material lodged in the valve was the cause of the near-miss.

Preventive Measures:

1. During the investigation, it was evident that maintenance people needed to be better informed about the hazards of chemicals handled in the area, and this will be done.

2. This particular job was being done while the unit was still in operation. In the future, supervision will carefully review jobs to determine if repair is necessary immediately or if they can be delayed until a unit shut-down is made.

Reference Number of this Incident: OI-12

Publication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 13

Inadequate Ground of Welding Machine

Description: Boilermakers were installing a stop on the 2½" extruder turntable in the research laboratory. A permit had been issued for welding in this laboratory and following normal plant practices, the boilermaker grounded the welding machine to the nearest ground which happened to be a steam line outside the building. Welding of the stop proceeded. The extruder is mounted on a turntable consisting of a shaft and bearing mounted in the floor. All electrical wiring leading to machine is in flex-conduit. Water is carried in rubber hoses; and because of these conditions, there was no good return ground for the welding operation except for the four electrical conduits which are of thin-walled flexible material. Although considered adequate for grounding the machine in case of electrical shorts, the conduit could not carry the load generated by the welding machine. The smallest of the four conduits, a 1-inch line, became so hot that the outside insulation melted and the wire insulation inside the conduit fused in one mass. There was no injury, but damage resulted to the electrical wiring.

Cause: Improper grounding of the welding machine.

Preventive Measures:

1. Although the National Electrical Code accepts this type of flexible conduit as being sufficient ground, additional grounding cable will be used to provide a more adequate ground.

2. This incident will be brought to the attention of all plant welders.

Reference Number of this Incident: OI-12

Publication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 14

Ammonia Splash

Description: Operator and pool man were loading NH_3 into tank car. Pool man noticed excessive leakage at loading pipe connection into car liquor valve. He closed rack valves and cleared lines venting to the atmosphere as prescribed in operating manual. When vent to atmosphere indicated lines were bled down, he went out to car and flipped down locking cam on quick coupler. Liquid NH_3 squirted from coupling, striking insides of both wrists and upper legs. He ran to shower on rack, but water was so slow in coming out here, he ran to other end of rack and down steps to other shower. After showering, although convinced he had no burns, on advice of nurse, proceeded to dispensary and applied vinegar to all parts contacted by NH_3.

Cause: The last step before uncoupling hoses is to bleed loading and vent pipes by opening valve at elbow of these pipes. This step of the operation was not completed.

Preventive Measures:

1. Review all procedures, especially those entailing hazards such as this, and make doubly sure that all operators and pool men are fully aware of these hazards and the procedures for counteracting them.

2. Showers must be adjusted and maintained in proper operating condition to provide adequate water.

Reference Number of this Incident: OI-14

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 15

Bromine Burn

Description: Mechanics started on necessary repairs to put the bromine system in a building back into service. The system had been shut down for several months, and it was necessary to replace gaskets, vent lines, valves, and thoroughly check out the system. Mechanics were closely observed while cutting into system by supervision, and everyone was made aware of hazards when handling bromine. Plastic gloves and gas masks were worn while initially cutting into lines. On the morning of the accident, two pipefitters were assigned to check out the piping system for blowing bromine from tank cars and to replace gaskets and necessary fittings and valves. As the system was already disconnected in several locations, gas masks were put aside. Shortly after lunch, they were replacing pressure reducing valve and noticed ½" ell was loose. In order to tighten this ell, it was necessary (because of clearance from wall) to remove needle valve. The injured started to remove this valve, loosening it very carefully; when valve was nearly off, he wiggled it but seeing no evidence of any liquid or fumes coming from connection, removed it. Immediately, a small portion of bromine trapped from top of needle valve to ell spilled out, burning him on the forearm, wrist and hand and splashing over his clothing. Another fitter working nearby on vent system suffered a minor burn on his leg.

Cause:

1. Nitrogen pumping system was not considered a hazardous part of the system. (No bromine was supposed to be present at this point.)

2. Some items of protective equipment were not used after initial break-in.

3. Gloves worn on this job did not adequately protect hand and wrist.

4. Piping was installed so that natural pocket for material was formed.

5. There is no written procedure for shut-down of this system.

6. There is no positive method of completely purging system of bromine.

Preventive Measures:

1. Revise bromine piping so that ½" needle valve and regulating valve are above straight section. Revise nitrogen inlet section of piping so that any liquid will drain east towards tank car.

2. Install flange covers on all lines which carry liquid bromine.

3. Write down specific instructions for shutting down bromine system at the end of a run. Consider purging lines with nitrogen or some other inert medium.

4. When working on the bromine system, a Santosite-Soda ash (50:50 mixture, solution to be provided at all times to neutralize any spills in the area. Water in copious quantities should be readily available for skin contact.

5. Minimum protective equipment when working on any part of the bromine system is: gas mask, rubber gloves (shoulder length), and rubber suit. A full rubber suit and an air hood with an outside air supply is strongly advised, when blockages occur and pressure cannot be released. The bromine piping is considered to be the entire system, from the nitrogen cylinder - to the tank car - to the reactor - to the caustic scrubber - to the atmospheric vent.

6. All department supervision review the protective equipment requirements for similar hazards in their respective operations.

7. All maintenance supervisors and foremen re-emphasize the fact that hazardous systems are still hazardous even after initial break-in, and safety precautions should not be relaxed at any time.

8. All departments review this accident at the next safety meeting.

Reference Number of this Incident: OI-15

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 16

Inert Gas Leak

Description: Two men were instructed to install pipe connections to the bottom section of a 10' x 21' cone-bottom aluminum tank. One man went inside the tank while the other man remained outside. The man on the outside heard a noise as if someone had fallen into the tank. Upon investigation, he saw the man lying unconscious on the bottom. He called to a third man for help, and rushed in to rescue his fellow worker. He too fell unconscious in the tank. Inert gas was suspected, so other workers inserted several air hoses to flush the tank. Rescue was made largely through the heroic efforts of the members of the safety department wearing self-contained breathing apparatus, and the quick thinking of the fellow workers. Both men were revived.

Causes:

1. The feed and return lines to the tank had not been removed or blanked off.

2. Neither ventilation nor an oxygen check had been provided. Inert gas had leaked into the tank from a pipe tied into the pneumatic conveying system at a diverter valve. Also, an 8" return line had been tied into the pneumatic conveying system about 20' from the feed bin. Neither of these two lines had been blanked off from the feed bin.

3. Standard safe practices for entering tanks were disregarded.

4. A safe work permit, approved by supervision, had not been secured.

5. An approved safety harness, with life line attached--in the hands of an outside helper, was not being used.

6. Failure of the fellow worker to protect himself by entering the tank without adequate safeguards.

Reference Number of this Incident: OI-16

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 17

Acid Solution Spray

Description: An operator had been assigned the job of cleaning out a dehydrator system. He had completed the removal of the liquors in the system with the steam ejector and started the washes. When the first wash was completed, he requested the hook-up of a rubber steam hose from the discharge side of the dehydrator transfer pump to the storage tub which is used to store make-up water for the absorbers. (A steam hose had been used twice before for this job.) A department mechanic made the hook-up and also checked for leaks after the hose was in use. The operator stayed on the job until 12:00 noon when he left the plant. Another employee, who was an extra operator that day, was assigned to the job just before going to lunch. When he returned at 12:15, the chief operator gave him the line-up and also told him to check the hose connection to the discharge pump. He went up to the 12' level where the hose was connected and observed that the hose connection to the piping on the discharge side of the pump was leaking badly. The spray from the leak prevented him from closing the valve to the hose. He then went directly to the switch for the transfer pump and turned it off. He started back to check the leak again when the connection gave way and allowed the hose to drop to the floor. The hot solution continued to spray out due to the static head pressure of the liquid in the system. He was approximately 10' from the connection when the injury resulted. In the manufacturing of maleic anhydride, a section of the process requires the dehydration of maleic acid. The equipment used in this dehydration is cleaned out periodically. The exact time of the cleanout is dependent on a build-up of deposit of tars and residues which cause partial blockages and affect the vacuum. When a designated loss of vacuum is observed at the flash chamber, it means the equipment must be cleaned out. The first step in cleaning out the system is to suck all liquor in the system to the stripping still. After this is completed, water is introduced to the system and heated. A large circulating pump is started and the hot water is continuously pumped through the whole system for a half-hour. In the past, three separate washes were made on the system and on the completion of each, the liquor was pumped to the sewer. Through recent investigation, it was found that the first of the three washes contained maleic acid, so in an effort to better the yield, the liquor from the first wash is pumped through a rubber hose to the make-up water tank for the absorbers rather than being sewered. The second and third washes are still pumped to the sewer. A project recently was submitted, approved and is scheduled for the near future which includes the installation of a storage tank for this liquor and the permanent piping necessary to pump the first wash to this storage tub.

Cause: It is believed that rapid corrosion of iron fittings caused by maleic acid was the principal cause of this accident. It was found that there were iron fittings on the steam hose and the piping to the pump.

Preventive Measures:

1. Hoses used for this operation be provided with 316 stainless steel fittings, and these hoses properly identified.

2. All blow-out and drain lines be changed to 316 stainless steel.

3. Inform personnel on location and use of special hoses and post sign INSTALL HOSES WITH 316 S.S. FITTING ONLY at each steam water mixer when stainless steel fitted hoses are attached.

4. Each department supervisor check hoses and fittings in his department from a corrosion standpoint. If it is found that the standard hose with steel or brass fitting is not suitable in all cases, production supervisor should: determine what material is suitable in each case, see that material required is installed, acquaint operators with resulting changes.

Reference Number of this Incident: OI-17

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 18

Perlite Inhalation

Description: On the day after an oxygen unit had been shut down for repairs to the main condenser, several employees were in a conical section of the housing to replace a blown rupture disc and to install a wood chute to remove perlite insulation prior to repair of the condenser. Some perlite (fine granular powder) flooded into the conical section suddenly through one or more of the four relief ports in the floor. The attendant dust cloud made vision practically impossible in the section. All employees got out of the area except one who was found about ten minutes later by a supervisor who had entered the area immediately to search for any trapped employees. Resuscitation efforts failed to revive the employee who had apparently inhaled quantities of perlite.

Cause: It is believed that the perlite flooding was caused by a sudden movement of a mass of the material in the upper section of the tower where ice formation had caused bridging which released the material when thawing occurred. The situation resulting in ice formation had been created by a leak in the main condenser.

Preventive Measures: Plans and design changes are being formulated to eliminate the hazard of flooding perlite into an area occupied by employees.

Reference Number of this Incident: OI-18

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 19

Hydrogen Sulfide Exposure

Description: A synthetic chemical plant employee received an acute-fatal exposure to hydrogen sulfide gas while making benzimidazol-ethiol. In this reaction ethylxanthic acid potassium salt is added to orthophenylaminediamine in alcohol. After the first reaction and refluxing, the mixture is acidified by adding glacial acetic acid. Large amounts of hydrogen sulfide may be given off during this acidification. The formulation procedure indicates that acetic acid is to be added slowly and that hydrogen sulfide must not be allowed to escape.

Cause: Evidence indicates that acetic acid was being added to the kettle by pouring directly from a plastic carboy without using a dropping funnel or other method of control. Evidence also indicates that the agitator was not running and that the vent ejector was not turned on. A violent foaming apparently caused the material to froth out of the manhole, releasing a large amount of hydrogen sulfide. The frothing was sufficient to project some of the material from the mezzanine level to the first floor of the building so that other employees were immediately aware of the situation. The injured man was immediately removed and given rescue breathing with administration of oxygen but failed to revive. This accident demonstrates the high hazard of hydrogen sulfide and the need of every precaution to prevent release of material or inhalation of the gas. The area is equipped with air-supplied respiratory equipment. The mixing kettle is provided with a dropping funnel to provide slow feed of acetic acid through a closed tube. The mixer is also provided with a vapor ejector and with an agitator.

Reference Number of this Incident: OI-19

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 20

Rupture of Glass-Enclosed Magnetic Stirring Bar

Description: A commonly used laboratory stirrer is a small cylindrical magnet encased in an inert material such as glass or Teflon. The magnet is dropped into the fluid to be stirred and the vessel set on top of a magnetically-linked motor which rotates a magnetic field and causes the stirring bar to rotate. One of these stirring bars, about 1-1/8 inches in length and about 3/8 inch in diameter encased with glass, was the source of a possible personal injury to a laboratory assistant. The accident occurred when the laboratory assistant took the stirring bar from the laboratory bench drawer and laid it on the bench top while he prepared a solution to be stirred. While the bar rested on the bench top, it suddenly ruptured with a loud report. The glass cover on the magnet broke into several pieces, one of which struck the arm of the laboratory assistant. Fortunately, he was not injured. An examination of the bar revealed that it was covered with scale and light-colored powder material. The powder had not been observed through the glass because of the presence of glass wool which apparently is used to cover the magnet before encasing it in glass. Laboratory tests show that the light-colored powder was iron sulfate. A small amount of black scale appeared to be iron sulfide.

Cause: The stirrer had been used on many occasions to mix solutions containing sulfuric acid. The glass seal must have contained a small pinhole due to improper sealing. Over a period of time, sulfuric acid must have seeped into the glass case and formed the solid sulfate. The solid material must have built up to the point where the glass was ruptured.

Preventive Measures: In the future, only Teflon covered magnetic stirring bars will be used. The Teflon material is chemically resistant and is also flexible and would not rupture as did the glass.

Reference Number of this Incident: OI-20

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 21

Acetic Anhydride Splash

Description: While preparing to siphon acetic anhydride from a drum by means of glass and rubber tubing, a drip of anhydride flicked from the end of the flexible rubber tube and entered the operator's eye. After treatment in the surgery he was examined by an eye specialist and detained in a hospital. The siphon device consisted of a rubber bung bored for two glass tubes carrying lengths of ½ inch rubber tube approximately 2 feet 6 inches and 6 feet long. The usual place of stowage was the flat top of a disused centrifuge 4 feet 6 inches high on which the rubber tube was bundled haphazardly. It was obvious that any drainings which collected inside the tube between transfers would remain there until next time the tube was handled. No precautions were taken to guard against splashing from such drips apart from wearing of gloves and the general instruction that goggles must be worn during transfer of acetic anhydride. It appears that in the operator's interpretation of the instruction, the term "transfer" did not include "preparation for transfer."

Cause:

1. Unsafe procedure.

2. Failure to wear chemical goggles while handling corrosive material.

Preventive Measures:

1. A suitable stowage to be provided for the siphon device whereby the rubber tubes could hang vertically and drain into a suitable container.

2. Instruction on wearing of eye protection to be re-drafted and explained to all operators.

Reference Number of this Incident: OI-21

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 22

Anhydrous Ammonia Burn

Description: The employee was reconnecting the piping to an anhydrous ammonia pump. While reaching over the equipment, he inadvertently bumped or leaned against a quick opening valve handle moving it to the open position. Anhydrous ammonia under 125 p.s.i. pressure was released through an open one-inch pipe ell onto the lower portion of his body resulting in severe burns to the lower torso and legs.

Note: This valve was red tagged and constituted the block valve in one of the suction lines that had already been connected to the pump.

Cause:

1. Limited work area.

2. The handle was not removed from the quick opening valve while work was being done near it.

3. The employee did not use good judgment in positioning himself for the work.

4. Employee reached over the equipment.

5. Possibility of laxity on the part of supervision in over-seeing the job.

Preventive Measures:

1. Valves of this type will have lever handles removed while such valves are red tagged.

2. Consideration is being given to replacing the lever handle with a wheel

3. Additional emphasis will be placed on the need for prompt and adequate washing of all external parts contacted by hazardous liquids.

Reference Number of this Incident: OI-22

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 23

Chlorine Gas Inhalation

Description: A chemical solution Second Helper, on his first shift by himself, was checking the scale tanks. At this same time, he was making bleach liquor with liquid chlorine from the scale tanks. During the latter operation, the pressure in both scale tanks dropped below normal. In order to build the pressure back to normal, the compressor was started. As the pressure built up in the scale tanks, the flow of liquid chlorine to the bleach-making chest increased, resulting in the bleach liquor becoming over-chlorinated and a considerable amount of chlorine gas escaping to the atmosphere. The concentration of chlorine gas was heavy and the chemical solution Second Helper, with a small respirator on, inhaled chlorine gas. The chemical solution First Helper who was operating the reactor realized what was wrong and immediately went out to the scale tanks and shut off the liquid chlorine to the bleach-making chest. Immediately following the escape of chlorine gas, the Decker Operator went in to the machine room and advised the machine tenders on No. 1 and No. 2 machines. At the same time, the machine room Foreman and Shift Supervisor noticed the strong smell of chlorine gas, and not knowing what was wrong, agreed to get personnel out of the machine room until the condition cleared up. The machine room Foreman carried out this plan of action. Personnel remaining in this area were equipped with full face respirators which afforded adequate protection for this concentration of chlorine gas. Shortly after the release of gas, a Viscosity Tester was on the stairway when he noticed a strong smell of chlorine gas. He went back up the stairway to the control laboratory to get a respirator. On the way he inhaled chlorine gas. When he arrived in the control laboratory, he put on a full face gas mask. A Sample Collector in the control laboratory also inhaled chlorine gas and put on a full face gas mask. Another workman in this area also put on a full face gas mask and suffered no discomfort. The chemical solution Second Helper, the Viscosity Tester, and the Sample Collector reported to first aid and were treated for exposure to chlorine gas.

Cause: Operator, on shift for first time by himself, had three things to watch at the same time and forgot one - control of liquid chlorine to the bleach-making chest. (Chemical solution Second Helper was apparently in a gas concentration too strong for the small personal respirator; the Viscosity Tester did not have his small respirator on his person; the Sample Collector was apparently not familiar with the full face gas mask and had difficulty putting it on.)

Preventive Measures:

1. All personnel have been given the following instructions: If for any reason the person making bleach liquor with liquid chlorine has to leave the bleach-making system unattended for any length of time, or to perform another job, he must first shut off the liquid chlorine at the bleach-making chest.

2. All personnel have received further instructions on the care and use of respiratory equipment.

3. This incident was discussed at a machine room safety meeting immediately following the occurrence and it was agreed that all the full face gas masks would be removed from the floor and serviced by the Fire Patrolman.

4. This operating procedure and others will be checked and brought up-to-date and placed in operating manuals for every job involving chemical solutions.

5. All supervisors will make certain that personnel in their respective departments must be fully instructed on:

   a. Care and use of respiratory equipment.

   b. Ruling regarding the wearing of respiratory equipment.

5. All new employees will be instructed in the above before commencing work.

Reference Number of this Incident: OI-23

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 24

Fire - Nitric Acid Absorption Building

Description: The nitric acid concentration operator saw flames on the roof and wall near the absorption tower. The operator shut down the two concentration towers and telephoned the Power House and the foreman. The Power House advised the fire brigade and supervision. Electricity on adjacent power lines was turned off, and the fire was extinguished with fire hoses. A guard remained in the building overnight. The fire was not considered to be out of control at any time.

Cause: It is thought that the fire was caused by 20 psig steam tracing on a water line to the waste acid absorption tower. The tower has not been used since 1958, so it is concluded that the steam valve was turned on by mistake. Sections of wood from the area of the fire were tested for combustibility. The ease of ignition was about the same as dry wood which has not been exposed to nitric acid fumes. Electrical wiring and insulation adjacent to the burned wood was inspected and found to be in good condition, so it would not have caused the fire.

Preventive Measures:

1. Disconnect all unused steam lines.

2. Reinspect all steam lines passing through wood or other combustibles to ensure that they are installed in the approved manner, i.e., with adequate clearance and properly supported.

3. Connect small hoses on each floor of the nitric acid concentration building to the filtered water line for use in fighting small fires. This will provide water at 80 psig rather than 40 psig raw water.

Reference Number of this Incident: OI-24

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

AESB Operational Incident Report No. 25

Sulfuric Acid Splash

Description: A pair of pipers were removing a nipple and cap from a 66° Be. sulfuric acid line in preparation for installation of a valve. This section of line was between two closed valves and had not been used for approximately 20 days. One piper had gone for the valve while the other piper was unscrewing the nipple. At that time the production foreman came up to spread a little soda ash on the few drops of acid that had come from the loosened nipple. As the last thread was disengaged, acid spurted out of the line spraying both men about the face and neck. The piper was wearing splash goggles and the foreman had on safety glasses, thus preventing possible blindness to the two men.

Cause:

1. Reaction of the sulfuric acid on the iron line releasing hydrogen, thus building up pressure.

2. No provision for bleeding line prior to dismantling except back to storage or to reaction vessel (where another type batch was being made).

3. Insufficient knowledge that the acid could react and build up pressure.

Preventive Measures:

1. Production supervision will each check their own areas to make sure they do not have acid in contact with iron in a completely closed system.

2. All plant personnel have been made aware of the fact that confined acid in iron can cause pressure build-up.

3. Emphasis to be placed on this incident by all supervision to further promote the use of safety eyewear in the plant.

Reference Number of this Incident: OI-25

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 26

Acid Splash

Description: An "outside" acid truck driver was splashed with 20° baume hydrochloric acid about the face, eyes and chest. The accident occurred on top of the truck platform as the driver was disconnecting the hitch on the acid hose delivery line. At the time of the accident, the man was alone in the area of the unloading station. He made his own way, a distance of approximately 100 feet, and was placed under a safety shower by the employees.

Cause: The truck driver violated the plant rule that outside drivers neither connect nor disconnect to company storage tanks. The acid is unloaded from the tank truck by blowing with air. The driver disconnected the transfer hose before the air pressure had been completely vented. Although the transfer line valve was closed it was faulty, permitting residual acid to spray out when the hose was disconnected. The driver was not wearing goggles.

Preventive Measures:

1. The purchasing and traffic departments have notified the carrier to insist that their truck drivers observe the plant regulations.

2. The operating personnel in this area have been reinstructed that outside truck drivers are not to handle any of the unloading equipment.

3. This review is being circulated to plant supervision to show the hazards which result when "outside" truck drivers do not comply with plant regulations.

Reference Number of this Incident: OI-26

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 27

Electrical Shock

Description: The shift operator on day shift at the Stengel operation, received a strong electrical shock at the Compactor when he took hold of the cable leading to the bagger foot switch. The bulk flow had been washed down and the floor had some water and wet ammonium nitrate on it. The foot pedal and cable had been laid on the conveyor during washdown. On starting up, the pedal and cable were placed on the floor and the cable was tangled under the empty bag box. A bag was being filled when operator reached down and grasped the cable about four feet from the pedal. He immediately received a continuous electrical shock which numbed him, threw him against the wall and kept him from releasing the cable. The current flow ceased when the bag on the bagger was filled to capacity and the bagger door snapped shut. Operator had to be helped outside the bagging room where he quickly recovered.

Cause: At the time of the shock operator was not grasping any metal but his feet and shoes were wet with ammonium nitrate solution. Moisture was found in the pedal and around the cable at the switch. The cable was wet on the outside along its whole length.

Preventive Measures:

1. Installation changed to permanent conduit and switch relocated to prevent moisture exposure.

2. Ground system improved to prevent breakdown.

Reference Number of this Incident: OI-27

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 28

Hydrogen Sulfide Release

Description: The operator and his supervisor went to investigate an H_2S odor coming from a reduction vessel. The fumes were so pungent the men experienced difficulty in breathing and immediately headed for an exit. When they got outside the operator collapsed but revived quickly and was taken to Plant Health.

Cause: The scrubber unit, to which this vessel was attached, had been charged with fresh solution before the reaction began. The scrubber blower, which is interconnected with an alarm, is shut during this procedure and the alarm bell turned off manually. After the scrubber was returned to service, the alarm bell was not turned on. During the reduction step, the blower motor failed mechanically but since the alarm was shut off, the operator was not aware of the failure. The H_2S fumes escaped into the room creating the noxious situation. The operator was attending a vessel in another part of the room and was not aware that the H_2S was escaping. This gas has the insidious property of causing olefactory fatigue and dangerous concentrations cannot be smelled after short exposure.

Preventive Measures: To prevent a recurrence, the batch sheet was revised to require the operator's signature that the alarm has been re-energized. In addition, it has been found that a lead acetate solution will absorb H_2S and detect it in the HCN detector in this room. This will ring an alarm when H_2S escapes into the room. Lead acetate paper also is available to be used when leaks are suspected.

Reference Number of this Incident: OI-28

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 29

Sulfuric Acid Spill

Description: The acid plant tank car man was loading a car of 25% oleum in the normal manner, using a conductivity probe connected to a bell alarm to determine when the car was full. About 4:00 PM, the tank car man was standing by waiting for the bell to sound when oleum overflowed out of the dome of the car. The pump was shut off immediately and the car washed down very carefully. The fill pipe and the conductivity probe were removed, the contents sampled, and the lid replaced on the dome. For the loading operation, the pressure relief assembly is removed and the conductivity probe is inserted in the air inlet on the dome of the tank car. The pressure relief assembly is fastened to the tank car with a short piece of chain so that it hangs against the side of the dome during the loading operation. When the tank car man attempted to replace the assembly, acid which had collected in a dome-shaped section spilled onto his left leg. He washed off the acid immediately at the loading dock safety shower. While washing, acid and water got inside his rubber bootee through a crack on the top of the bootee and burned the top of his foot. Investigation revealed that the connection between the conductivity probe and the alarm circuit was poor, so that the alarm would not work part of the time. The tank car man had tested the equipment before installing it on the car and had found it satisfactory.

Cause: The primary causes for the injury were:

1. Failure to wash the acid out of the pressure relief assembly hanging on the side of the car.

2. Faulty bootees and insufficient protective apparel.

3. Defective conductivity alarm.

Preventive Measures:

1. Repair of conductivity alarm equipment.

2. Replace bootees and emphasize to all employees the importance of having bootees in good condition and properly laced.

3. Instruct all personnel to wear protective clothing when washing down spills of corrosive chemicals.

4. Emphasize the necessity of checking equipment and the importance of thorough washing of any equipment involved in any chemical spill.

Reference Number of this Incident: OI-29

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 30

Arc Welding Near Vehicle Fuel Tank

Description: An employee was assigned to arc weld a metal spacer in place on the interior wall of the vehicle compartment, adjacent to the fill opening of the empty gasoline tank. As the employee struck the electric arc, a spark or flash ignited vapors from the lacquer process coating in the gasoline tank. The tank ruptured, blowing out the heavy metal side directly in front of the employee and his helper. Both employees were injured by concussion and shock.

Cause: Ignition of an explosive vapor mixture which had accumulated in the unvented tank while in storage.

Preventive Measures:

1. When gasoline tanks have been in storage with the openings sealed shut, welding should not be permitted in close proximity until the tank has been purged with air to assure that no flammable atmosphere of explosive vapors exist within.

2. Adequate safety measures should be incorporated in procedures for electric arc welding. Before welding is permitted on or near flammable liquid tanks, the safety of the work area (including the tanks) must be determined.

3. Adequate inspections should be made of areas where welding operations are performed.

Reference Number of this Incident: OI-30

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 31

Pressure Rupture of Uncoded Vessel

Description: An area maintenance mechanic was attempting to clear a plugged product feed pipe line connected from a separator to a vented horizontal receiver located on the floor below. He had cleaned out the sight glass and was attempting to steam out the product pipe line which was still plugged. He connected a high pressure steam hose from a 125 psi steam header to a coupling on the product line on the second floor below the overflow sight glass. He closed the valve underneath the sight glass and opened the valves on the product line and the steam header applying steam to the product line. When last seen the mechanic was standing on the receiver feeling the temperature of the pipe. A short time later, the receiver suddenly ruptured at the east end and the mechanic was fatally injured.

Cause: Failure to recognize the potential hazards existent in this cleanout process. The horizontal receiver was an uncoded vessel. Calculations made after the accident indicated that, with all available venting unrestricted, a 6 psi pressure could develop from a sustained flow of 125 psi steam through the product line. The receiver, when new, would have failed at about 13 psi. Corrosion had weakened the vessel to some degree and available venting was significantly reduced by product buildup. When steam broke through the blocked product line, the venting system did not release the steam rapidly enough to prevent a pressure buildup to the fail point of the receiver - under 13 psi.

Preventive Measures:

1. Engineering changes have been made in the process and equipment which completely eliminates the need for a horizontal receiver, and the product is piped directly from the separator into the process.

2. A comprehensive survey is being made of all plant operations involving pressure to assure pressure requirements use (high pressure steam especially) are kept to within safe use limits.

3. Employees have been reinstructed to note any abnormal occurrences including plugged lines and steaming operations on operating log sheets.

4. This accident has been reviewed with plant supervisory personnel.

Reference Number of this Incident: OI-31

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 32

Acid Spray

Description: The accident took place on the operating floor of a mixing unit, within the cubicle containing the acid-measuring tank to the mixer. The tank and auxiliary equipment had been out of service for a year and removal was underway. At the time of the accident, only a 2-inch lead acid delivery line remained to be dismantled, and had been assigned to two pipefitters as part of their day's schedule. The lead line which had delivered 93% sulphuric acid from an outside storage tank to the measuring tank ran horizontally at floor level across the back of the operating floor, up the wall, and then ended in a 180° bend at the discharge to the tank. The maximum height of the bend was 6 feet above the floor, with the open end of the pipe about 5 feet above the floor. A carpenter and helper were repairing a section of the wooden floor across which the pipe ran, and nearby two pipefitters were installing an air line to the mixer. All were wearing hard hats, and safety glasses with side shields. The two pipefitters assigned to the lead pipe removal were still working in another area. The carpenter, having bumped his head against the bend-over of the lead line, considered the line a hindrance and asked the pipefitters about it. Upon being told the pipe was to be removed, he decided to cut the pipe himself. At a spot where the pipe crossed the floor horizontally, the carpenter, facing his fellow workers, cut 3/4 of the way through the pipe with one blow of an axe. On removing the axe, acid sprayed forward a distance of approximately 8 feet, hitting one pipefitter in the back of the neck and shoulders, and the other in the face as they worked together threading pipe. The carpenter hurriedly put his foot over the spray, but deflected the spray onto the elbow of his helper working on the other side of the cubicle. The pipefitters and helper proceeded to the showers immediately; after showering, received treatment at the plant hospital; and returned to work.

Cause: When use of the equipment was stopped a year ago, the line was not drained and the acid remained in the line from the valve to the highest point in the 180° bend at the mixing unit. The carpenter had no authority to cut the line and used unorthodox tool and method. This work had been assigned to two qualified pipefitters, experienced with acid lines, who would normally have checked the line for residual acid before proceeding with dismantling. At the time of the accident, no one was aware that the line had been left full of acid, and the work area in general was considered safe.

Preventive Measures:

1. For a lengthy equipment shutdown, any process liquid line should be immediately drained and blown clear and blanked off at both ends.

2. Discussion of this accident with plant personnel, stressing:

   a. The value of safety equipment.

   b. Necessity for always assuming an acid line is full.

c. Use of proper tools and methods at all times.

d. The potential hazard in performing unfamiliar work outside the work assignment.

e. The importance of issuing proper instructions to craft employees.

3. Emphasize to all employees the importance of wearing personal protective equipment as a means of avoiding personal injuries.

Reference Number of this Incident: OI-32

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 33

Acid Spray

Description: An employee was changing the flow direction of phosphoric acid from a centrifuge to several locations. As he was closing a valve in a pipe line leading to a tank car, a short rubber hose connection leading from the centrifuge blew off its nozzle and sprayed the employee with acid.

Cause: Failure to open one discharge pipe line before closing off another caused excess pressure on a weak connecting section of pipe.

Preventive Measures: A rupture disc and return line to the centrifuge sump has been placed in the discharge pipe line between the centrifuge and the acid loading lines, to protect lines from excessive pressure and personnel from any resulting acid spray. Operational procedures have been prepared and posted.

Reference Number of this Incident: OI-33

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 34

Solution Splash

Description: An employee was loading copper wire into the top of a partially open 5'x5' chlorinator which contained an acidic solution of cuprous ammonium chloride up to a level approximately 6"-8" from the top. He used a five-foot 2x4 to push the wire to the rear of the chlorinator. During this pushing operation, the 2x4 slipped and fell into the solution. The solution splashed into his left eye, resulting in a severe chemical burn. (Note: The employee was wearing safety glasses with side shields - a department standard.)

Cause: The push stick which slipped from the employee's hands might have been improperly designed; or, the push stick and/or the employee's gloves might have been wet with solution.

Preventive Measures:

1. An adequate (nitrometer type) face shield will be required on this job. A survey is also being made of all department operations to find if more adequate eye protection is required on other jobs.

2. A properly designed push stick will be provided on the job.

3. The engineering department has been requested to make a study for modification of the chlorinator to reduce the splashing hazard during the loading operation.

4. Supervision of organic chemicals department will devote more effort to improving operating procedures, equipment, and instructions on all jobs in the department.

Reference Number of this Incident: OI-34

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 35

HF Sprays

Description: An employee wearing full protective clothing removed a screwed-type plug cock from an HF line. He put the cock down on a grating-covered trench, left the area, and removed his protective clothing. When he returned a few minutes later, he held the cock down with his foot, while he opened it. HF and other material spurted out, striking him in the face. Safety glasses with side shields, his only protection, saved him from almost certain blindness, but his face was covered with numerous pitted burns, requiring extensive injections of calcium gluconate.

Some years ago at another location, an employee was clearing and greasing several plug cocks which had been out of service for about 6 weeks. Cocks were being washed with solvent and then greased. Employee opened one of the cocks after greasing and was sprayed on both forearms with HF. Two hospitalizations were required, the second for skin grafting, and employee was under medical attention for approximately 1 year.

Preventive Measures:

1. When removing a valve or plug cock, screwed or flanged type, from a line, full protective clothing including a face shield must be worn until the valve or cock has been opened, drained, washed and decontaminated.

2. Valves and plug cocks should be opened on the line before removing them. This may relieve built-up pressure, but there is no guarantee it will.

3. No plug cock that has been removed from a line is to be left unopened for any period of time.

(Note: Valves and plug cocks may be opened under water as an additional precaution.)

Reference Number of this Incid OI-35

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Additional Information on Operational Incident Report No. 35

The note following this case history indicates that valves and plug cocks may be opened under water as an additional precaution. This procedure would not be suitable in dealing with all liquids for several examples could be given where materials and water react in such a manner that would make the suggested practice a hazardous one.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 36

Chlorine Inhalation

Description: During start-up, an operator opened a valve in a chlorine feed line which releases liquid chlorine into the reactor. This caused an excessive amount of chlorine in the system which vented to a water seal pot off the recycle tank near the operator, and he inhaled vapor while closing the valve.

Cause: The excess chlorine in the line caused the accident. Operating procedure called for opening the chlorine valve last during start-up. The vent line froze up causing chlorine to vent through the water seal pot. The operator was not wearing a gas mask.

Preventive Measures:

1. Vent line will be removed from sewer and tied to recycle tank vent, then to caustic scrubber instead of water seal pot, so that chlorine will be neutralized.

2. Operating procedure has been changed so that chlorine valve will be opened first when starting up.

3. Operators have been instructed to wear gas masks during start-up.

Reference Number of this Incident: OI-36

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Operational Incident Report No. 37

Polymer Plugged System

Description: Just prior to the time of this incident, a separator was being tested for leaks by use of high pressure. The pressure had then been released using normal venting procedures and the pressure gauges on the test panel board indicated zero pressure. A pipefitter loosened the high pressure tubing connections and found no indication of residual pressure. As he bent over to complete the disconnection of the tubing, there was a mechanical failure of a fitting in the system. The stream of test oil struck his leg and knocked him down. The pressure continued to be released intermittently, forcing the man to crawl out of the area in order to avoid being struck by the swinging high pressure tubing. The pipefitter received a serious laceration of the leg, but was able to return to work the same day.

Cause: The plugging of the system with polymer from the test item was the direct cause of the incident. This polymer held pressure in the system in such a way that the gauges did not indicate that pressure existed.

Preventive Measures:

1. Piping system is to be revised to provide another pressure indicator and an additional method of venting.

2. The entire system has been completely inspected and cleaned, and in the future, items to be tested will be cleaned prior to testing.

Reference Number of this Incident: OI-37

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Operational Incident Report No. 38

Oxygen-Fed Fire Inside Air-Supplied Suit

Description: An employee received severe burns to the chest, shoulders, neck, stomach, and legs when oxygen-saturated cotton underwear ignited inside an air-supplied suit he was wearing. After disconnecting the air supply and exhaust lines from his air-supplied suit and leaving the controlled atmosphere room, the employee removed his helmet and lit a cigarette. He then connected an air supply line from another room to his suit to flush and cool the suit. This second supply had been provided for this purpose. Following these actions, the employee's underclothing caught fire. Two employees cut and tore the suit from the employee and beat out the fire, after which the injured employee was transported to the plant medical facilities for first-aid treatment and then to the local hospital.

Cause: Apparently a spark from the cigarette ignited the oxygen-saturated cotton underwear which, in turn, ignited the suit. Investigation disclosed that the respiratory air supply to the second room, normally enriched by 2-3% oxygen, actually contained 68-76% oxygen resulting from the failure of the air-oxygen mixture control valve. This situation introduced a severe hazard to a procedure which otherwise had been determined safe and had been used routinely for some time.

Preventive Measures: Pending installation of more reliable instrumentation and controls on the oxygen feed, addition of oxygen to the respiratory air system was suspended.

Reference Number of this Incident: OI-38

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

Operational Incident Report No. 39

Sulfuric Acid Reaction

Description: On Monday, March 11, 1963, a new procedure for recovering acid ester was started. Prior to this time, no attempt was made to recover acid ester routinely due to severe fume problems. After a fume scrubber was installed, members of the production and technical service department experimented with recovery techniques and demonstrated the final procedure on Friday and Monday day shifts. The procedure was adopted on Monday for routine operations. Operating instructions were posted at the chief operator's desk and inserted as an addendum to the formal operating instructions at the operator's desk. At the start of the split shift on Monday, the washer operator asked the chief operator to assist him in removing an alkaline wash. At approximately 5:50 PM, they opened the valve in the alkaline wash line and began draining into an acidified heel in the acid ester tank located on the first floor. They then opened the sulfuric acid valve one turn. Both the wash and the acid entered the acid ester tank through the same nozzle. The mixer was not running at this time nor at any time during the draining of the wash. The operating instructions specified that the agitator be left off because experience had shown that the bottom propeller was not submerged in the liquid until all the wash was in the acid ester tank and then only to a depth of one to five inches. The possibility of severe foaming with this situation was recognized and the operating instructions included a note to shut off the acid flow if this should occur. The chief operator tested the wash and found it strongly alkaline. The wash continued to drain during this time. Three to five minutes later, the material foamed out of the manhole of the acid ester tank onto the floor. The chief operator told the operator to shut off the alkaline wash. He then went to observe the acid ester tank from the second floor and the ground floor. After noticing that the foaming was subsiding, he returned to the second floor to again drain the alkaline wash after a total elapsed time of two to four minutes. After observing no further incident, the chief operator left for dinner at 6:05 PM. Approximately fifteen minutes later, when approximately fifty gallons of wash remained in the No. 6 washer, two operators heard a loud report and observed a geyser of material spraying from the acid ester tank manhole to the roof some 26' above the manhole of the tank. Both went to the east door and then returned to give aid. An operator who was operating in the south section went into the north section, then returned to call the guards and the dispensary. Two operators were standing by the control panel on the third floor at the west end of the building. Their position placed them some 15' above and in front of the acid ester tank manhole. The force of the eruption knocked them both down. In falling, they both lost their glasses and suffered lacerated knees. One began crawling because of the slippery grating and was found approximately 15' away from the panel by another operator who immediately took him to the hose in the south section and washed out his eyes and flushed his body. He did not

attempt to use the safety shower in the north section because of the material dripping from the underside of the roof. The injured also crawled to the safety shower on the third floor, stood up and turned it on. After remaining in the shower a short time, he went to look for the other operator, but when he could not find him, returned to the shower. Because of the fumes, he again left the shower and went into the south section. After finding the other operator who was being assisted, he returned to the north section and descended to the ground floor where he again showered with assistance. He was taken to the dispensary by the guards.

The following observations were made about thirty to forty minutes after the incident:

1. A 2'x6' piece of floor grating above the manhole of the acid ester tank had been lifted out of place and turned sideways.

2. The acid valve was still open about $\frac{1}{4}$-turn.

3. The liquid in the tank was still boiling violently. A check with congo red paper showed it to be slightly acidic.

4. A liquid puddle in front of the panel on the third floor tested faintly alkaline to brom thymol blue paper and slightly acid to congo red paper, indicating a pH of 5.0-6.0.

Cause: This accident was caused by stratification of concentrated sulfuric acid in the bottom of the tank as a result of inadequate mixing with subsequent sudden mixing and violent reaction liberating CO_2 and probably steam. Exactly when the stratification occurred is problematical. Some accumulation could have occurred during this batch or even the preceding batch. However, it is felt that the major contribution to the buildup probably occurred during the period after the initial foaming when the acid line was left open while no wash was draining. During this time, the acid stream was falling into a stagnant acidic aqueous solution, thus plummeting directly to the bottom with little mixing. A check of several batches showed a wash specific gravity of 1.05 to 1.11 versus 1.70 for 60° sulfuric acid. The eruption apparently occurred after the alkaline wash reacted with the acid in the upper layer and had reached the lower layer of concentrated sulfuric acid. This type of reaction is known to occur suddenly and violently.

Preventive Measures:

1. Review and evaluate the acid ester recovery operations for possible benefits from a new or revised system. If the results of this study show that any continued use of the present system is desirable, the following changes should be made:

a. Revise the mixer in the north tank to give thorough mixing under all conditions.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 40

Chemical Spray

Description: A railroad tank car, from which product is pumped into a process kettle several times daily, had been emptied except for a remaining six-inch heel. Before disconnecting the car, the operator prepared to blow the transfer pipe line back to the tank car clear with air (see Sketch). He connected the air hose (at valve 3) to the transfer line, and applied air pressure (opened valves 1, 3, 4, 7, 8, 9, 11, 12 and 14). Noticing that mist was not coming out of the tank car dome, indicating air was not flowing back to the tank car, he shut the air off (at valves 1 and 3) and disconnected the air hose. He cracked a valve (at 13) open slightly and immediately closed it when product sprayed out. The employee went to the top of the tank car and attempted to move the foot valve (at 15) which was closed. The pressure remaining in the transfer line vented into the heel and splashed product out of the tank car dome onto the employee.

Cause: Failure to vent pressure remaining in the transfer line into the kettle (south kettle-valve 10) before attempting to move the tank car foot valve. (Note: The transfer line is blown clear with air through the tank car foot valve. When the operator, from a ground level location, notices mist coming out of the tank car dome, he shuts the air off, closes a valve (14) under the car, and closes the foot valve. After venting the remaining pressure in the transfer line into a process kettle (through valve 10), he disconnects the tank car.)

Preventive Measures:

1. Air-blowing pressure for clearing the transfer line will be reduced from 50 pounds to 15 pounds.

2. A new vent valve has been installed on the hose side of the air valve so the transfer line can be rechecked for pressure before the hose is disconnected.

3. Employees have been re-instructed to vent line pressure into the processing kettle before disconnecting the line or moving the tank car foot valve.

4. Employees have also been recautioned to place themselves in a protected location when checking blowing operations.

Reference Number of this Incident: OI-40

Duplication of this report is authorized.

b. Relocate the mixer starter switches and the main acid valve from their present positions above the acid ester tank manholes to a more remote location.

c. Revise the acid piping so that the north and south tanks will be supplied by separate lines from the second floor with separate sight glasses and throttling valves.

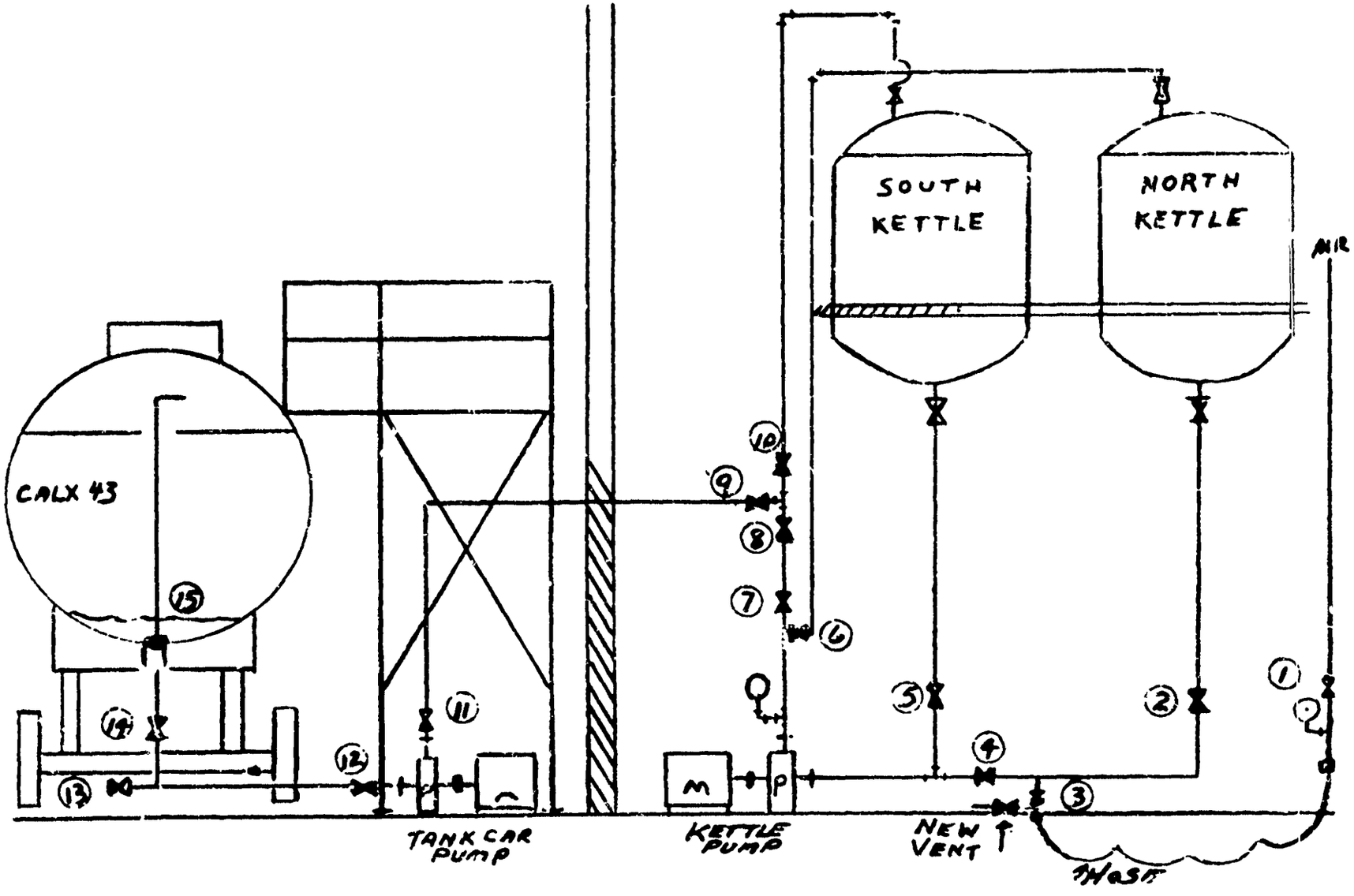
d. Provide a system for sampling the north tank from the second floor similar to the one in use on the south tank.

2. Completely review safety shower locations and number. Install at least one additional safety shower on the third floor.

3. Emphasize to all operators the need for use of the south tank agitator at all times during the acidification.

Reference Number of this Incident: OI-39

Duplication of this report is authorized.


SOUTH KETTLE
NORTH KETTLE
AIR
CALX 43
TANK CAR PUMP
KETTLE PUMP
NEW VENT
WASTE

OI-40

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 41

Polymer Slurry Spray

Description: An operator in the pilot plant was sprayed in the face with a stream of polymer slurry. He suffered minor chemical burns to both eyes. Polymer in a hydrocarbon suspending agent is transferred from the reactor to a 500-gallon Pfaudler vessel. Alcohol is added to this vessel, and the mixture is heated, cooled and a sample taken for laboratory evaluation. Although the pilot plant had been in operation several weeks, this vessel had not been used but had been piped up. One week before this incident, the vessel was cleaned and during this cleaning operation, an operator discovered an open line on the pump discharge with a crows-foot connection on it. Rather than call in a pipefitter, the operator placed another crows-foot with a downstream valve on the tank crows foot and completed the cleaning operation. In the rush, maintenance was never scheduled to complete the job properly. The injured operator opened the valve downstream of the crows foot to take a sample, and in the process the connection parted. Some of the slurry sprayed into the operator's face, causing the chemical burns.

Cause: Improper installation of piping and the subsequent parting of the crows-foot connection.

Preventive Measures: Permanent piping was installed and the proper use of crows-foot connections was reviewed with both operators and supervisors.

Reference Number of this Incident: OI-41

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 42

Inhalation of Hydrogen Cyanide Fumes

Description: While working on a decontaminated HCN feed line to a reactor, an operator inadvertently opened a 1-inch bleeder on the HCN feed line to an adjacent operating reactor. The resulting spill caused the operator to lose consciousness a short time later. He was breathing when help reached him and amyl nitrite was administered. He was taken to the hospital and released after one hour with no after-effects from the cyanide. During the same incident, after the bleeder valve had been closed by a supervisor, a pipefitter who assisted the supervisor and then stayed to wash down the spill was also overcome by HCN. After being administered artificial respiration and amyl nitrite, he, too, was sent to the hospital and released with no after-effects.

Cause: The operator was overcome because of the combination of the following:

1. He opened the wrong valve without checking the valve line-up thoroughly.

2. He thought that the liquid was water and failed to recognize the exposure.

3. He was a relatively inexperienced operator and expected the cyanide to exhibit a more pronounced odor.

The pipefitter was overcome by taking too great a risk in the vicinity of the spill. Although familiar with HCN, he did not recognize that he was getting too much. He used a mouth mask part of the time, but it was not in place when he fell.

The design of the HCN feed system contributed to the incident since valves and lines to the various reactors were intermingled and confusing. However, both of the lines in this case were labeled within a foot of the bleeder lines and the "hot" bleeder was about 3 feet above the decontaminated bleeder.

Reference Number of this Incident: OI-42

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 43

Sulfuric Acid Spray

Description: The injured employee was instructing a new man for the first time to prepare samples of synthetic rubbers to determine their viscosity. He instructed the new co-worker to open a nitrogen needle valve on a compressed gas cylinder. Excessive nitrogen pressure blew the plastic tubing (from the sulfuric acid scrubber) off the glass connection to the sample bottle. The sample bottle was being heated in a hot oil bath (135°C). Cold concentrated sulfuric acid (5-10 ml.) and hot oil sprayed out onto the man's face, neck, abdomen, and hands burning him.

Cause:

1. An inadequate pressure regulator was used. (The type used is the standard valve used for small cylinders.)

2. Opening of the needle valve permitted the direct flow of nitrogen from the cylinder to the sulfuric acid scrubber. A smaller Hoke valve located in this line had not been closed.

3. A shield was not provided for the bath and scrubber apparatus.

Preventive Measures:

1. Proper regulating valves and pressure-reducing devices will be used to insure delivery of safe amounts of gas.

2. Shields will be provided to protect against splashing corrosive chemicals and equipment rupture.

3. Where corrosives are used for drying gases, other means will be considered to obtain dry gas wherever possible.

4. Laboratory supervision will increase their observation and instruction time during the period of increased hazard while a new man is being trained.

Reference Number of this Incident: OI-43

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 44

Acetaldehyde Vapor Ignition

Description: Suction to an acetaldehyde feed tank had been lost. To regain suction, it was necessary to bleed off the pump through the sample draw-off. A hose was attached to the draw-off and extended to a point outside the pumphouse. Acetaldehyde vapors traveled approximately twelve feet and were ignited spontaneously by the heat from a steam line in the pipeway.

Cause: This is a very infrequent operation. The vapors were ignited by the heat from the steam line.

Preventive Measures: All personnel at this unit are instructed to bleed this pump into a flume well removed from any source of ignition.

Reference Number of this Incident: OI-44

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 45

Chlorine Gas Inhalation

Description: A considerable amount of chlorine gas was generated and released in a work area by the overflow from a process filter and HCL acid entering a sewer at the same time. An operator wearing a small inadequate mask, inhaled a considerable amount of gas before he made a switch to a larger canister mask. He received first aid treatment and finished the shift. The following day he experienced some difficulty with his breathing and was advised to stay off work by his doctor.

Preventive Measures:

1. In the future, caustic will be added from the neutralizing tank during acid washing procedure.

2. Discharge lines from the filtrate receiver and the filter will be separated so that each tank is pumped separately to the decomposition area.

Reference Number of this Incident: OI-45

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 46

Chemical Spray

Description: An employee was pouring acetic acid into a catalyst pot which had previously been used for addition of KOH. Residual KOH reacted with the acetic acid, causing chemical to blow back through fill line and spray onto the employee's face, head and shoulders. Investigation revealed that the employee was wearing eye protection, but not the type prescribed for this operation. He received chemical burns to both eyes, face and shoulders.

Preventive Measures:

1. A separate location will be used for the addition of acetic acid (treatment tank) to prevent mixing of KOH with acetic acid.

2. Safety rules pertaining to the handling of chemicals will be strictly forced.

Reference Number of this Incident: OI-46

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 47

Caustic Spray

Description: An employee was loading a tank car with 50% caustic. There was a surge on the filling line as the pump was started, causing the filling line to come out of the tank car dome opening. Caustic under pressure sprayed in every direction, striking the employee in the face and on the body. He received alkali burns in the mouth, eyes, on both ankles and on the left leg.

Cause: Investigation revealed the following:

1. A center loading car was positioned under the loading station used for offset cars only.

2. The car was poorly positioned causing hose cramp in filling line.

3. The tie chain used for fastening the filling line in position was improperly attached to car.

Preventive Measures:

1. Immediate action was taken to replace the flexible hose with a section of steel reinforced hard suction hose.

2. Operating instructions were reviewed with all operators and positive position provided for loading line.

3. Loading station to be redesigned in such a manner as to eliminate problem of off-center and center loading car.

Reference Number of this Incident: OI-47

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 48

Acid Spray

Description: Truck driver was preparing to connect a sulfuric acid tank truck discharge pipe line to a customer's receiving pipe line. The driver pulled the receiving line, which was in a raised position, down to connect it to the truck discharge line. As he pulled the pipe down, residual acid which was still in the raised pipe spilled on the employee's right foot. The employee washed the acid from his foot, applied his own first-aid, but refused outside medical treatment. He completed his delivery and returned to the plant that evening. Two days later the employee had to be hospitalized for further treatment.

Cause:

1. Failure of another driver, who had left the receiving pipe line in a raised position, to make sure the pipe was drained before leaving the premises.

2. Failure of injured driver to inspect the pipe to make sure it was clear before attempting to make his connection. (If he had been wearing proper footwear, such as rubber booties or overshoes, the injury might have been minimized.)

Preventive Measures:

1. Employees have been reinstructed on the need for caution when handling acid pipe lines, including making sure lines have been properly drained in accordance with motor vehicle safety precautions.

2. The importance of wearing prescribed personal protective equipment when working with corrosive material and receiving immediate medical attention was stressed with all truck drivers.

Reference Number of this Incident: OI-48

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 49

Ammonia Spray

Description: A field representative was training a new agent how to load out ammonia from the storage tank to the field tank. The hose he was using was stiff and easily twisted. As the field representative attempted to straighten out the hose, it slipped in his hand and the valve struck his face causing the valve to open slightly. A small amount of liquid and vapor ejected from the open valve and struck the employee's face. His injuries consisted of irritation to both eyes, burned mouth, face, neck, shoulders and partial chest.

Cause: It was determined that the accident resulted from failure to remove the vapor and liquid ammonia after previous use. In addition, the handle on the valve had not been sufficiently tightened.

Preventive Measures:

1. Additional training and safety meetings will be held to emphasize this subject.

2. Employees have been instructed to see that all valves are tightly closed when not in use.

3. The supervisor will constantly check to see that protective equipment is worn and every safety precaution observed.

Reference Number of this Incident: OI-49

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 50

Sulfur Tank Car Spray

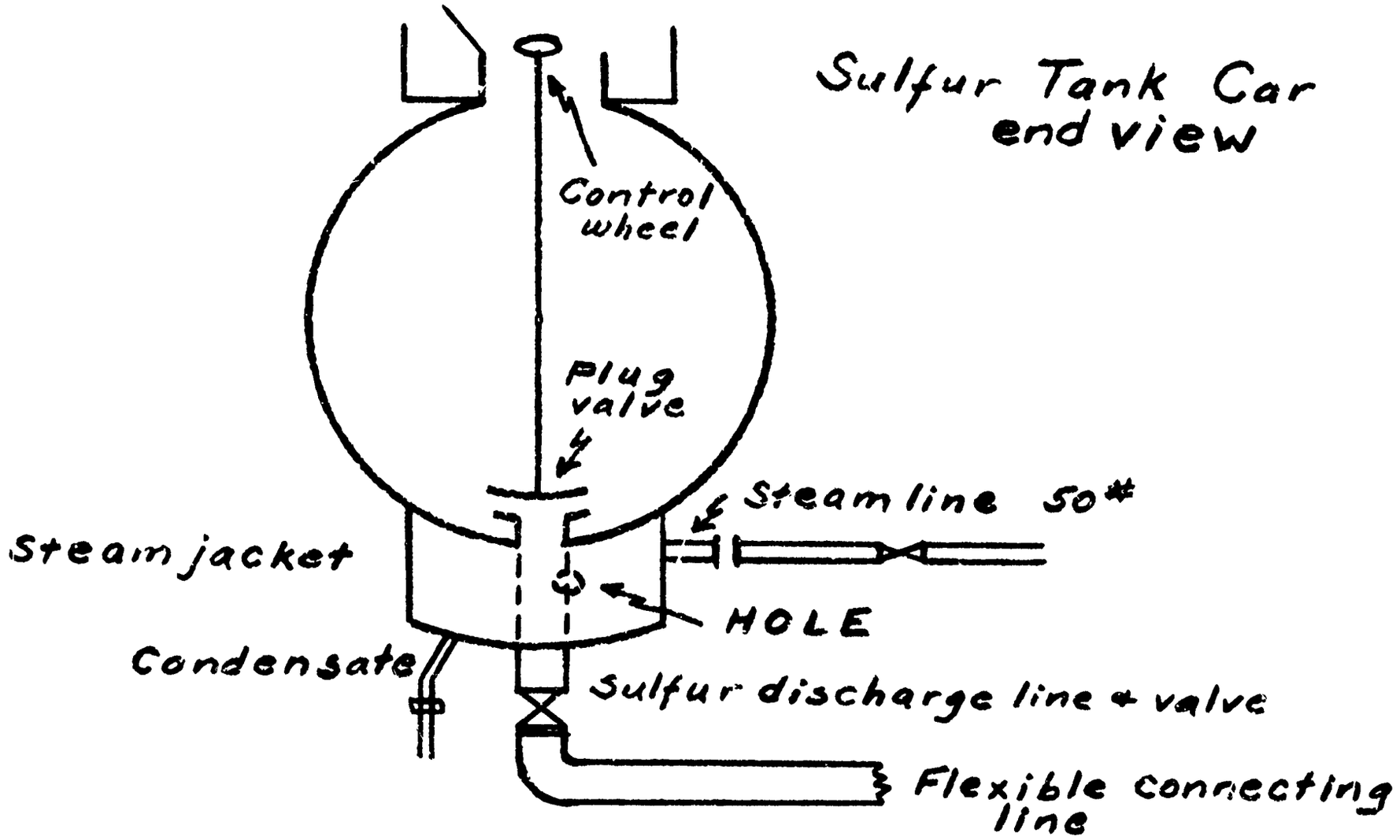
Description: Maintenance men were preparing to unload a tank car of sulfur when an incident occurred that could have been very serious. They made a steam hookup to the steam jacket in order to free the discharge line of any plug. The discharge valve was opened and this line was drained. After draining, the discharge valve was closed. They then connected the flexible connecting line to the discharge valve. Steam was still on and now ready to open the plug valve. Upon opening the plug valve, hot sulfur (130°C) and steam blew up through tank car opening, spraying catwalk area and running down the tank car. The man on the top and men below miraculously escaped injury.

Cause: A hole had developed in the discharge line inside the steam jacket and when the plug valve was opened, live steam and sulfur was forced out of the top.

Preventive Measures: In all future unloadings, after the discharge line has been cleared, the steam will be shut off. The discharge valve will also be opened before the plug valve is opened. The vendor has been notified of the bad discharge line and the job procedure has been rewritten to insure the safety of the men.

Reference Number of this Incident: OI-50

Duplication of this report is authorized.


Sulfur Tank Car
end view
Control
wheel
Plug
valve
Steam line 50#
Steam jacket
HOLE
Condensate
Sulfur discharge line + valve
Flexible connecting
line

OI-50

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. OI-57

Hydrogen Sulfide Cylinder Leak

Description: Hydrogen sulfide leaking from a cylinder caused two minor injuries. It was necessary to apply warm water to a H_2S cylinder to increase gas flow to a reactor. The cylinder was located on the third floor of an operating building. The valve and flow regulator assembly were under a canvas hood supplied with exhaust ventilation. At the time of the incident, the operator was wearing an air mask, as prescribed, while switching cylinders. After hooking up lines to a fresh cylinder, he tied the water hose to the top of the cylinder, walked to the steam-water mixer, and turned on the cold water. He heard a hissing sound, turned off the water and returned to the cylinder to check. He stated he smelled H_2S through his mask and ran from the area. When the end of the air line was reached, about 30 feet away, he tore off the mask and continued running towards the exit. He became dizzy and fell against a building column, lacerating his ear. He regained his senses quickly and left the floor safely via the center stairway. When the supervisor was contacted, he called an ambulance for the injured operator, took another operator with him and went to the third floor via the same stairway. When he opened the door the gas odor was very strong. He ran across the floor to where he saw an air mask lying on a drum and put it on, but the air supply had been turned off. He removed the mask and then ran to the platform to turn on the air, began to feel dizzy, turned to the south stairwell and pushed open the window to get fresh air. He fainted momentarily and fell, striking his head on the concrete landing and lacerating his forehead. He recovered quickly and was assisted down the stairs to the ambulance by other men. The gas cylinder was then carried to an adjacent roof by men wearing self-contained air masks. With technical assistance, the operation was shut down properly and all personnel accounted for.

Cause: Investigation revealed that the fusible plug had begun to melt, possibly because the initial surge of water to the cylinder was hot. The plug melts at 160-165°F. The very hot water may have been due to a leaky or partially open steam valve at the mixer heating the residual water in the hose used for the cylinder. The H_2S cylinders have a gold-plated rupture disc in contact with the cylinder interior, followed by the fusible plug. This rupture disc was found to be broken and the manufacturer's representative felt it may have been broken before this incident occurred. It the rupture disc had been intact, the gas could not have leaked out. The leak became very small once the remainder of the fusible element reharденed and the cylinder did not offer any further problems when it was permitted to empty on the roof.

Preventive Measures:

1. Supervisors and operators are being reinstructed on the need for obtaining emergency respiratory protection before entering contaminated areas.

2. A totally enclosed, ventilated, container will be built to house two H_2S cylinders, capable of handling all the H_2S which could flow from a cylinder.

3. A water collar ring will be used for the hot water which will prevent getting water or steam on the cylinder valve assembly containing the safety devices.

4. A "Strahman" type steam-water mixer will be provided that does not permit flow of steam until there is a flow of water.

Reference Number of this Incident: OI-51

Duplication of this report is authorized.

[illegible]
Washington, D. C. 20315

Operational Incident Report No. 52

Chemical Spray

Description: This accident occurred in the salt removal portion of the hydrazine production plant. The specific equipment involved was an 8-inch sight glass in the line from the slurry thickener to the mother liquor tank. There had been repeated instances of the 8-inch pyrex view plate cracking due to the difficulty in adjusting the four bolts on the glass support ring. There was also a tendency for the slightly alkaline mother liquor to etch the back of the glass making viewing difficult. Approximately 45 days before the accident, a piece of 4-inch plexiglass was substituted for the 3/4-inch eight-inch diameter pyrex glass. It was found that the plastic would not crack and was not affected chemically by the solution. Since this system normally operates under little or no pressure at this point, it was felt that the substitution was justified. On the day of the accident, the line below the sight glass became blocked with salt as it had in the past. The sight glass became filled with liquor and the overflow from the thickener was stopped. The employee, believing that the line was under vacuum rather than pressure, attempted to vent the line by loosening the two top bolts of the sight glass support ring. As soon as the ring was loosened, the plastic which heated beyond its softening point, pulled from beneath the flange and then broke. The hot liquor sprayed forcefully onto the employee's face and body, resulting in first, second, and third degree burns to approximately 20% of body surface including face, and burns to cornea of both eyes.

Cause: Three basic items were involved which contributed to or caused this accident.

1. Poor judgment on the part of supervision to substitute material in the salt removal system which could not tolerate the 255°F liquor temperature.

2. Unsafe act on the part of the experienced foreman in making an adjustment to a process line while in operation.

3. The flaw in the process which would allow a portion of the system which would normally be at atmospheric pressure to become pressurized to an estimated 30 to 35 psig.

Preventive measures:

1. In order to eliminate the problem of vapor lock in this mother liquor line, a condenser had already been ordered and was due for delivery 5 days after the accident occurred. This unit will be installed and will eliminate such difficulty in the future.

2. The sight glass will be modified to reduce the viewing port to 6-inch which should eliminate the breaking problem experienced in the past. It is possible that a thick plexiglass plate will be used if tests indicate it can survive the designed capacity of the sight glass unit.

Reference Number of this Incident: 61-62

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 53

Fluorine Leak

Description: On Thursday, a new fluorine feed cylinder was installed in the aqueous fluorination system. The two pressure regulating valves in the line from the cylinder were closed and the main cylinder valve was then opened. A fluorine leak was detected and an attempt to close the main cylinder valve was made. However, it could not be closed tightly enough to stop the leak. The cylinder was left to leak down over the week-end, but the fluorine odor still persisted on Tuesday morning. The fluorine was disposed of Tuesday night by reopening the main valve and the pressure regulators (using a Scott Air Pak), metering the fluorine to the reactor hood in the usual manner, and exhausting to the atmosphere. Since the fluorine feed area was purposely located in an isolated area and the main valve remotely operated, there was no personnel exposure or curtailment of other operations in the building as a result of the incident.

Preventive Measures: As a precautionary measure, a leak test of the piping and fittings will be made in the future prior to opening the main cylinder valve.

Reference Number of this Incident: OI-53

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 54

Bromine Spray

Description: Mechanics started on necessary repairs to put the bromine system in a building back into service. The system had been shut down for several months, and it was necessary to replace gaskets, vent lines, valves, and thoroughly check out the system. Mechanics were closely observed while cutting into system by supervision, and everyone was made aware of hazards when handling bromine. Plastic gloves and gas masks were worn while initially cutting into lines. On the morning of the accident, two pipefitters were assigned to check out the piping system for blowing bromine from tank cars and to replace gaskets and necessary fittings and valves. As the system was already disconnected in several locations, gas masks were put aside. Shortly after lunch, they were replacing pressure-reducing valve and noticed ½-inch ell was loose. In order to tighten this ell, it was necessary (because of clearance from wall) to remove the needle valve. The injured started to remove this valve, loosening it very carefully. When the valve was nearly off, he wiggled it but seeing no evidence of any liquid or fumes coming from the connection, removed it. Immediately, a small portion of bromine trapped from top of needle valve to the ell spilled out, burning him on the forearm, wrist and hand and splashing over his clothing. Another fitter working nearby on vent system suffered a minor burn on his leg.

Cause:

1. Nitrogen pumping system was not considered a hazardous part of the system. (No bromine was supposed to be present at this point.)

2. Some items of protective equipment were not used after initial break-in.

3. Gloves worn on this job did not adequately protect hand and wrist.

4. Piping was installed so that natural pocket for material was formed.

5. There is no written procedure for shut-down of this system.

6. There is no positive method of completely purging system of bromine.

Preventive Measures:

1. Revise bromine piping so that ½-inch needle valve and regulating valve are above straight section. Revise nitrogen inlet section of piping

so that any liquid will drain east toward tank car.

2. Install flange covers on all lines which carry liquid bromine.

3. Specific written instructions for shutting down bromine system at the end of a run. Consider purging lines with nitrogen or some other inert medium.

4. When working on the bromine system, a Santosite-Soda ash (50/50 mixture) solution to be provided at all times to neutralize any spills in the area. Water in copius quantities should be readily available for skin contact.

5. Minimum protective equipment when working on any part of the bromine system is: gas mask, rubber gloves (shoulder length), and rubber suit. A full rubber suit and an air hood with an outside air supply is strongly advised, when blockages occur and pressure cannot be released. The bromine piping is considered to be the entire system, from the nitrogen cylinder - to the tank car - to the reactor - to the caustic scrubber - to the atmospheric vent.

6. All department supervision review the protective equipment requirements for similar hazards in their respective operations.

7. All maintenance supervisors and foremen re-emphasize the fact that hazardous systems are still hazardious even after initial break-in, and safety precautions should not be relaxed at any time.

8. All departments review this accident at the next safety meeting.

Reference Number of this Incident: OI-54

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 55

Ammonia Cylinder Rupture

Description: Rupture of an ammonia cylinder resulted in moderate injury to one man and relatively light damage. It was accepted procedure to fill a 2-liter cylinder from large ammonia cylinders by placing it in a bath of dry ice and acetone. This was done a few hours before the rupture and it was stated that the correct weight of 1 kg was charged. The cylinder lay in the walk-in hood of a production laboratory and no one was working in the hood when the steel failed with a clean split up the entire length of the cylinder. A bottle containing PCl_3 and one containing chlorosulfonic acid (both stored in the hood) broke. A thick cloud of fumes resulted. Two members of the fire brigade, wearing air masks, determined that there was no fire and it was decided to spray water on the floor to neutralise the reaction. As soon as this was started, another explosion occurred and a small fire resulted which was quickly extinguished. The sprinklers in the hood were operating from the time of the cylinder rupture. The second explosion was caused by exposing approximately 520 grams of sodium which was stored in a bottle in the hood, to the water spray. The injured was a technician who was working next to the hood. He suffered burns of the feet and a hand and was put under a safety shower as soon as possible. Damage was limited primarily to the hood interior.

Cause: In discussions with gas cylinder suppliers, they felt that subjecting the steel to acetone-dry ice temperatures of -70°C would cause it to become brittle and fail under nominal pressures. The cylinder was tested two years ago at 225 atmospheres.

Preventive Measures:

1. Alternative approved methods are available for cylinder filling.
2. Storage of chemicals in a working hood should be banned.

Reference Number of this Incident: OI-55

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 56

Chlorine Gas Inhalation

Description: An employee was engaged in charging chlorine cylinders. This involves the connecting of a full 1-ton cylinder to the distribution system, and disconnecting the empty cylinder. Present practice has been to have canister type gas masks at the job location, but not to wear them. In this case, the gas masks were present, but were not being worn. The chlorine cylinder station is located outside. The employee, who had performed this job many times, had checked the isolating valve to see that it was closed tight and then proceeded to remove the 3/4-inch steel pipe plug from the free end of a 3-foot length of 5/16-inch copper tubing. When the plug became loose, a quantity of chlorine gas was released and inhaled by the employee.

Cause: Investigation revealed that a procedure was written several years ago that required the wearing of a gas mask while performing this operation, but the shortcut of having it present but not wearing it has been substituted.

Preventive Measures: The procedure will be reviewed with supervision and a gas mask will be worn by persons performing this operation.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-56

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 57

Acid Spray

Description: An employee was heating a cast iron acid line containing 99% sulfuric acid to thaw the line. While trying to establish flow by heating the line, the acid sprayed out from a crack in the line into the employee's face. The employee's injuries consisted of second-degree acid burns about the face and hairline, neck, and forehead. In addition, he sustained severe corneal burns to both eyes.

Cause: Investigation revealed that the cast iron pipe cracked from heating the line. The employee was wearing safety glasses but should have been wearing safety goggles or a face shield.

Preventive Measures: Acid line will be steam traced and insulated to prevent freezing. Employees have been instructed in the use of protective clothing, face shields and safety goggles.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-57

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 51

Ammonia Inhalation

Description: Employees were starting up a granulation operation after a 4-hour shutdown. They were in the plant control room. As the granulator started rotating, liquid ammonia, which had leaked past the closed valves, vaporized rapidly, overtaxed the fume collecting system and billowed out. The doors at the discharge end of the granulator were open for observation, and the ammonia vapors flowed out and into the control room just as the employees were leaving to inspect the granulator product exit. The employees were forced to retreat and leave the room through an exit behind the control panel, which exposed them again to heavy ammonia concentrations. One employee was hospitalized.

Cause: Ammonia which leaked past two closed manual block valves, and a closed automatic control valve, did not vaporize because it was trapped by crusted material or because the sparger nozzles were plugged. Also, the granulator fume collection duct and the duct entering the primary scrubber were partially blocked. (NOTE: The vapors discharged so rapidly, employees did not have time to don protective masks and leave the control room which is in direct line with the granulator discharge. The door in front made it necessary for the employees to exit from the room via a door behind the control panel which opens alongside the granulator.)

Preventive Measures:

1. The leaking control valve has been repaired and the two block valves are being replaced.

2. The granulator fume system will be cleaned regularly and the plant will not be operated unless there is sufficient draft on the fume collection system. Also, a spray has been installed in the duct entering the primary scrubber to prevent blockage at this point.

3. A door is being installed at one end of the control room to provide another emergency exit.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-58

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 59

Corrosive Liquid Spray

Description: An operator was pumping DMF with a portable pump from a 55-gallon drum into a stripper bottoms pump suction. Since the distance between the pumps was only three or four feet, the 50-foot rubber hose which was used was rather tightly coiled and apparently kinked. After pumping the contents of the drum, the operator closed the valves at the pumps and opened the bleeder to depressure the hose. After observing that the DMF had stopped draining from the bleeder, the operator then attempted to disconnect the hose from the stripper bottoms pump suction. As he did so, DMF sprayed from the connection onto his face, clothes and shoes. He immediately went to an eye bath located thirty feet away and washed out his eyes. He then returned to the control room, reported the incident to his supervisor, and went to the dispensary. He was then referred to a physician, and his eyes were found to be only irritated and no permanent damage was incurred.

Cause: The probable cause was that the hose was kinked and did not allow the pressure to be completely bled off prior to the hose being disconnected.

Preventive Measures: Metal "Flexitallic" hose with hammered type unions will be standard equipment in the ethylene plant for the portable transfer of all fluids except water. This replaces the common rubber hose and crows-foot connectors.

Reference Number of this Incident: L-98

Duplication of this report is authorized.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 60

Sulfuric Acid Splash

Description: An employee received burns on the face, arm and back when a 1-inch ID glass pipe containing sulfuric acid broke. Two field department mechanics had completed repairs to a diaphragm valve located in a glass pipe line that was located overhead. They were wearing protective coats and overalls although they were not wearing head or face protection. When repairs to the valve were completed, the injured employee was requested to check the operation of the valve to make sure it operated in a satisfactory manner. When this was done the two mechanics began replacing a large "L"-shaped stainless steel guard over the glass pipe that protected it from physical damage. The two legs of the guard measured approximately 5 feet and 8 feet respectively. Due to the unwieldyness of the guard, the mechanics asked the injured employee to assist them in replacing it even though he was not wearing protective clothing. In their attempt to replace the guard, the glass pipe was apparently struck. It broke off at a reducing nipple where it was connected to the valve. One of the mechanics and the injured employee were splashed with approximately ½-gallon of concentrated sulfuric acid. The protective clothing saved the mechanic from injury, but the man from the operating department who was wearing only a skivy shirt suffered the injuries noted above. Although a safety shower and a hose were within 8 feet of the injured employee, he apparently became confused and ran approximately 80 feet from the scene of the injury to a location where he knew that a hose was available.

Preventive Measures:

1. No person should be allowed to work on or about the existing glass pipe without the guard in place unless the line is drained.

2. It is recommended that glass-lined iron pipe be installed in place of the existing glass pipe.

3. All persons working on acid lines should be equipped with proper protective clothing designed to protect the head, eyes and body.

Reference Number of this Incident: L-99

Duplication of this report is authorized.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 61

Chemical Exposure

Description: The demand for breathing-air exceeded supply in cylinder and resulted in chemical exposure. A supervisor noticed acid fumes in the area of an outdoor storage tank containing dilute Ethanolic HCl. He donned a 5-minute self-contained breathing apparatus and upon investigation determined that the material was flowing onto the ground from the broken glass bottom outlet line. The air supply became depleted and he inhaled some of the fumes. He obtained a larger unit and succeeded in closing the bottom valve with a wrench. He felt dizzy and reported to Plant Health along with two operators who were exposed to the fumes. No one was seriously injured but several lessons can be learned from this incident.

Cause: The glass line was rigidly fastened to the pump and probably broke due to stresses transmitted by the corrosion of the pump fittings.

Preventive Measures:

1. An armored pyrex expansion joint in the line would have reduced leakage.

2. Operating personnel have been instructed that all vessel bottom outlet valves must remain closed when not in use.

3. Five-minute air cylinders are acceptable for quick rescue work. Larger sized cylinders with low pressure alarms should be available for all other emergencies.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-61

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 62

Acid Spray

Description: Eruption from a sulfuric acid line did not cause serious injury but revealed a dangerous condition. About 75 feet of 1½-inch carbon steel line ran from a second-floor concentrated sulfuric acid tank to a first-floor receiver. The valve below the acid tank and the valve in the line above the receiver were both closed for approximately a month. When an operator opened the valve at the receiver, pressure in the line blew out a gasket on a porcelain section between the receiver and the valve on the carbon steel line. The acid and precipitated ferric sulfate, which evidently plugged the 1-inch nozzle into the receiver, sprayed out over a wide area and on to the operator. The injured man quickly got under a shower and removed his clothes. He received a second-degree burn on his left forearm. His clothes were literally destroyed.

Cause: This is a graphic illustration of what can happen when a section of pipe containing a corrosive material is isolated. The hydrogen generated by the action of the acid on the steel must have developed high pressures.

Preventive Measures: To prevent a recurrence, all areas in the plant will survey their sulfuric acid systems for seldom-used or abandoned lines and take proper steps to prevent this type of occurrence. Dry vents will be installed on sulfuric acid tanks to prevent introducing moisture into storage tanks, which accelerates pipe corrosion. Mechanically interlocked cocks to drain and vent seldom-used lines containing corrosives should be considered.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-62

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 63

Ammonia Vapor Spray

Description: After loading another tank car, an employee passed by the compressor being used to unload an ammonia tank car and noticed a pressure reading of 190 pounds. He concluded that the excess-flow check valves in the tank car liquid unloading line were closed and followed the accepted practice in this situation of stopping the compressor. He then went to the top of the tank car to close the valves in the tank car liquid unloading line. He closed one, leaned over the relief valve to reach the other and had it almost closed when the relief valve (set at 225 pounds) opened. Later it was indicated the valve opened at 210 pounds. The "blow" lasted only five to eight seconds but discharged ammonia vapor into the employee's face and into his mouth. Chemical goggles undoubtedly saved his eyes from injury.

Cause: Failure of supervision to establish safe operating procedures.

Preventive Measures: Operating procedures have been changed to install valves at platform level and close these before closing those on top of the tank. In addition, a breathing-air system will be installed for the employees' use during the short time nearness to the tank car relief valve is necessary.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-63

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 64

Hydrogen Peroxide Spray

Description: An employee had disconnected the pipe between the 70% hydrogen peroxide pump and the tank trailer filling station at bulk terminal in preparation for hooking up and unloading a tank trailer due to arrive. The line was broken above a closed valve at the discharge of the pump but was not locked out. Because some hydrogen peroxide was running down over the pump, the employee opened the valve, inserted a water hose, and washed out the discharge side of the pump. He failed to close the valve. When it was decided about two hours later to reconnect the broken line to load a tank trailer, the employee stood on the dike wall and was in the process of lining up a pipe flange, gasket, and valve flange above the pump when his foot struck the butterfly switch, starting the pump and discharging the pump's contents into his face with such force and at such an angle as to dislodge his goggles. Hydrogen peroxide splashed under his goggles and into his eyes. Fortunately, he was able to prevent very serious burns by immediately washing his eyes for 15 minutes under a nearby shower and then for 5 minutes with a water hose.

Cause: Failure to de-energize pump.

Preventive Measures: Additional training is planned and the importance of strict adherence to lock out and tagging procedures is being re-emphasized.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-64

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 65

Sulfuric Acid Splash

Description: The circumstances leading up to the injury were as follows: Normal procedures call for drawing a sulfuric acid sample every 2 hours from a sample point at the suction lines (5 psi) of the P-5 pumps to test the strength of the acid to the HCL drying column. These sample points were not enclosed in sample boxes. On June 30 pump No. P-5A developed a leak around the packing and since it was felt unsafe to pull up further on the packing, pump No. P-5 was put in service at noon. The injured operator reported to the supervisor soon afterward that the valve on the sample point at P-5 was very difficult to open and close and he was unable to use it for taking his samples. The supervisor informed him that the next day, July 1, they would put P-5A in service long enough to replace the faulty valve on P-5. For the remainder of that day the subject drew his sample from a $\frac{1}{2}$" bleed valve on the discharge line (50 psi) of the pump downstream of the acid cooler. Other extenuating circumstances were that the suction valve on P-5A (bad packing) leaked through to such an extent that it could not be isolated and repaired until the drying system was shut down and drained. At 11:00 AM on July 1, the injured employee prepared to draw the sulfuric sample, and rather than use the $\frac{1}{2}$" bleed valve downstream of the acid cooler he had used previously, looked about and decided to use a new recently-installed 1" block valve on the suction line to the pump near the drying column. This line is approximately 6'6" above grade with the discharge of the valve at or near face height, depending on the height of the individual. This was not and had not been a sample point, but was in the line for draining purpose. The shift supervisor was unaware of the operator's intent to use this valve, and the operator was unsure why he chose this spot for sampling rather than use the one at the cooler. Prior to his attempt to take the sample, he had placed the graduate below the drain valve and was cautiously opening the valve when he was splashed and sprayed with acid about the face, neck, chest, and arms. The supervisor later discovered material in the graduate that indicated saddles from the tower had evidently plugged the valve and when the valve had been opened far enough, had broken loose with a gush, struck the bottom of the graduate, and deflected back onto the injured's face and upper body. After the accident, the subject was able to make it to the safety shower approximately 10 feet away and with the immediate assistance of an operator who happened to be nearby, started to flush the affected area with water. The supervisor and operator displayed excellent judgment and kept the injured man under the shower for 15-20 minutes after which he was taken to the hospital, by ambulance, for medical attention. The employee sustained second degree and possible third degree burns to the lower face and neck with first and possible second degree burns to upper chest and right arm. Chemical goggles unquestionably saved the man from very serious injury or loss of both eyes.

Cause: Investigation determined the accident causes to be:

1. Use of improper sample point at an unsafe location. Corrosive sample should never be drawn above waist height.

2. Plugged valve.

3. Poor judgment in opening valve above safe limits due to plugging.

4. Inadequate protective equipment for hazard involved.

Preventive Measures:

1. That a permanent order be issued for sampling corrosive materials, with sample stations conforming to a uniform specification throughout the plant.

a. Sample stations be provided with a minimum 1-inch line and valve back welded or flanged.

b. All sample lines have double block valves installed.

c. Sample lines be enclosed in lead box with observation window on one side.

d. Sample boxes installed below waist height and stations clearly marked.

e. Sample points be inspected weekly for corrosion or cracks.

f. Sample will not be taken at any location other than designated location without the approval and direct observation of the supervisor.

g. Acid hood, rubber coat, and rubber gloves be required for normal sampling.

h. Acid hood, rubber coat, pants, gloves, and boots will be required for sample at any location other than normal sample point and when depressuring or bleeding equipment in corrosive service.

2. Plugged lines, proper procedure for opening valves, and the associated hazards will be discussed with the man when he returns to work.

3. The faulty sample valve on the P-5 suction line has been repaired.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: C--65

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 66

Chemical Spray

Description: This accident occurred in the salt removal portion of the hydrazine production plant. The specific equipment involved was an 8-inch sight glass in the line from the slurry thickener to the mother liquor tank. There had been repeated instances of the 8-inch pyrex view plate cracking due to the difficulty in adjusting the four bolts on the glass support ring. There was also a tendency for the highly alkaline mother liquor to etch the back of the glass making viewing difficult. Approximately 45 days before the accident, a piece of ¼-inch plexiglass was substituted for the 3/4-inch eight-inch diameter pyrex glass. It was found that the plastic would not crack and was not affected chemically by the solution. Since this system normally operates under little or no pressure at this point, it was felt that the substitution was justified. On the day of the accident, the line below the sight glass became filled with liquor and the overflow from the thickener was stopped. The employee, believing that the line was under vacuum rather than pressure, attempted to vent the line by loosening the two top bolts of the sight glass support ring. As soon as the ring was loosened, the plastic which heated beyond its softening point, pulled from beneath the flange and then broke. The hot liquor sprayed forcefully onto the employee's face and body, resulting in first, second, and third degree burns to approximately 20% of body surface including face, and burns to cornea of both eyes.

Cause: Three basic things were involved which contributed to or caused this accident.

1. Use of material in the salt removal system which could not tolerate the 255°F liquor temperature.

2. Unsafe act on the part of the experienced foreman in making an adjustment to a process line while in operation.

3. The flaw in the process which would allow a portion of the system which would normally be at atmospheric pressure to become pressurized to an estimated 30 to 35 psig.

Preventive Measures:

1. In order to eliminate the problem of vapor lock in this mother liquor line, a condenser had already been ordered and was due for delivery 5 days after the accident occurred. This unit will be installed and will eliminate such difficulty in the future.

2. The sight glass will be modified to reduce the view port to 5-inch which should eliminate the breaking problem experienced in the past. It is possible that a thick plexiglass plate will be used if tests indicate it can survive the designed capacity of the sight glass unit.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-66

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 67

Sulfuric Acid Spray

Description: The shift foreman and the injured employee attempted to fill two containers with sulfuric acid drawn from a filter drain in a chlorine dioxide plant. The sulfuric acid was needed for a water treatment plant because the steam and recovery unit was inoperative. When the drain was opened, the rubber hose ruptured. The injured was sprayed with sulfuric acid, suffering burns of the face and neck. Safety glasses protected his eyes.

Cause: Action of the acid on the lining of the rubber hose caused the hose to collapse and form a blockage. When pressure was applied the hose ruptured at the point of blockage.

Preventive Measures: The hose was removed and replaced with a permanent drain line to the sewer. All workers have again been instructed to wear proper protective clothing when handling or working with acids. This will include full face shield, rubber gloves and rubber clothing.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-67

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 68

Liquid Hydrogen Turbopump Rupture

Description: During test of a gaseous hydrogen-driven turbine (used for operating a liquid hydrogen turbopump), gas pressure suddenly increased to approximately 1500 psi, causing the turbine casing to rupture and turbine disc segment ejection in the plane of the turbine rotation.

The accident is of interest primarily because of what did NOT happen. Test conditions involved anticipated flow rates up to 30 pounds of hydrogen per second -- rapidly enough to generate potentially over 150,000 cubic feet of explosive gas (when mixed with air) per second. The area in which the test work was conducted was maintained under inert gas atmosphere so that, following hydrogen release during the accident, adequate air was present to permit forming explosive mixtures. Further, immediately following the rupture, a variety of automatic safety controls functioned to terminate rapidly further hydrogen release, while other safety devices functioned to introduce an inert gas purge, preventing possible airflow into lines that had been used to handle the liquid hydrogen. Personnel performing test control activities utilize remote controls to permit conducting their work at a safe location, again a reflection of pre-planning and hazard evaluation.

Reference Number of this Incident: OI-68

Duplication of this report is authorized.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 69

Tank Collapse

Description: A two-compartment trailer connected to a tractor and operated by a common carrier was delivering acetic acid to a plant. After the truck had been connected for unloading, the truck driver opened the top manhead on each of the two compartments. These were propped open by resting them on one or more of the lugs that are used to fasten the manheads closed.

Pumping of the acetic acid was started by one of the operators. After the pumping was started, the operator climbed to the top of the trailer to obtain a routine sample from the forward compartment. To obtain the sample, he had to lift the manhead from the supporting lugs and open it wide. After the sample had been obtained, the manhead was reclosed. A few seconds after the manhead was closed the tank imploded.

After the tank collapsed the driver immediately closed the outlet valve on the bottom of the compartment. He then went to the top of the trailer and found the manhead cover on the forward compartment closed and held tightly by the vacuum. It appears that the operator, after getting his sample, let the manhead go completely closed instead of leaving it partially open.

Cause: The tank on this trailer was equipped with a spring loaded vacuum breaker on each compartment. Apparently this vacuum breaker failed to open or was sized too small.

Reference Number of this Incident: OI-69

Duplication of this report is authorized.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 70

Chemical Spray

Description: Injured had completed a reaction involving fluorinated alcohol and phosphorous pentachloride and had distilled off the product. The residue (about 500 ML) was poured into a one liter flask, which was about 2/3 full of crushed ice, to decompose the by-product (phosphorous oxychloride) of the reaction. He stopped stirring the solution for about 30 seconds, to obtain additional ice and when he started to insert the stirring rod to continue stirring, a violent reaction occurred, throwing the solution on his head, face and eyes and right shoulder. Medical examination disclosed 1st and 2nd degree burns on the forehead and cheek and minor irritation to the eyes. Wearing of safety glasses prevented more serious damage to eyes.

Cause: The bumping would not have sprayed a broad area if a flask were not used because of its narrow neck. A large beaker of ice would have prevented the spray, however, shield will be used between worker and system of this nature in the future.

Reference Number of this Incident: OI-70

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 71

Laboratory Accident

Description: Employee had picked up a one-gallon glass bottle containing a solution of concentrated sulfuric acid and potassium dichromate from which she poured a small quantity to clean laboratory glassware. As she was replacing the bottle on the shelf, the bottom of the bottle fell out, and the acid solution splashed over the lower part of her legs.

Cause:

1. Failure of the glass container, possibly due to improper mixing of the solution.
2. Injury might have been avoided if the bottle of solution were stored and transported in a proper container.

Preventive Measures:

1. The bottle will be kept in a protective container while it is being transported or stored. It will be taken out of container only when the solution is being poured over the laboratory glassware.
2. Dilute, instead of concentrated sulfuric acid, will be used in the future.
3. The bottles used for acid cleaning solutions will be protective-coated on the lower section.

Reference Number of this Incident: 01-71

Publication of this report is authorized.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.).

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 72

Phthalic Anhydride Tank Overflow

Description: At approximately 12:15 a.m., a phthalic department operator started the pump to transfer crude phthalic from the M8A tank to the crude storage tank. Approximately 15 minutes later, the crude storage tank was observed to be overflowing. The chief operator and the operator immediately shut down the pump and closed the valve on the M8A tank.

After the flow of phthalic stopped, the chief operator returned to the control room to arrange for control and clean up of the spill. The operator promptly climbed the vertical ladder to the top of the crude storage tank. As he approached the gauge hatch on top of the tank, molten phthalic erupted from the gauge hatch and struck the operator, covering his left arm and chest and both legs from the waist down.

The injured operator descended the 24' vertical ladder himself and proceeded to the first aid room, advising the boiler operator to notify the chief operator of what had happened.

Following first aid treatment, the injured was transferred to the hospital where he was released after treatment in the emergency room.

Cause: The cause of the crude hold tank running over was improper procedure on the part of the injured employee, who did not gauge the tank outage prior to pumping into the tank.

The reason the injured employee climbed to the top of the tank which had just run over was evidently emotional to determine the extent of damage he had caused. He stated he had no reason to go on the tank, and it was not necessary from an operational standpoint.

Why the molten phthalic erupted from the gauge hatch after all pumping had ceased is not known for certain. It is believed that inert gas purge line on the tank became plugged due to liquid phthalic entering it due to the high level. This could have caused the inert gas pressure to build to 60 psig. If the pluggage in the line was then suddenly released, 1 - 2 cu. ft. of gas would have been released below the liquid level near the gauge hatch, causing the liquid to erupt through the hatch.

The level indicator on the crude storage tank was not working properly but did not contribute to the accident since procedures call for the tank to be gauged.

Preventive Measures:

1. All employees to be reinstructed to avoid unnecessary exposure to hazards such as in this case. Case to be reviewed with all employees.

2. All operating procedures on transferring of materials be reviewed and revised where necessary by department supervision. Procedures then to be reviewed with all operating personnel.

3. a. All departments to review performance of tank level indicators and

b. Maintenance to investigate means of improving reliability of the level gauge on the crude tank.

4. Expedite completion of a secondary escape platform from the top of the crude tank. (This was partially completed when the accident occurred. It would not have prevented injury in this particular case, but may be of value in the future.)

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-72

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 73

Accidental Firing of Rocket

Description: An operation consisting of unpacking, continuity testing, and repacking 3.5 inch Practice Rockets was in progress. A test barricade, constructed of three sheets of 3/8 inch steel plate (bolted together), was located within the bay. Within the barricade was a holding fixture for the rockets to be tested. An Alinco Tester, 101-5A, was located outside the test barricade. A conductive floor mat was in place at the rocket holding device within the test barricade.

An operator removed one rocket at a time from the unpack table and hand carried it to the test fixture. He then placed the rocket in the holding fixture. One test lead was connected to the contact band of rocket, and the other test lead to the unpainted tail groove. The shorting clip was removed from the rocket. The operator returned to the outside of the barricade to continue the test.

At the Alinco Tester, the lead wires from the barricade were shorted by using a clip. One lead wire was removed from the shorting clip and connected to the tester. When the other lead wire was being removed and while the operator was in the process of connecting it to the tester the rocket fired. The holding fixture failed. The rocket struck the ceiling and broke up.

Prior to the incident thirty-eight (38) rockets had been tested. The temperature in the bay was approximately 65°F and the humidity was about 30 per cent.

Cause: The concensus of opinion is that during the connection of the test lead wires, a static charge from the operator caused the rocket to fire. The individual operating the tester was not wearing conductive sole shoes, thereby providing no bleed-off of static electricity.

Preventive Measures:

1. The test fixture will be modified to provide an air vise for holding rockets.
2. A conductive ground mat will be provided for the operator performing the test.
3. The tester case will also be grounded and will be provided with a positive locking key. The operator placing the rocket in the test fixture will control the locking key.
4. The standing operating procedure will be revised accordingly.

Reference Number of this Incident: CI-73

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 74

Plastic Tubing Rupture Releases SO_2

Description: Two laboratory employees were injured recently when a length of plastic tubing ruptured and sprayed the men about the face with corrosive sulfur dioxide.

This accident resulted in some temporary eye and lung damage. One employee was hospitalized for three days; the other was taken to a hospital for overnight observation. The latter employee had been wearing safety glasses, which undoubtedly saved his eyes from more serious injury. Two other employees in the area at the time inhaled enough SO_2 fumes to require local treatment.

This incident took place during the testing of a gas scrubber system. Sulfur dioxide was being introduced into the system as a contaminant gas through a $\frac{1}{2}$" plastic tube. The rupture occurred while the employees manipulated valves between the SO_2 cylinder and the vaporizer. Maximum pressure on the system at the time of the accident was approximately 35 p.s.i. (the vapor pressure of SO_2 at room temperature). The action of SO_2 on the plastic tubing apparently weakened it and resulted in the rupture.

Cause: Although fresh plastic tubing (of the type involved) will withstand pressures up to 100 p.s.i., it is not considered an adequate material for pressure systems. Such tubing may be weakened by a variety of chemicals and physical conditions. This weakening is unpredictable and may result in a rupture at low pressures.

The accident described above is typical of a number that have occurred recently in AEC activities and in other industrial or laboratory operations outside of the Commission.

This problem has become more prominent with the growing misuse of plastic and glass for moving hazardous liquids, solids and gases from one place to another either by gravity flow or under pressure.

Another facet of the problem concerns the method of fastening and couplings used in attaching tubing or piping to vessels, cylinders, or apparatus. Too frequently the tubing is slipped onto a nozzle without any fastenings or couplings, and sometimes couplings are of a type that can work loose and separate. These conditions also set the stage for an unplanned release of a hazardous material.

Plastic tubing is manufactured from a wide variety of different compounds and is resistant to chemical and temperature effects in varying degrees. Most have one common weakness--they soften and/or melt at elevated temperatures and some will burn when subject to flame. The weakness of glass tubing and piping is that it will fracture when subjected to impact, unusual strain, or sudden extreme temperature change.

We do not wish to imply that such materials should never be used--but--these accidents suggest that, before they are used, a hazard review be made to determine the results of a possible failure and whether or not released material can be confined within an enclosure or system where it cannot cause injury, unplanned damage, fire, or explosion.

One of the most common hazards found in a number of laboratories is plastic and other types of tubing connected to the nozzle on a cylinder of highly toxic, flammable, or explosive gas without a clamp or with an inadequate device for securing the tubing to the nozzle. In the majority of such cases, the unsafe practice causes no trouble but, occasionally, a serious accident results when the tubing either slips off or is blown off, releasing the hazardous material.

Preventive Measures: Here are a few questions for determining whether an assembly of plastic or glass tubing might be safe to use:

1. Is the tubing part of an assembly to be used in an enclosure where a rupture will not affect personnel or cause a serious accident?
2. What are the temperature and pressure limits of the plastic or glass tubing to be used? If glass, what impact hazards prevail?
3. Is the tubing chemically compatible with the material to be run through it?
4. Is the proposed location for its use such that it could be pulled loose or broken by passing traffic (people, carts, etc.)?
5. Is it to be used on a bench or location where flames are also used?
6. Would it be safer to use metallic tubing?
7. Will the method of securing the tubing hold under conditions of pressure and/or temperatures available or anticipated?

These questions are just a few suggested by the accidents that have occurred.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-74

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 75

Explosion of Pyrotechnic Device

Description: At approximately 1330, February 2, 1965, while training operations on the test and handling of pyrotechnic devices were being conducted, an accidental explosion of one of the devices occurred. There were no personnel injuries.

The tests were being conducted to familiarize new employees of the prime contractor on the project, with procedures for testing and verifying the reliability of explosive devices used on the test vehicles.

The device being tested was a component of a vehicle destruct system, known as a Safe-Arm Unit. This unit, a cylindrical metal housing approximately 8 inches long, contained 2 electric-actuated squibs which, in practice, would initiate the firing of a shaped charge in the destruct system. The hardware, equipment, and recommended procedures had been approved for conducting the tests and were being used. The test hardware and equipment consisted of a vented, heavy steel box designed to contain the explosion of a device of this nature, a Safe-Arm Unit Test Box with cable harness required to connect it to the Safe-Arm Unit, a 28-volt DC power supply, an Alinco ignition tester, and a 500 volt megohmmeter.

Prior to the time of the accident, all safety procedures had been followed. The area warning lights were on and the gates closed. The heavy steel box containing the Safe-Arm Unit had been placed in the corridor of the terminal building. The connecting cable harness from the Safe-Arm Unit led through the door and to the Safe-Arm Unit Test Box in the terminal room. This Safe-Arm Unit Test Box is primarily a junction to feed the test voltage to the Safe-Arm Unit, and a test point to measure squib circuit resistance. It contains 6 external terminals; 2 on the side for connecting the power supply, and 4 on the top - 2 each for the squib circuit test points. All were female "banana jack" type of the same size, with each set labeled. The test had proceeded to the sequence which called for connecting the 28-volt DC power supply to the Safe-Arm Unit Test Box. An Instructor, handling the male "banana jack" terminations of the energized power supply leads, inserted them in the female squib resistance test connections on the top of the box instead of the power supply connections on the side. The explosion immediately occurred.

Cause: This accident was the direct result of inadvertently connecting the power supply to the wrong terminals on the test box, thereby impressing 28-volts DC across the squib leads. Inattention on the part of the operating personnel as well as poor terminal design on the Safe-Arm Unit Test Box were the contributing causes of the accident.

Preventive Action:

1. Re-educate personnel concerned, emphasizing the critical and hazardous natures of these tests, and stressing the need for constant alertness.

2. Change the terminals on the Safe-Arm Unit Test Box, making it physically impossible to connect the power supply to any terminal except where required. Incorporate in this change the elimination of the energized, exposed terminations of the power supply leads, either by a female terminal or changing the procedure instructions to state the power supply is to remain OFF until the voltage is actually required.

Reference Number of this Incident: OI-75

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 76

"Safe" Gases Can Be Dangerous

Description: A potentially serious accident occurred during changes to a pressure controller on a nitrogen manifold.

Nitrogen is, of course, a non-hazardous gas -- it makes up nearly 80% of the air we breathe -- and yet too much nitrogen can create a problem by reducing the amount of oxygen if a very large quantity of nitrogen is released.

In this instance, changes were being made to a pressure controller for a reserve bank of nitrogen cylinders located in a compressor room. A new pressure tap was being provided. In the course of the work the mechanic closed the valve on the original pressure connection, not realizing that this would cause the controller to open. Full cylinder pressure of 2,000 psi was released into the 150 psi piping causing relief valves, which discharged inside the building, to open.

The mechanic left the area immediately and met another man, the "outside services operator." This operator tried to get assistance by phone but could not because of the noise of the escaping gas.

Without going into detail about the action of several persons who became involved in handling the emergency, it appears that one man, the "outside services operator" collapsed inside the building and was in the area an appreciable time.

Two men (one of them the mechanic who had been working on the system) attempted a rescue but realized they could not move the injured man and collapsed themselves just inside the door.

Properly equipped emergency personnel helped these two men out of the building and then removed the injured man. All three were taken to the Medical Department. The two would-be rescuers were released almost immediately. The man who had received the maximum exposure was taken to the hospital and released after two days.

The accident points out the hazards that may be created by relief valves discharging within a building, even for a quite harmless material.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-76

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 77

Electrical Failure-HCl Release

Description: Two mechanics, wearing full acid suits with breathing air to the hood, were replacing a valve in the discharge line from the HCl separator to a scrubber. Isolation of the section of the line included reliance on an electrically-actuated, air-operated plug cock. An electrical fault, believed to be caused by snow blowing into the top vent of the substation cubicle and being melted by a small leakage current over the face of the insulator and then combining with the dust on the insulator to form a path to the ground, in a load break switch in another area of the plant resulted in a complete power failure. This failure de-energized the solenoid valve controlling air to the plug cock operator, causing the valve to change from the closed to the open position. The failure of electricity also resulted in complete darkness in the building and rapid loss of plant air flow to the acid suit hoods. The opening of the plug cock allowed gas in the chloride scrubber to escape through the opening in the pipe line where the mechanics were working. One employee escaped from the area without incident; the other apparently became lost in his search for the door to the stairwell leading to the ground floor. Two rescue attempts were unsuccessful because of evidence of leakage around the face piece of the masks worn; the third attempt, about 15 minutes after the incident, was successful, but the employee died the next day at the hospital. A member of the emergency brigade assisting in the rescue apparently inhaled some HCl fumes during the brief period his mask was removed when it caught on some obstruction. He recovered after a few days in the hospital.

Cause: Although the job had been preplanned by operating supervisors in the field, it was reviewed with the maintenance foreman and the two mechanics at the semi-graphic panel in the control room. The valve and piping arrangement shown by the panel for this portion of the operation was not entirely accurate. In addition, there was excessive reliance on electrically-operated equipment.

Preventive Measures: Filters are being installed on enclosed substation vents to prevent entrance of snow and reduce dust accumulation; insulators in enclosed switch gear will be cleaned annually. Equipment shut-down for maintenance will be checked visually instead of relying on diagrams or panel boards. Procedures have been revised to include a requirement that automatic valves used for isolation purposes shall be rendered inoperable in the closed position. In addition, consideration is being given to providing additional emergency lighting and a stand-by air supply, as well as locating breathing-air stations near doorways so that employees can follow their air hose to an exit.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-77

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 78

Laboratory - Acid Handling

Description: A bottle washer was preparing to fill a three quart pan with a solution of concentrated sulfuric acid (66° Be) and potassium dichromate. This is a cleaning solution used for contaminated glassware.

The solution was still warm and was in a one-gallon glass jug.

The employee carried the jug to the sink counter and set it down. On grasping the sides of the bottle with both hands and lifting to pour it, the bottom fell away. The solution splashed and came in contact with the arms, legs and front part of the body.

The employee received third degree burns of both thumbs, second degree burns of all fingers on both hands and minor first degree burns on the legs.

Cause: The cause of this accident was the improper handling of acid and the lack of proper personal protective equipment.

The employee was not wearing gloves, apron or adequate face protection for the job she was performing. Handling of acid in glass jugs in this manner without a bottle carrier, etc. is contrary to safe practice.

The heat evolution of the solution could have provided sufficient thermal shock to the glass to permit it to crack when lifted free of the counter, or setting it on a cold counter top, or a shock in setting it down could have contributed to the bottom separating or lifting.

Preventive Measures:

1. Written procedures for the handling of acids should be followed.

2. Personal protective equipment consisting of face protection, rubber apron, and gloves must be worn by any person engaged in similar operations.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-78

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 79

Employee "Loses" Eye Protection

Description: A pipefitter was lowering a small acid hose through a floor opening. As the hose was lowered, it struck an employee walking through the area and knocked his hard hat off. The employee's chemical goggle band was stretched around his hard hat; and the falling hat caused the goggles to slip away from his eyes, exposing them to 15% HCl running out of the hose. He received a severe chemical burn to his left eye and a minor burn to his right eye.

Cause:

1. Allowing hose to drop with acid flowing from it through a floor opening without first roping off or barricading the area, or seeing that warning signs were in place, or checking for personnel below.

2. Employee was wearing chemical goggle band around his hard hat.

3. The line this small hose was attached to did not have a valve or other means of stopping the flow of acid when repairs were necessary.

4. There was no written job procedure and the job line-up was inadequate.

Preventive Measures:

1. A general plant rule will be adopted requiring everyone using chemical goggles to wear the goggle band around his head.

2. On jobs where corrosive material could be a hazard, the area will be roped off.

3. A cut-off valve will be installed in this HCl line.

4. A job procedure will be written for this job.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-79

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 80

Gas Release - Sight Glass Failure

Description: At 12:40 pm the foreman noticed there was no pressure in No. 3 Hopper, almost simultaneously the gas alarm sounded and indicated a gas (flammable) concentration in No. 3 Bay. The unit was shut down immediately and an investigation revealed that gas was passing from the Bay into an adjoining room. The outside door of the Bay was opened and when most of the gas had been cleared out it was discovered that the flat sight glass in the Hopper had shattered and blown out. No one was in the Bay at the time of the incident. The rating of the sight glass with respect to temperature and pressure is well above any operating conditions that could exist.

Cause: The sight glass had been changed four days before the incident. There was no spare available, and a used sight glass was cleaned and installed. Care was taken when cleaning the ground surfaces but it is doubtful if the glass was in "new condition." It is not always possible to ensure that the flat surfaces of the holding flanges are perfectly clean because of the urgency in changing the sight glass to prevent air oxidizing the contents of the hopper. It is, therefore, likely that the sight glass failed because of a concentrated stress, either due to unequal torque on the holding bolts or imperfect flat surfaces, or possibly a combination of these factors.

Preventive Measures:

1. An immediate investigation is to be made regarding the feasibility of pre-assembling the sight glasses in a redesigned holder in the shops, where special attention can be given to prevent undue or unequal stresses. In addition, commercial designs are to be investigated.

2. Until Item 1 is resolved, the following procedures are to be followed:

(a) Only new (or clean) gaskets are to be used when replacing sight glasses. Consideration should be given to the use of a softer gasket material.

(b) Only new (or clean) sight glasses to be used. If sight glasses are reused the ground surfaces must be clear and not scratched.

(c) The mating flat surfaces of the holding flanges must be clean, and are also to be checked for flatness.

(d) Special care is to be taken to ensure that equal torque is applied to all bolts when tightening down. The wrench used is not to be longer than 8".

3. The feasibility of checking sight glasses for high or concentrated stresses is to be investigated.

4. A face shield is to be worn when looking into the hopper through the sight glass. Face shields are to be mounted near each hopper for this purpose.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-80

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Additional Information on OI-80

Sight Glass Failure

Reader's Comment: "Preventive measure 2(a) reads, '...Consideration should be given to the use of a softer gasket material.' E. K. Lofberg, in Chem. Eng., Apr. 26, 1965, 'Installation and Maintenance of Glass Equipment,' states 'The practice of "Killing Glass with Kindness" is quite common when it comes to mounting flat circular sight glasses...A soft outer cushion does not protect the glass...(one should) use a thin (1/16") hard asbestos cushion on the outer side of the glass.' "

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Duplication of this Information is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 81

Implosion in Still During Cleaning Operation

Description: A five thousand gallon stainless steel solvent recovery still imploded during cleaning operations. The vessel was designed for 14.5 lbs. pressure but not for vacuum. It was vented through separate two inch vents with flame arresters on the condenser, the reflux tank, and the receiver, but all the vents were on the same line from the vessel.

Previously, boiling water had been used to clean out the vessel whenever repairs were necessary. However, on the date of the incident steam at approximately 100 lbs. pressure was directed into the vessel and through the column and condenser for about 15 minutes. The steam hose was disconnected and the condensate drained from the vessel and column. Cold water was applied to cool the vessel and after the water had been turned on for a few minutes, the tank collapsed.

Cause: The contraction of the vapors due to the sudden cooling caused a partial vacuum since the total venting capacity was inadequate.

Preventive Measures: Ample size vents as well as a vacuum breaker have been provided on the replacement still. Engineering Standard MP-7 indicates minimum vent sizes required to prevent collapse due to sudden cooling.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-81

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 82

Contact Lenses

Description: A chemist, wearing contact lenses, failed to protect his eyes with safety glasses and had a speck of a corrosive material enter his eye. He removed his contact lens, washed out the affected eye and replaced the lens. Several hours later, while at home, his eye became very irritated. He again removed his contact lens and washed his eye but this time did not replace the lens. By the following day, his eye became very painful and he reported to the Plant Health Department. He has been hospitalized with a critical eye injury.

Preventive Measures: The doctor reported that the severity of the injury may have been greatly lessened:

1. If the injured had obtained medical assistance promptly instead of trying to treat himself.

2. If the contact lens had not been replaced following the initial washing. Contact lenses should never be replaced following any eye injury or irritation without medical advice.

The injury again emphases the importance of wearing eye protection in the chemical laboratory and especially when using contact lenses.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-82

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 83

Variable Transformers in Hoods Ignite Vapors

Description: An organic chemical being distilled in a laboratory hood was ignited presumably when the vapors contacted a variable transformer inside the hood.

The chemicals were being heated in a 22-liter flask. The vapors were passing through a bubbler column and a "drip-head." At the top of the drip-head there was a top-vented reflux condenser from which a small proportion of the condensate was being diverted to a 12-liter receiving flask.

Cause: Material escaped from the top of the reflux condenser and contacted the variable transformer causing a flash fire to occur.

Preventive Measures: Relocate all variable transformers outside the hood. This is standard practice on all new hoods.

Condenser outlets should be vented directly to the exhaust plenum of the hood.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-83

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 84

Ball Mill Maintenance

Description: Employees were preparing to unload a ball mill, which is used to grind pigment. An operator removed one manhole cover and noticed that a crust had formed over the manhole. He then removed a second manhole cover rather than break through the crust to take a sample. The operator had loosened two of the four bolts on the cover, when the cover suddenly blew off. The employee was sprayed with product.

Cause: Pressure buildup in the ball mill caused the manhole cover to blow off as employee was attempting to loosen and remove the cover.

Preventive Measures: A valve has been installed on the manhole cover to vent the mill pressure before the cover is removed, as a temporary measure.

An engineering study is underway to determine whether a venting device for the mill can be made. This will be installed as soon as determined.

A Job Safety Analysis is being made of the unloading operations and the safe procedures for opening the mill will be reviewed with all operating personnel.

An "on-the-spot" accident review will be held with all plant production supervisors.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: OI-84

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 85

Oxygen Incident

Description: An employee was changing standard oxygen cylinders on a four cylinder manifold installed about a decade ago by an outside supplier. He had changed one tank successfully, but after connecting the second tank, as he opened the valve, the hose from the high pressure cylinder to the manifold ruptured, shooting out a large ball of flame. Fortunately he was not seriously injured and there was no ensuing fire.

Cause: Investigation revealed the following: The hose was not approved for use in a high pressure gas system, being two layers of woven ferrous metal with a lining that appears to be neoprene and the outside of fabric. In actuality this is high pressure hydraulic hose.

With high pressure oxygen being handled in combustible hose, the source of ignition is academic, but here are the various possibilities:

(A) In high pressure oxygen, the auto ignition temperature of all materials is lowered--that of iron, for example, from 1700° to 1150° F. With a closed valve at the end of such a tube, adiabatic recompression generates heat, and if the valve had not been cracked first to blow out any foreign material before being attached, small particles of metal could be heated and could cause roughness in the rubber lining so that the combination of a heated metal particle and a small area of rubber with a lower auto ignition temperature could result in the fire. This is the most probable cause although oil or grease in the outlet from dirty canvas gloves cannot be ruled out.

(B) A metal fiber could have protruded through the rubber lining and been heated to the auto ignition temperature by vibrating in the high pressure stream of oxygen like in the above postulation. Instantly all the combustibles would burn. The compressed gas industry years ago found this to be the cause of many regulator fires in that the diaphragms were metal reinforced and when they would begin to wear and were not properly maintained, small wire fibers would exhibit this phenomenon.

Preventive Measures: Corrective measures in this particular situation include the following:

(A) A two stage regulator has been installed at each cylinder and now manifold pressure is fifty pounds.

(B) Hose approved for oxygen has been provided for the low pressure system.

(C) Cylinders will be handled only with protective cap on, and valves are cracked briefly before being connected to regulators which are being maintained regularly and properly.

ASESB OI-85 (Continued)

(D) A Lockseal joint compound containing alcohol and therefore not approved for oxygen use is no longer being used. Every effort must be made to keep grease, oil, and other organic materials from contact with oxygen, and it should not be assumed that any commercial compound sold for use with compressed gases is acceptable for oxygen.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident is: OI-85

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 86

Platform Truck -- Operator Walked Backward

Description: Employee was leading a loaded power platform truck out of a storage area perpendicular to the aisle. He was walking backward in order to guide his load past other loaded skids in storage without damaging the material. As he turned his truck into the aisle he backed against another platform truck which was parked, perpendicular to the aisle, in another storage area across the aisle from where his load had been stored, pinning his lower right leg between the two power trucks.

Cause:

1. The employee was walking backward while leading a truck and did not see the obstacle behind him.

2. The parked platform truck was too long for the storage area and was parked partially in the aisle.

3. The employee did not exercise precaution required to safely move equipment and load along the aisle.

Preventive Measures:

1. Employees have been re-instructed to look in the direction of travel.

2. Arrangements are being made to provide more working and storage space in this area.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-86

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 87

Laboratory Incident

Description: A solvent in contact with an open gas flame caught fire. Property damage was slight; however, a supervisor received an arm laceration requiring 12 sutures. The supervisor elected to use a gas burner rather than a heating mantle to prepare two liters of a flammable solution in a stainless beaker in a hood. While turning off the gas he inadvertently tipped over the beaker and the contents ignited as the solution ran to the floor. He left the laboratory to obtain water, shutting the door behind him. Upon his return, he had to break the glass to unlock the door and lacerated his forearm. Other employees quickly quenched the fire by using various types of fire extinguishers.

Cause:

1. Not securing equipment.
2. Use of improper means of heating.

Preventive Measure: Use mantles.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-87

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 88

Hydrochloric Acid

Description: Employee was filling small bottles with product which contained a small amount of hydrochloric acid. Some of the product spilled over onto his apron, ran down the legs of his trousers and into his safety boots. The employee did not flush his feet off with water immediately and he sustained chemical burns of both feet.

Cause:

1. The bottle filling station was a temporary set-up and awkward to work around.

2. Employee failed to comply with previous instructions and did not water flush the product off immediately, nor did he report to First Aid until the following day.

Preventive Measures:

1. The equipment has been realigned to provide for easier handling.

2. Additional protective equipment, such as personal protective equipment, is being provided.

3. Proper handling of hydrochloric acid is being reviewed with all concerned personnel.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-88

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 89

Exposure to Ultra-Violet Light Results in a Disabling Eye Injury

Description: A technician wearing safety spectacles spent a moderate amount of time during the course of the day viewing paper strip chromatograms in a darkened enclosure under a strong ultra-violet light. Shortly after work she experienced an itching sensation in her eyes and later severe pain.

Cause: The cause was attributed to ultra-violet radiation coming in and around the sides and top of the glasses.

Preventive Measures: A plastic shield has been erected in front of the light source to shield the radiation. Additional eye protection can be afforded by wearing a close fitting goggles while working around other similar light sources. All personnel should familiarize themselves to adequate shielding. All [illegible] should be posted with signs or decals, e.g. "U V Light - Protective Equipment"

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: [illegible]

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 90

Sulfur Dioxide Exposure

Description: An operator was attempting to pad a liquid SO_2 tank with air in order to transfer liquid from the tank to the fumigant mixing area. SO_2 vapors from the tank back-flowed into the air line contaminating the air supply to an acid hood he was using (approximately 300 feet away). As a result of the inhalation of the fumes, the operator was disabled for one week.

Cause:

1. The operator did not follow procedure for verifying that supply air line pressure was higher than tank pressure before opening air supply into SO_2 tank.

2. There was no check valve between air supply and SO_2 tank tie-in to prevent back-flow.

Preventive Measures:

1. A written comprehensive procedure will be provided for this operation.

2. Employees will be given the proper training and instruction in following this procedure.

3. A caution sign at the valve configuration, specifying pressure checking procedure, will be provided.

4. A suitable means of pressuring the tank other than by air will be investigated.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of This Report: OI-90

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Operational Incident Report No. 91

Chlorine -- Canister Masks Prove Inadequate

Description: In a chemical manufacturing plant, liquid chlorine is used in a chlorination system consisting of railroad tank car, chlorine vaporizer, and chlorination vessels. The system is protected against over-pressuring by a rupture disc, an alarm and a springloaded relief valve with the discharge piped out about 100 feet from the plant building. In the course of operation, the system did over-pressure. The rupture disc, alarm, and relief valve all functioned properly and chlorine gas was vented out of the discharge pipe. At the sound of the alarm, three operators converged on the area to determine what was wrong. At this particular time the prevailing wind was such that the end of the discharge pipe was directly upwind of the plant building. As a result, the building was filled with chlorine gas almost immediately. The plant is equipped with several gas mask stations containing full-face canister type masks with special chlorine canisters. When the operators and supervisor realized that chlorine was entering the building, they put on masks but by the time they finished closing valves to shut off the chlorine source, they all were affected by chlorine gas that had passed through the canisters. All were given oxygen on the site, and two men were sent to the hospital for treatment.

Cause: Although canister type gas masks have been used regularly in the plant with satisfactory results, they are not designed for protection against more than 2% chlorine. Due to the wind direction and atmospheric conditions at this particular incident, the plant was apparently filled with a chlorine density of considerably over 2%. The actual density is not known. There was no indication that routine servicing of the masks had not been complied with. All masks were in good order and had fresh canisters attached.

Preventive Measures:

1. Operators have been alerted to the fact that if the density of chlorine is high, they should not remain in the area with canister masks. However, the canister masks will be kept available for use in light concentrations of chlorine or for evacuation from the area.

2. There is one self-contained air breathing pack on the premises. It is kept in the production office which is outside the plant proper for use by a supervisor or other personnel to enter the plant and give assistance or rescue in case of severe chlorine escape. It is proposed to install a second unit so at least two people will be able to work together on rescue. It is proposed to install four air breathing masks with 50' of hose on each supplied by the plant air system. These will be mounted in a central location, out of the immediate chlorination area but within hose reach of all the chlorine valves and equipment. The intake to the plant air compressors will be piped up 80 feet in the air on an adjacent tower to prevent pulling chlorine into the compressed air system.

OI-91 - Continued

3. Due to the location of the plant and adjacent buildings, it is not possible to relocate the chlorine discharge line any farther from the plant. However, a drum of dilute sodium hydroxide has been set up as a seal leg so that the chlorine discharges into the drum below the surface of the liquid. The chlorine reacts with the sodium hydroxide, minimizing release of chlorine gas.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of This Report: OI-91

Duplication of This Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 92

Burned by Condensate

Description: Prior to start-up, inert gas had been steamed out of an inert gas drier in a cleaning operation. The drier is packed with aluminum dessicant which had been removed before the steam cleaning operation.

The steam was blocked in and the injured loosened a $2\frac{1}{2}$" plug in the bottom of the drier to remove the condensate. After the condensate ceased to run from the loosened plug, the injured unscrewed the plug from the drier.

When the plug was removed, the hot condensate gushed out, hitting the concrete below. The plug is located approximately one foot from the concrete base and the hot condensate splattered on the feet, legs and knee of the injured.

Cause: The injured man mistakenly thought the vessel was clear of condensate.

Preventive Measures: Piping revisions have been made to eliminate the need for steam cleaning.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-92

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 93

Aniline Stripper Ruptures

Description: Two employees were dumping a sludge press in one of the operating buildings. Suddenly, the top of an aniline stripper, adjacent to the press, ruptured and hot material sprayed from the stripper and struck the employees. The employees sustained second degree burns and were hospitalized.

Cause: The vapor line to the condenser and the water seal, which serves as a vent, were plugged with material. This permitted pressure to build up in the stripper which caused the top to rupture.

Preventive Measures:

1. Double valves and tell-tale bleeds will be installed in each steam leg line.
2. The steam out lines to the sampling legs will be removed and rod out devices will be installed.
3. Instrumentation, including level pressure recorders and alarms, will be installed on the stripper.
4. The safety seal design will be reviewed.
5. Mechanical agitation will be provided to minimize or eliminate "burping."
6. A Job Safety Analysis will be completed prior to placing this tool back on the line.
7. The accident is being reviewed with all operators and supervisors concerned.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OT-93

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 94

Safety Relief Valve

Description: The No. 2 main still vacuum pump discharge safety relief valve opened when the unit was started up. A surge of liquid was released from the safety relief valve discharge line and hit the operator in the face with sufficient force to push his goggles away from his eyes. He received some liquid in the eyes but prompt washing prevented any injury.

Cause: The safety relief valve discharge lines, terminating about eight feet above grade, vented into a personnel access way.

Preventive Measures:

1. The vacuum pump safety relief valve discharge lines have been extended to grade discharging into the distillation sewer system.
2. All areas of the plant have been checked to insure that no similar installations exist.
3. This incident has been reviewed with all operating departments.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-94

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 95

Aluminum Isopropoxide Drum Fire

Description: A drum of Aluminum Isopropoxide ignited while being transferred from one drum to another. The transfer was made inside a warehouse. Inside temperature was approximately 70°F. Outside temperature was approximately 42°F. Humidity 42% outside, unknown inside.

The material was being transferred from a fibre drum (supplier's package) containing 68 kg of Aluminum Isopropoxide granules to an empty fibre drum originally containing magnesium turnings. The original container specifications for Aluminum Isopropoxide are as follows:

30 gal. capacity leverpak - M3007-5H-M
Aluminum barrier board buried inside walls
Polyethylene lined
Metal bottom
Metal top with rubber gasket

The receiving container drum specifications are not immediately available. It was a 50 gal. capacity (approximately) fibre drum.

Due to the known possibility of static discharge from polyethylene drum liners, the material was being transferred from the original container and weighed in a non-hazardous area for use in a potentially hazardous atmosphere. The resultant fire proved conclusively this material transfer outside the hazardous area was necessary.

The transfer of Aluminum Isopropoxide was accomplished by stacking one skid of drums on top of another and removing the lid from each drum. The string which ties the top of the polyethylene liner is removed. The top of the liner is then held together with one hand while the other hand is used to tilt the full drum onto the empty receiving drum. As soon as the top of the liner is over the receiving drum, the hand holding the liner is released allowing the Isopropoxide to fall into the receiver from the polyethylene liner and drum. When the original drum is nearly empty, the remaining material and the polyethylene liner fall into the receiver. The original container is then placed on the floor in an upright position. The polyethylene bag is pulled from the receiving drum and placed in the now empty container.

The operation was repeated under carefully controlled conditions. The fire occurred in both instances as the polyethylene liner was being removed from the receiving or full container. This liner was almost completely removed from the drum before the fire occurred. The fire enveloped the entire opening of the full container and blazed well above the container. The fire was readily snuffed out by placing the lid on the drum.

The operator was grounded through his shoes to the concrete floor. The ground was checked by instruments and found to be functioning properly.

Possible Causes:

Heat - A. Discharge of static build-up on polyethylene bag to opposite charge on polyethylene coating of drum or vice versa.

B. Discharge of static build-up on polyethylene bag to opposite charge on material (Aluminum Isopropoxide) or vice versa.

Fuel - Isopropyl Alcohol vapors due to moisture absorption of Aluminum Isopropoxide from atmosphere exposure.

Preventive Measures: The full drum of Aluminum Isopropoxide is opened and the polyethylene liner is also opened and pulled back tightly over the sides of the drum. A metal funnel or pouring spout from a lid is placed on the full drum over the polyethylene and attached with a ring lock. The receiver is equipped with a lid fastened in the same manner. This lid has a hole in it large enough to receive the pouring spout. The full drum of material with the pouring spout attached is then up-ended onto the receiving drum. The top ring of both drums are bonded together and grounded.

If metal drums, or at least conductive liners, were used by the supplier, not only would the danger of static discharge be minimized but also this might eliminate one handling of the material.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-95

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 96

Employee Sprayed with Chemicals When Flask Implodes

Description: A laboratory employee was preparing to filter a reacted mixture of chemicals containing phosphorus oxychloride. He was using a modified Buckner type funnel and a flat bottom 3 liter flask with a side arm attachment. When the filtering was complete, he realized the chemical was to be cooled and filtered under nitrogen. To prevent further air contamination of the product, he placed a glass stopper on the open funnel. Almost immediately the 3 liter flask imploded spraying chemicals on the employee. He suffered chemical burns to his face, arms and eyes. (He was wearing safety glasses.)

Cause:

1. The selection and use of the wrong type of equipment, a flat bottomed flask, for this filtering procedure. This type of flask was not designed for vacuum work.
2. The correct filtering procedures were not used. The literature survey report was not clear in method of filtering to be used.

Preventive Measures:

1. The correct use of glassware for vacuum and pressure will be reviewed with employees. Use of shields will also be reviewed.
2. All modified flasks are to be marked "not for vacuum."
3. A check point list will be made for specific job instructions.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-96

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ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 97

Fire in Burning Field

Description: At approximately 10:17 A.M., an accidental fire occurred at the propellant burning field in C-Area. The fire broke out during the final stages of unloading propellant waste from the A-Area waste truck.

Upon arriving at the propellant burning field, the operator backed the truck up to the pad containing unburned waste from other deliveries, stopping within 2 feet of the materials on the pad. (Waste had not been burned on this pad during the week because of the presence of outside contractors installing power poles and preparing a foundation for a new building in the near vicinity.)

It is assumed that both operators left the cab of the truck (leaving the motor running to power the hydraulic tailgate) and went to the rear of the truck where one activated the lever that swings the tailgate down in an arc from the vertical to the horizontal position at the same level as the truck bed. Entering the truck bed, the men began transferring the containers from the truck to the pad.

It is believed, because of the position of the containers on the pad after the fire and the time element involved, that the operators moved the containers to the tailgate of the truck, dumping some, and then easing, dropping or throwing all containers onto the pad. There were no witnesses to the actual unloading operation or the start of the fire. That the fire started in the propellant waste off the truck after all drums, buckets and fibrepaks had been unloaded is borne out by the fact that no metallic remains from these containers were found on the truck bed after the fire. Some propellant waste in polyethylene bags was still on the truck, evidenced by the remaining debris and some remnants of polyethylene found under the debris, particularly toward the front of the truck.

The severity of the incident was increased by the close proximity of the truck to the pile of waste (approximately 2 feet) and by the canvas cover which prevented possible escape from the truck bed, except over the tailgate.

Cause: The exact cause of the fire was not determined. No close witnesses were found who can definitely state exactly how the unloading was being performed, and the investigation uncovered no definite cause for ignition. The most probable cause was impact or friction resulting from the dropping of the steel drums, pails, or steel bottomed fibrepaks from the tailgate onto drums already on the ground in the midst of propellant waste. Less probable causes are considered to be impact or friction

CI-97 (Continued)

from sliding polyethylene bags containing metal across the truck bed, opening a hot spot caused by spontaneous heating in the pile of previously discarded waste, the possibility of a spark generated by metallic contact igniting sawdust, rags or paper.

Recommendations: To prevent a possible recurrence the following recommendations are made:

1. Institute the use of low-bed uncovered trailers for pick-up of propellant scrap and waste to eliminate the opportunity or expediency of dropping materials from the truck bed. Cover all exposed metal in the trailer with wood or similar material.

2. Institute the use of nonmetallic waste containers.

3. Improve the burning field and pick-up operation.
   a. Revise the field to provide for smaller pads.
   b. Install barricades to prevent the waste carrier from being backed onto the pads.
   c. Strengthen the supervisory coverage of the propellant waste pick-up and the burning field by assigning responsibility to one Department.

4. Strictly separate propellant and propellant waste from other inert waste materials coming from the propellant operations.

5. Include a safety man as an observer with the pick-up crew, with the safety representative in charge

Other recommendations which are felt to be pertinent are as follows:

1. Provide a completely separate burning field and pick-up of waste for the laboratories. While the inclusion of the Lab waste was not felt to have caused this incident, many new materials and compositions are being tested and, for future safety considerations, these should be segregated from Production propellant waste.

2. Improve the identification of waste.

3. Where possible, use open trucks for in-plant transportation of propellant-containing items.

4. Implement the disaster plan, the better to control access to the scene of an incident.

Reference Number of this Report: 1173

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ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 98

Igniter Mix Flash

Description: An operator was removing wet igniter mix from a mixing bowl and spreading it onto a drying tray. Apparently he dropped the bowl striking the mix that had been dumped on the tray. The entire five pounds of igniter mix flashed, engulfing the man in flames, causing second and third degree burns on 70 to 80% of his body.

Preventive Measures:

1. Grounding of all equipment has been checked.

2. Discharge plate and leg stats, or other means of grounding operator, will be provided.

3. Flame-proof clothing has been issued to all operators.

4. Aluminized Fiberglas coat and hood will be worn during all phases of this mixing operation.

5. Procedures have been changed and posted to include protective clothing required.

6. Mixing bowl will be removed from building while scraping operation is performed.

7. Efforts will be made to determine feasibility of disposal or permanent conductive liner for bowl.

8. Provide panic bars or quick release for both doors to mixing building.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-98

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 99

Dilute Acid Solution Causes Severe Eye Injury

Description: The injured employee was scaling 2% mucochloric acid solution into two large graduated cylinders when a sudden surge in the line caused the flexible rubber tubing to slip out of the graduate so that he was splashed with the chemical. Although he was wearing safety glasses, a small amount of the acid solution entered his left eye. With the help of a fellow employee he flushed his eye for approximately two minutes and then reported to the Medical Department. He was able to work for almost three weeks after the accident, until small perforations appeared on the cornea, necessitating hospitalization of the man for a corneal transplant.

Preventive Measures: This injury serves to show us that safety glasses are not the panacea against all eye injuries, and that cover-all goggles, face shields, etc. may be indicated for many jobs where chemicals are handled. The injury further points out the need for adequate flushing of the eyes when a chemical splash occurs. Two minutes should not be considered adequate; fifteen to twenty minutes is recommended. Chemical workers should be reminded of this along with the rest of their safety indoctrination.

As a result of this accident, fixed piping and valves have been installed to prevent the "whipping" action often related to hoses and monogoggles or full face shields are provided for the workers.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-99

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ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Operational Incident Report No. 100

TROUBLE ALERT! - Nylon Seat Ball Valves

Description: An incident involving the use of nylon seat ball valves in high-pressure air service has indicated that a safety and operational problem can arise from this type installation.

Initially, a new four-inch ball valve with nylon seat, installed in a 5000 psig air service line, failed at 4000 psig. Investigation showed that the nylon seat had decomposed (burned) due to the heat of compression of atmospheric air already in the pipe.

Since several similar valves were already installed in an 1800 psig air service system, a quick check was made to see if under certain operating conditions these valves would be subject to failure.

The test showed conclusively that at 1800 psig it was possible for a seat to fail. No tests were run at lower pressures; however, failures can be expected.

Action. These valves have been removed from service where this problem can exist until a suitable seat material can be obtained.

Comments: Recent comments received about "popping" hydrogen valves and certain fires associated with oxygen system valves lead to conclude that this experience is not an isolated case but rather part of a general problem, heretofore not properly recognized. At this point, regardless of the gas involved, all valves, particularly the large sizes, with polymetric components or internal coatings are suspect, if the system can allow significant heat of compression to develop in the valve area. Field installation safety offices are urged to examine all such inhouse and contractor operations to determine the extent, if any, of this problem and to take appropriate corrective action.

Reference Number of This Report: OI-100

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ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Additional Information on OI-100

Nylon Seat Ball Valves

"During the week of January 16, 1967 a 4-inch 6000 psig valve with a new seat material (DuPont SP-21) was pressurized fifty times to 3900 psig and 50 times to 4700 psig. The pressurization time per cycle was two seconds or less. The valve remained leak tight during this cycling. The SP-21 seats were then removed and no deterioration was found.

"Strain gages were attached at all critical points on the valve and no stress was found in excess of 6000 psi when the valve was hydrostatically tested to 6000 psig.

"From the above it is the writer's opinion that the valves in question are suitable for use with air provided the nylon seats are replaced with SF-21.

"This information is furnished for edification purposes only and is not intended to be nor should it be construed as a positive recommendation for the use of SP-21 in any valve other than those used for controlling air flow."

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ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

Additional Information on OI-100

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ARMED SERVICES EXPLOSIVES SAFETY BOARD
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Washington, D. C. 20315

Operational Incident Report No. 101

Azide Poisoning

Description An employee was performing his regular operation for the preparation of lead azide in the precipitation room. He was watching the water pipette fill to the calibration mark, when sodium azide solution began to overflow from the sodium azide pipette. At the time, he was unaware that this pipette was filling. On the preceding shift, pipefitters had worked on the rotameter of the sodium azide pipette and had left the solution valve open. The operator in the other precipitation room turned on the sodium azide pump (pumps to both rooms) to fill the pipette in his room which in turn filled the one in the other room. While turning off the valve to the sodium azide pipette, the employee was sprayed with the solution. He became ill and blacked out.

Preventive Measures:

1. Check all equipment at the beginning before transferring material.

2. Reinstruct personnel to the hazards of toxic solutions and corrective procedure to follow to avoid coming in contact with this type solution.

3. Instruct personnel of the necessity of washing off solution of this nature and removing contaminated clothing.

4. Consider the employee's physical condition before allowing him to work in this type of operation.

(REPORTED BY THE MANUFACTURING CHEMISTS ASSOCIATION, INC.)

Reference Number of this Report: 01-101

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington D. C. 20315

Operational Incident Report No. 102

Inc. Test Set Up - Detonation of Armed Fuse

Description Test being conducted was one of a series to determine the "g" level necessary to detonate a Fuse Assembly Impact Locator. The fuses are composed of a detonator, a four inch length of mild detonating fuse (MDF) and a lead azide relay. The machine being used to subject the fuse to varied "g" levels was a AVCO Model SM-005-2 shock machine.

The following is the sequence of events leading up to the accident:

1. The fuse in question was subjected to a shock of 1000 "G" and failed to detonate.

2. As a result of the failure it was decided by the development engineer that the fuse should be destroyed by recycling the unit at an increased shock level as the integrity of the unit was now in question.

3. The unit was safed by removing the striker pin assembly and reinserting the safety pin.

4. The cushioning pads on the table were changed to increase the "g" level.

5. With the shock table in the raised or cocked position the Laboratory Test Technician seated the test cell instructing the Ordnance Technician to arm the fuse and set the control switch at manual.

6. The fuse was armed by reinserting the striker pin assembly and removing the safety pin.

7. The final act performed was the turning of the control switch of the shock machine to "manual." (This would normally allow the table to drop slowly under gravity.

As this last act was performed the table descended rapidly, detonating the fuse. The fragments from the detonation struck the Ordnance Technician in the face, right arm and chest.

The emergency number was called and the ambulance, nurse, and fireman were dispatched to the scene of the accident. The nurse rendered emergency treatment and accompanied the injured man to the hospital where he remained overnight for observation.

Conclusions:

1. The Ordnance Technician was in violation of one of the most standard ordnance safety rules when he armed the device prior to having the test set up completed. That is, the test set up is not considered complete until the table is in the uncocked or down position. Had this sequence been followed the failure of the shock machine would not have transpired with the fuse armed.

2. The regulator was proven to be faulty preventing proper bleed off of pressure as designed.

3. Supervision had failed to provide the technicians with adequate instructions on the performance of the operation.

Recommendations

1. A review be conducted of all laboratory systems and a PM system be established for refurbishment of equipment as required.

2. Increased supervisory control of individual test activities.

3. Increased use of written test procedures.

Reference Number of this Report: OI-102

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

OPERATIONAL INCIDENT REPORT No. 103

Ignition of Igniter Assembly

Description: The Igniter Assembly is composed of a dual ignition system. Each system consists of an electrically actuated squib and six (6) boron potassium nitrate pellets weighing approximately .150 grams per pellet. With reference to the squib the pellets are located such that a vertical center line drawn through the squib if extended down would pass through the center of each of the six pellets in succession. When assembled the dual systems are parallel to each other and separated by a clear space of approximately 1-1/2 inches.

Since the pellets are hygroscopic the assembly was stored with desiccant in a polyethylene bag. The operator was in the act of removing an assembly from the polyethylene bag when one of the two squibs ignited thus causing the pellets just below the squib to ignite. The hot gases from the burning pellets bridged the 1-1/2" clear space and ignited the pellets in the other half of the ignition system.

The operator's first reaction was to drop the assembly and step back from the work bench. As a result there were no injuries.

The temperature in the work area was 72°F. with a relative humidity of 40%.

Cause: Extensive tests were conducted to determine if it was possible for an individual to generate enough static electricity to ignite the assembly. The results of these tests indicated that it was.

Immediately following the incident standard conductivity checks were made which gave a 45,000 ohm resistance between two electrically connected weights situated at the location of the incident. A 40,000 ohm resistance was measured from the operator through his conductive shoes and between 25,000 and 30,000 ohms resistance was found between the conductive floor and ground. The total is considerably less than the 1,000,000 ohms allowed.

After a thorough analysis it was first theorized and subsequently proven that the particular lot of squibs was substantially more susceptible to a static discharge than any previous lot. As a result, they could be ignited by a relatively small static discharge.

Recommendations: The preventative measures which were initiated included the following:

1. The operators are required to wear two (2) legstats to preclude the possibility of his being temporarily ungrounded if one foot is off the ground.

2. The use of non-conductive plastic bags for storing igniter assemblies has been discontinued.

3. The humidity of the assembly area has been raised to the upper end of the acceptable range.

4. The practice of merely twisting the two squib leads together in order to short the squib has been discontinued. Provision has now been made to bring the squib bridge wire and the squib case to the same potential.

5. Provision has also been made for a positive electrical contact between all portions of the assembly and earth ground through fixtures, work benches, etc.

Reference Number of This Report: OI-103

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

OPERATIONAL INCIDENT REPORT NO. 104

Trinitrotoluene (TNT) Poisoning

Description. On 25 July, a female employee, working as a puddler was observed by some of her co-workers, to have a yellowing of the skin. The Assistant Supervisor immediately sent her to first aid at the Plant Hospital. She was examined by the Medical Director who prescribed adequate rest and diet and recommended that she be removed from work in TNT. Employee worked from 25 July to 1 August in metal parts and was not exposed to tritonal or TNT. On 1 August, employee was placed on complete rest at home by a local physician. On 16 August she was admitted to the Hospital where she remained until she expired on 21 August. The Death Certificate indicated that she died from toxic hepatitis probably due to trinitrotoluene (TNT) poisoning.

Findings.

1. Systemic poisoning resulting from exposure to trinitrotoluene can cause toxic hepatitis. It is usually impossible to distinguish between infectious hepatitis resulting from virus and toxic hepatitis.

2. Employee received physical examinations on 25 March and 3 June. Both examinations indicated she was in good health except for obesity.

3. As a puddler, employee was exposed to liquid and dry tritonal which is a composition of trinitrotoluene (TNT) and powdered aluminum. She wore all the protective clothing provided for her work, bathed before leaving the plant after work, and followed other safety procedures as directed by foreman and SOP.

4. Medical history indicates that middle-aged women and fat people are normally more susceptible to acute yellow atrophy than other people. The employee's physical indicated that she was 36 years old, 4 feet 11½ inches tall and weighed 182 pounds. This would place her in the more susceptible category.

5. Certain individuals are hypersensitive to trinitrotoluene and can receive systemic poisoning from short exposure which in most individuals would not be toxic. It is believed that death was caused by systemic poisoning and that the employee was hypersensitive to TNT.

6. There is no way to determine whether an individual is sensitive to a particular chemical before they are exposed to it.

7. Blood tests and urinalysis will sometimes give early signs of poisoning from TNT so that sensitive individuals can receive medical attention before complications set in. No such tests were made of workers exposed to TNT during the period said employee worked as a puddler.

8. For approximately six months prior to 7 July the Plant did not have a Medical Director and found it necessary to employ part-time services of a local physician. The Medical Director employed on 7 July did not have experience in Industrial Medicine or toxic poisoning, but since his arrival, through joint effort of the Safety Department, plans are being made to run the Webster Test and take blood tests periodically of all employees exposed to TNT.

9. Ventilation in the building where the employee worked was provided by open doors and windows. There were no exhaust fans or mechanical type of ventilation. It is stated that all available doors and windows in the puddling bays were open during the period in which the employee worked there. It is felt that the ventilation in the area where the employee worked is adequate when the doors and windows are open, but there is no means to quantitatively measure the ventilation which is dependent upon atmospheric conditions.

10. On 28 and 29 March, air samples were made in the building to see if the concentration of TNT was within the maximum allowable level of 1.5 milligrams per cubic meter of air for eight hour a day exposure. Tests were not taken in the area of puddling operations because cross winds in puddling bay at that time would have given a reading below normal, but readings were made in a less ventilated area where the Safety Director considered the concentration to be much greater. This test gave a reading of 0.8 mgm^3. Two tests were made in Bay 16 of the building on 30 August while workers were puddling bombs. These tests gave readings of 0.283 mgm^3 and 0.142 mgm^3. Readings are only good for time and place that they are taken, but since the same operations were being performed during the period that the employee was a puddler, it is felt that the concentration to which the employee was exposed was never greater than 1.5 mgm^3.

11. The protective clothing and powder uniforms required by the SOP are adequate and the clothing furnished by the company is adequate except on some occasions it was noted that clean gloves were not available. The wearing of the face shield required by SOP is not always enforced.

12. Bathing facilities and lockers provided employees are adequate, and measures are being taken to insure that all personnel bathe before leaving the plant after working in TNT.

13. Training for employees concerning the wearing of protective clothing and personal cleanliness is adequate but does not include symptoms of systemic poisoning, proper diet for people who are exposed to TNT and the importance of the diet, and warning on the hazard of people who drink alcoholic beverages even moderately working in TNT.

14. The only food available for TNT workers at the plant is that which is available in vending machines.

15. There is no scheduled rotation of TNT workers from their jobs.

Recommendations:

1. Employment of obese personnel where they will be exposed to TNT be discouraged, and if they are employed where exposed to TNT, they be placed under close observation until sensitivity to TNT is established.

2. Positive steps be taken to insure that personnel who are exposed to TNT have clean gloves daily.

3. Required rotation of puddlers and other TNT workers from their jobs at a time period determined by the Medical Director and based on drop in hemoglobin and red blood count experience.

4. The planned Webster tests and blood tests be started immediately.

5. Education program be changed to include the importance of well-balanced diets for TNT workers, the recommended diet, symptoms of systemic poisoning from TNT, and the danger of TNT workers drinking alcoholic beverages.

6. A low cost balanced meal be made available to workers exposed to TNT, and workers be encouraged to eat the meal.

7. Although the ventilation meets present recommendations, an engineer study the feasibility of increasing ventilation by exhaust fans or other mechanical means.

8. Air-dust samples be conducted in all areas where workers are exposed to TNT at least once monthly.

Reference Number of this Report: 1188

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

OPERATIONAL INCIDENT REPORT NO. 105

Accidental Fire Resulting from the Card-Gap Test

Description: An incident occurred during the measurement of shock sensitivity of an explosive mixture containing hydrazine by the card-gap method. A spontaneous ignition occurred when the liquid dripped on the tetryl donor explosive; the fire that resulted consumed both explosives.

Cause: Since the liquid explosive was being tested at elevated temperature, a Teflon diaphragm was used to close off the bottom of the acceptor container instead of the polyethylene sheet that is normally employed. A minor leak developed and the first drop of the hydrazine mixture on the tetryl booster caused it to burst into flame.

Preventive Measures: The compatibility of liquid explosive systems with explosive donors should be determined prior to possible cross-exposure. Extra precautions should be taken to protect the donors by a protective sheath in addition to the diaphragm that is stretched over the container. Overfilling in the acceptor should be avoided and the detonator should be installed only after the system has been inspected for leaks.

Reference Number of this Report OI-105

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

OPERATIONAL INCIDENT REPORT NO. 106

Toluene Vapors Released Through Sight Glass

Description: An old style, 3 in. diameter sight glass failed in a stripper kettle circulating line and released toluene vapors in operating area.

Cause: The sight glass had been installed recently and apparently failed due to flaws in the glass or from improper tightening.

Preventive Measures:

1. Sight glass has been replaced with new pressure-type.
2. Reviewed proper installation methods.
3. Procedure for periodic cleaning and inspection is being established.
4. Investigating elimination of sight glass and check design ratings against possible process pressures.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of This Report: OI-106

Duplication of this Report is Authorized.

[illegible] INDUSTRIAL SAFETY BOARD
[illegible]
[illegible]

OPERATIONAL INCIDENT REPORT NO 107

Instrument Failure

Description. A flame transmitter on high-pressure hydrogen service had a failure of its internal mechanism resulting in rupture of the diaphragm designed to relieve excessive internal pressure in the transmitter.

Cause. A blow-out plug provided relief for pressure on the external housing after rupture of the internal disc failed to provide sufficient venting capacity and the housing blew apart. Escaping hydrogen caught fire, the resulting flame being initially about 20 feet high and then subsiding to a steady flame about 6 feet long.

Action. Fire was extinguished in about 2-3 minutes and hydrogen supply was shut off at which time the flame was 15 feet. Hydrogen flow was restored about 25 minutes later after the instrument had been by-passed.

There was no damage other than to the instrument which the manufacturer has already replaced; no injuries and no loss of process material.

The instrument was rated as suitable for this application and the manufacturer has been given the instrument in question for study.

Precautions Taken. Engineering and instrument staff are studying the instrument in question and working closely with the manufacturer to determine cause of failure and prevent future failures. Instrument was not supposed to fail over-ranged as being used. Instrument location was already safest possible location at moderate risk of fire.

[illegible] MANUFACTURING CHEMISTS ASSOCIATION, INC.

[illegible] this Report [illegible]-107

[illegible] of this Report is authorized

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

OPERATIONAL INCIDENT REPORT NO. 108

Explosive Accident in Dynamite Factory

Description:

On the 22nd February, 1967, at 10.28, a kneading house for dynamite exploded. Two workers in the house, 57 and 52 years of age, were killed. They had worked with the company for 38 and 34 years, respectively. Secondarily, about 3 minutes later a partial detonation occurred in an injector nitration plant about 80 metres from the kneading house. The nitration plant is automatic and was at the time unmanned. No personal injuries were caused in the plant outside the kneading house.

The kneading house was of timber and had a double Draiswerke kneading machine of an old revolving type. The kneading chamber was lined with copper. In the kneading house about 275 kilos Extra dynamite type IV, 140 kilos gelatined notroglycerine/nitroglycol and 120 kilos nitroglycerine 50/50 exploded. About 200 kilos notrotoluene mixture (N-content 11,8%) and about 30 kilos notrocellulose with 30% water did not take part in the explosion. The explosion took place just before lunch time. The third man of the work team had left for the workers mess. The investigation has clarified that the kneading machine was not in operation at the time of explosion. Probably, initiation was caused when ammonium nitrate was added into one of the mixing chambers. Ammonium nitrate is kept in cases of stainless steel and shall be discharged into the kneading chamber by two men. Parts of corpses, which have been found, indicate that only one worker was near the centre of the explosion, and probably, against the regulations, the filling of ammonium nitrate was made by only one worker.

By the ground vibration two control instruments in the nitration plant were damaged. The glycerine flow increased and thereby the nitration temperature rose above 60°C compared to normally 47°C. Registration of the nitration temperature is only possible up to 60°C. No impulse for restriction of the glycerine flow was released. The signal which breaks the nitration at 54° was also put out of operation. The faulty nitration continued for 3 minutes, and then an explosion started in the coil cooler just after the nitration injector and was interrupted in the next tubular cooler.

Preventive Measures:

In order to prevent a repetition the glycerine pipe has been provided with a diaphragm, which prevents overdosage of glycerine. A further contact breaker has been installed to break the operation at 54°C. A device for remote-interruption of the electric energy for the nitration has been arranged.

(Foreign source)

Reference Number of this Incident 01-108

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

OPERATIONAL INCIDENT REPORT NO. 109

Pyrotechnic Composition Flash Fire

Description:

Pyrotechnic composition (Boron and Potassium Nitrate) was blended, screened and then placed into aluminum containers. The covered container was dropped by the operator and this resulted in a flash fire followed by explosions. The operator died as a result of severe burns and a nearby operator received minor abrasions and bruises.

Cause:

Ignition of pyrotechnic composition when container was dropped.

Action:

Line personnel were evacuated and a fire alarm was turned in after the first explosion. The fire propagated to adjacent material when a second explosion occurred. After it was determined that no other explosives were in the area, the fire department laid hose lines and the fire was extinguished.

Recommendations:

Employees handling sensitive pyrotechnic compositions should be instructed, trained and supervised in the specific hazards involved and the handling techniques to be followed.

Supervisors should maintain a continuous program of follow-up, reinstruction and enforcement of regulations with each employee.

Continuous cleaning, to prevent accumulation of dust, should be carried out as frequently as local circumstances require for maintaining safe conditions.

Process requirements should be reviewed to determine whether blending and screening operations could be conducted separately in order to reduce dust accumulation.

Reference Number of this Report: OI-109

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

OPERATIONAL INCIDENT REPORT NO. 110

Nitration Explosion

Description: An organic intermediate (to be nitrated) was dissolved in sulfuric acid and then mixed nitric and sulfuric acids added at a controlled rate to maintain relatively constant temperature (20°C.).

Following nitration the batch was gradually heated to 55°C. to complete the reaction.

Special precautions were taken to control heating because of known product instability above 150°C.

During the heatup cycle a violent reaction occurred, with considerable damage in all three floors of one 20' x 20' bay of a large manufacturing building. Three very minor injuries occurred.

The top head of the 500-gallon reactor was separated from the body of the vessel with enough force to throw it, accompanied by the agitator (a total of 540 lb.) a distance of over 500 feet.

Cause: A shortage of sulfuric acid shifted the sulfuric acid-intermediate ratio forming an unstable mixture on addition of nitric acid. When heated, an uncontrollable exothermic reaction occurred.

Calculations indicated decomposition could result in 2600 lb. pressure in the vessel from the volume of CO_2 released.

Thermal stability tests proved a serious exotherm at 60°C. resulting in development of 3300 lb. pressure.

Preventive Measures:

1. A better understanding is needed of potentially unsafe reactions especially those caused by an unbalance of reactants.

2. Positive means are being studied to assure the correct charge of critical components.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: OI-110

Duplication of this Report is authorized

POTENTIAL INCIDENTS

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 1

Wing Nut and Washer Imbedded in Propellant

Description: During a trimming operation, a wing nut and washer were found imbedded in the propellant at the bottom (as cast) of the motor. The wing nut and washer were the types used on the tie rods which hold the casting fixtures in place. Because of the design of the casting fixtures, loose wing nuts and washers are required in the assembly area. To assemble the motors for this batch, approximately 300 were required. Apparently the wing nut and washer fell into the assembled motor in the assembly area and were not observed before the motor was cast. No missing pieces were observed during the disassembly operation.

Preventive Measures: Modify all casting fixtures so that it is not necessary to remove the wing nuts and washers from the tie rods to assemble and disassemble motors, and modify the rods so that these items cannot be removed. This will eliminate the need to have loose wing nuts and washers in the assembly area. All other items required for motor assembly are too large to fit into the motor. In addition, establish a check list and a more thorough inspection procedure to check all motors for correct assembly and freedom from foreign objects before casting.

Reference Number of this Incident: P-1

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 2

"Close Call" in Chemical Processing

Description: A man wearing conductive shoes and standing on a wet conductive floor was adjusting a de-energized heating mantle which, presumably, was also wet from moisture dripping from a condenser nearby. A second man, thinking the adjustment completed, turned on the power. The victim received enough current to freeze his hands, but he was able to break the electrical circuit by kicking the mantle plug loose from its variac. It is considered that this man escaped serious injury or death only because the variac happened to be turned low (the exact setting was not established).

Preventive Measures: Since heating mantles cannot be grounded effectively, their use in rooms with conductive floors has now been prohibited in Chemical Processing. This accident prompted a review of all electrical hazards in the group facilities; a number of other weaknesses were found, and corrections were made. No action was taken on the special problem presented by anti-static use of conductive shoes and floors, because this is a complex problem. It was questioned that the hazard of handling explosives by ungrounded personnel is as serious as the hazard of electrical shock to grounded personnel in chemical processing operations. This question may be pertinent to the chemistry laboratories for which conductive floors are being considered.

Reference Number of this Incident: P-2

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 3

Glass in Dopes

Description: On September 1, 1961, while dope house crew was making netrogel 1 HV dopes, an unfamiliar noise was heard in the screen unit. A screen check was made and glass was found on the screen. Five dopes had been made up to this point since the last screen inspection and all five were destroyed. In an attempt to determine the source of the glass and to insure the remaining ingredients were free of glass, all apricot pit pulp, B-pulp, corn flour was drawn from the bins and rescreened and found to be free of foreign material. The ground soda was not suspected because of the manner in which it is processed and handled. Microballoon, barytes and chalk are not screened on the plant prior to use and one of these would be suspected. Manufacture of the dopes resumed after restocking the bins and with careful examination of the microballoons, barytes and chalk. No further foreign material was found and has not been found since.

Cause: It is considered that one piece of glass was in one of the ingredients not prescreened on the plant and that it broke up into smaller pieces in the feeder hoppers or dope screen. The glass found appears to be a high grade glass with a curvature and a slight twist. It is unlike any glass in any of the ingredient operations or warehouses.

Preventive Measures: This incident emphasizes the advantages of alert operators following procedures properly.

Reference Number of this Incident: P-3

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 4

Powder Spill

Description: On August 16, 1961, a trucker returning from the wheel mix went onto the siding and bumped into a parked shell truck, spilling approximately 10 pounds of powder. The shell truck was parked on the siding going into No. 1 Gel - the shell trucker was walking into No. 1 Gel to check on shells. The powder was cleaned up and put in bags for the burning ground, and the contaminated area was saturated with NG remover.

Preventive Measures: Both truckers were given oral reprimands. It was emphasized to the trucker who spilled the powder that part of his job is to keep alert and check the switches at all times to make sure they are set the correct way. The shell trucker was also told to return the switches to the main line position after going onto a siding.

Reference Number of this Incident: P-4

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 5

Metal Chips in Pulp

Description: On August 4, 1961, during unloading a shipment of pulp, metal filings and lath turnings were found stuck to the bottom of the bails of pulp that were unloaded from both ends of the car. Pieces of metal were found stuck within the steel strips of the floor of the car also.

Cause: Failure to clean car thoroughly prior to loading.

Preventive Measures: The shipping agency was promptly notified, and attention called to the hazard of foreign material, especially metal, being free around explosives manufacturing plants. It was requested that action be taken by the shipping agency to assure that future cars loaded with pulp are thoroughly cleaned out and in good condition prior to loading.

Reference Number of this Incident: P-5

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 6

Operator Caught in Feed Hopper

Description: On June 6, 1961, an employee at the Petron pack house received lacerations of index and middle finger of left hand, while checking feed hopper on Petron machine. The machine was in motion and the employee was standing on a chair, with his hand resting on the side of the hopper. His foot slipped and his hand went into the hopper causing the injury.

Cause: One of the causes for this accident was the practice of using a chair instead of a platform. A platform is provided for this inspection, and was near the location. Another cause was not shutting the machine down for the inspection. During the past 3 years, two lost-time injuries have resulted from this type of accident and violation of the "shut-down" is involved in 12.5% of all injuries.

Preventive Measures: Education and enforcement of the "shut-down" rule. A sign has been posted at this operation, next to the machine, with wording "SHUT DOWN MACHINE WHEN WORKING ON THE FEED HOPPER". Employees are required to use the platform provided for this job instead of a chair.

Reference Number of this Incident: P-6

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 7

Powder Spill - Loci Collision

Description: On June 2, 1961, a shell trucker was in the portal at 3&4 LLC unloading shells. The powder trucker was returning from the mix house with a mix of extra 40. He stopped and threw the switch leading into 3&4 LLC and started to proceed into the building. When he saw the shell house truck, he put on his brakes; however, the tracks were wet and he slid into the shell truck. About 2 pounds of powder spilled from one hod. The equipment was left standing until all the powder was cleaned up and NG remover had been put on the area of the spill.

Preventive Measures: The shell truckers were advised to leave their locies sit so they are visible from the switch point leading into the building. Blind spots should be eliminated by mirrors and speeds held down to allow adequate stopping distance in wet weather.

Reference Number of this Incident: P-7

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 8

Wooden Strip and Screws in Powder Hopper

Description: On April 19, 1961, a No. 1 Hall machine was packing its fourth mix of Giant Black Stumping 1¼ x 8 when the shear pins broke. The operator immediately shut down the machine. When they were cleaning the powder out of the hopper, they found pieces of quarter round and some screws in with the powder. All the powder was removed from the hopper and the belt and sent to the holdover for screening. The machine was cleaned and dismantled to determine where this piece of wood and screws had come from. It was found that directly over the powder hopper (where the ceiling meets the machine frame) a piece of quarter round that had covered the crack was missing. This piece had become loose and had fallen directly into the hopper. It is impossible for the operator to see anything clearly in the hopper when packing black stumping, so he could not see it fall, in order to shut down the machine before the shear pins broke. Damage to the stirrers was one broken pin.

Preventive Measures: This piece of quarter round was not replaced, but plywood was fitted to cover the ceiling above the machine. All ceilings and trim should be inspected carefully for loose fittings during building inspections.

Reference Number of this Incident: P-8

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 9

Overheated Stirrer Rod Bearing

Description: On July 19, 1961, at approximately 8:25 AM, the packer on No. 6 Starrett machine observed smoke originating from the right stirrer rod bearing. Both machines were immediately stopped and the building vacated. The bearing overheated and caused the grease to smolder; no flames occurred. The operator entered the building about 5 minutes later and found the smoke had subsided. The bearing cap was removed and cold water poured on the shaft and bearing to cool them. All powder was removed from the machines and taken from the building. A new stirrer rod was installed and the machine operated for a period of time to determine any evidence of the bearing and shaft heating. The building was back in operation about 2:00 PM.

Cause:

1. Bearing cap was too tight, causing it to contact the shaft and prevent grease from uniformly covering both shaft and bearing surfaces.

2. Stirrer rod bent slightly which may have created a whipping action to the end of the shaft.

Preventive Measures:

1. The incident was reviewed with all the packers.

2. The packers were instructed to operate the newly-installed stirrer rods by hand to be certain the bearings are not binding on the shaft. Also, to check the clearance between the stirrer pins and the stirrer box walls to be certain of proper shaft alignment.

3. To prevent the possibility of installing bearing caps improperly, dowel pins will be installed so that cap installation will be unidirectional.

4. The machine operator training program will be reviewed and revised as required to provide more complete training on all phases of machine operation with an emphasis on safety.

Reference Number of this Incident: P-9

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 10

Liquid Hydrocarbon Line

Description: A pipefitter, using a pipe-cutter, cut into a 1" liquid hydrocarbon line which was under approximately 100 psig of pressure. The pipefitter, upon noticing a pin-hole leak, stopped the job before there was any equipment damage or injury to personnel. Before this revised hydrocarbon pipe system was put in service, it was necessary for a 1" line in this system to be separated from the feed header. The supervisor instructed the pipefitter, pointing out the line to the craftsman and told him that it had been vented and prepared for cutting. The craftsman misunderstood which pipe was to be cut and proceeded to cut a pipe which was in service.

Cause: The supervisor did not clearly designate which pipe was to be cut. These pipe lines were approximately 12 feet from the ground and immediately below the open grating on the compressor house catwalk. The pipefitter, believing that he understood which pipe was to be cut, did not question the instructions.

Preventive Measures: Both the supervisor and the craftsman have been reinstructed on the proper procedure for such work and their responsibility to fully communicate and understand the job instructions. Other maintenance supervisors and craftsmen have been informed of this incident through their regular safety meetings.

Reference Number of this Incident: P-10

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 11

Chlorine Truck - Phenol Tanker

Description: A near-miss accident occurred when a truck carrying six cylinders of chlorine rolled into a tanker of phenol which was being unloaded. The phenol tanker was positioned by the tractor driver who had towed it, and a chock was placed in front of one of the front wheels to prevent rolling. A second chock was subsequently placed in front of one of the rear wheels. The tanker which contained approximately 900 gallons of phenol at 60-70°C was sampled by a member of plant study department. The foreman coupled up the tanker and proceeded to unload, using rubber hoses and compressed air. The truck carrying the chlorine arrived and stopped about 10 feet from the phenol tanker since it could not be unloaded until the phenol was transferred to the storage and the tanker removed. Total weight of the truck and chlorine was about 14 tons. There was a slight down-slope from the truck to the phenol tanker. A drum cradle from the melter was on the road opposite the chlorine bay, and this was moved by the three persons present (including the truck driver) thus diverting their attention. During this period, the truck rolled into the phenol tanker pushing it until the unloading hose and air line were fully extended. The transfer was stopped, and the truck moved, the phenol tanker pushed back into position, and unloading completed. The truck received some damage from the collision. The fact that the unloading hose was relatively new and special non-slip couplings to secure the hose to the vessel and the tanker were recently fitted prevented either a broken unloading line or one of the couplings failing. In either event, hot phenol would have sprayed the area. With the exception of the formalin tanker which is fitted with a brake, the usual procedure with tankers throughout the company is to chock the wheels to prevent rolling.

Cause:

1. The truck carrying the chlorine was not adequately braked and was parked in such a position that it could collide with the phenol tanker.

2. Chocking is only adequate to prevent rolling under own weight and not suitable to withstand external force.

Preventive Measures:

1. Adopt a general rule that under similar conditions, trucks at unloading points are not parked on a collision course.

2. Where hoses are used for either loading or unloading purposes, insure that secure and adequate couplings are used.

3. Carry out regular inspections of hoses used for these purposes.

4. Use warning signs marked DANGER TANKER UNLOADING.

5. Supervisors involved in the loading or unloading of tankers should insure that adequate safety precautions concerning the tankers are carried out.

6. Use more efficient chocks.

7. Check the hand brakes of all trucks.

Reference Number of this Incident: P-11

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 12

Mechanical Failure of Hydrostatic Press

Description: On August 14, 1961, at approximately 6:15 PM, a 20-inch hydrostatic press located in the press bay of the building ruptured during regular production pressing of 40 pounds of high explosive charge. The press was loaded with the 40 pounds of high explosives. It had reached its maximum operating pressure and had been on dwell for one-third of the required time when the pressure vessel failed. The operation was by remote control. The rupture occurred during the fourth pressing of the shift, which was the sixteenth pressing for the day. This rupture was at or near the first full thread, approximately 7 inches up the inside wall and 4½ to 5½ inches up the outside wall of the bottom portion of the vessel. There were no injuries. The vessel, support stand and pipe fittings were damaged. There was no building damage. No fire or explosion resulted.

Cause: An imperfection, in the form of a groove or tool mark was detected in the vessel after the incident. It was located in the bottom of the first full thread of the bottom closure. As a result of a high localized stress riser, metal fatigue developed, resulting in sudden failure and rupture of the pressure vessel without warning.

Reference Number of this Incident: P-12

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 13

Foreign Material in Powder Hopper

Description: The shear pins broke on the stirrer of an LLC machine. The machine was stopped and the powder hopper cleaned out, the stirrer removed, and the powder, hopper and stirrer examined. A piece of wood 8" long and ½" thick, crescent shaped and 1" wide at the widest part, was found in the powder hopper. It was found that a piece of wood had broken off the bottom of a fiber dope drum at the wheel mixer.

Cause: This was an obvious case of everyone not paying close attention to what he was doing. This large piece of wood should have been found by 4 different operators: the one that dumped the dope into the bowl, or that shoveled the mix from the bowl into the hod, or that shoveled the powder from the hod into the powder hopper, or that raked the powder into the stirrer box.

Preventive Measures: This near accident points out the necessity for everyone to be continually alert and watching for unusual happenings that may occur. Incidents of foreign materials getting into powder equipment emphasize the need for all personnel to realize the large explosion potential involved and the increased caution needed to prevent such incidents.

Reference Number of this Incident: P-13

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 14

Foreign Object in Powder Hopper

Description: An operator on an LLC machine was finishing the last of his powder. He had removed the powder from under the machine and rescreened it all but the last two dust pans full. This he threw directly into the powder hopper. It was then noticed that a foreign object was in the hopper, but before he could shut off the machine, three stirrer pins were broken off the stirrer. The machine was cleaned, all the powder removed and screened. The foreign object was a bolt from the double connectors. The stirrer was repaired and the equipment inspected before the machine resumed operations the following day.

Cause: A contributing factor to this near accident was the bolt in the bottom of the machine. The repairman had changed the machine that morning from the double connected 8 tamp set-up to the 16 tamp set-up. At this time, the repairman must have lost this bolt that eventually wound up in the powder hopper.

Preventive Measures:

1. The operator was reprimanded for failing to screen all powder before it was reworked, and it was pointed out that this was a violation of a safety practice that has been set up to prevent such an occurrence as this.

2. Repairmen have been cautioned to make sure that all equipment has been removed, intact, when a machine change or size change has been made.

Reference Number of this Incident: P-14

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 15

Runaway Railroad Cars

Description: Two employees were about to move two railroad boxcars that had been spotted for unloading at the rear of the ingredients dry house. The leading car had been unloaded the previous day, and the cars were to be moved so the second car could be spotted for unloading. The cars had been choked with one steel rail clamp and one wooden chock. In preparation for moving, one employee withdrew the steel rail clamp and set it further along the track, and the other employee then took out the wooden chock. With this, the cars began to move and, since the track has an incline, they were soon out of control. The front wheels of the lead car hit the steel rail clamp and forced it along the track for a short distance. When the clamp again took hold, it then acted as a de-rail; and, with the loaded car pushing, the lead car was forced off the track with all wheels and traveled for a distance of approximately 38', narrowly missing the ingredients dry house before it came to a stop.

Cause: Failure to check if the brakes had been applied when the railroad crew spotted the cars and failure in not having a man handling the brakes when the chocks were pulled.

Preventive Measures:

1. All employees re-instructed that no car of this type be moved without a man on the brakes.

2. Emphasize that safety rules and common sense be practiced while in performance of all duties.

Reference Number of this Incident: P-15

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 16

Oleum Spill

Description: A mechanic proceeded to the sulfonator-neutralizer area in the phenol plant to repair a leak in the oleum transfer line from the acid plant. He signed in on the maintenance log with the operator and requested the acid plant advised and the oleum valve closed and tagged at the acid plant. The mechanic then went out to the oleum tanks to watch for the acid plant operator to go out and tag the valve (distance between oleum tanks and valve approximately 100 yards, but clearly visible). Mechanic did not see anyone go out to the valve, so he proceeded to the acid plant and asked the swing shift acid operator to close and tag the valve for repair work on the line. The acid operator and mechanic together went to the valve, which is an overhead valve operated with a chain from ground level. The valve chain was tagged and locked, and the mechanic proceeded to repair the line. A second mechanic took over the repair job approximately 1½ hours later, as the repair was incomplete, and the first mechanic told him that the valve chain was tagged and locked out at the acid plant. The line was cut open. When it became apparent that the repair would require much longer than first expected, the job was postponed until the next day and the line was left open. A note was placed in the head operator's log book in phenol that the job would be completed the next day; the mechanic noted on the maintenance log at the sulfonator-neutralizer area that the job was incomplete; and he called the acid plant and asked them to note in their log book that oleum should not be pumped the next day because the line was not repaired. The next morning the acid plant day shift head operator read the note concerning the line repair and was uncertain whether repair had been completed. He called the phenol sulfonator-neutralizer operator who checked the line in the vicinity of his valves and told the acid head operator that as far as he knew, the line was all right. He was busy with process difficulties due to a stuck neutralizer agitator at this time and did not check the maintenance log which showed the job as incomplete. He did not know what the job on the oleum line was although he could tell work had been done there since a 12'x12' canvas tarpaulin was suspended in the vicinity. He did not look up at the pipe line to the level of the pipe bridge where the line was open. The acid head operator advised the acid A operator that the phenol sulfonator-neutralizer operator said the line was all right and told the A operator to pump the oleum. The acid head operator then went to the personnel building to talk to the mechanic who was just coming in to work. He asked him the status of the work on the oleum line and the mechanic told him the line was open and would not be completed for some time. About this time, the acid A operator proceeded to open the valve which started oleum moving to phenol plant. He walked back to the control room and immediately the sulfonator neutralizer operator phoned to tell him to shut the oleum line off due to an oleum spill. Estimated quantity of oleum spilled was 25 gallons. No one was injured.

Cause:

1. Failure to follow correctly the lockout and tagging procedure.

2. Failure to make proper use of the maintenance log.

3. Lack of a designated responsibility for the oleum transfer line.

Preventive Measures:

1. At the time of shift change, operators, as part of the normal informational exchange, will check the maintenance log for possible work going on in that area.

2. All operators and maintenance people will be given a review of the proper maintenance log procedure.

3. All operators and maintenance people will be given a review of the tagging and lock-out procedure with special emphasis on:

a. Use of personal locks.

b. Proper use of tag signatures (who signs, what he signs, and when and by whom may the tag be removed).

4. Establish responsibility for interdepartmental pipe lines (preferably a single department's responsibility).

5. Consistent with normal acid plant procedure, future work on this particular line be done only after the pumps have been locked out or the line blinded.

Reference Number of this Incident: P-16

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 17

Oil Heated by Open Flame

Description: For several years turbine wheels have been placed on the shaft by using a hot oil bath to expand the hub of the turbine wheels. No accident has been experienced by using this method but the potential was always present.

Cause: The oil used for the bath had a flash point of 400° and was heated for several hours by four torches (four welders). The bath temperature often exceeded the flash point because the flame was hard to regulate accurately. Fumes from the hot oil were unpleasant to personnel besides causing a fire hazard. As the wheels were removed from the bath, oil drippings on the floor created a slipping hazard. By the old method it was very dangerous for the machinist to measure the opening because it was necessary to reach across the hot oil and near the flame to reach the center of the wheel.

Preventive Measures: A new assembly (case) has been fabricated which is well insulated and electrically heated. The heat can be raised to 600° without any danger of fire or hazard to personnel. Besides eliminating the various hazards, the job can be done with a fraction of the manhours formerly used. The degree of expansion can now be measured easily by simply removing a small section of the top insulation without any hazard to the machinist.

Reference Number of this Incident: P-17

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 18

Foreign Material in Mix

Description: Operator at gelatin mix house noticed, when he lifted screen out after last dope of day, that three screws were missing from the underside screen. He noticed one of the screws in the mix that was still in the hopper. The mix was screened, but the other two screws were not found. The prior mixes were then hand packed in order to avoid the possibility of introducing the screws into the pack machine.

Preventive Measures: Existing procedures indicate that no repairs or changes in equipment can be made without proper authorization. Disciplinary action has been taken and existing procedures will be emphasized.

Reference Number of this Incident: P-18

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 19

Contamination - Foreign Material

Description: The helper shoveling onto the machine belt noticed a nail on top of the gelatin in the hod. This was a hod of gelatin which had just arrived from the mixing house. The helper immediately removed the nail and reported this to the assistant supervisor. The nail appeared to be a box nail approximately 1-5/16 inch long x 5/64 inch thick. This machine had been down 2 wee for flourescent light installations, general machine clean-up and repainting, and was thoroughly inspected by building operators, repairmen, and the powder line supervision prior to start-up. A semi-annual inspection had just been completed on this building.

Cause: It is not known where this nail came from or how it made its way into a powder hod. There was no evidence that the nail had gone through the mixing house due to its cleanliness. The only possible explanation is that this nail could have stuck somewhere on the inside of the machine housing. Why it would have been there is a mystery as nothing of this nature is ever used in a powder building.

Preventive Measures: This is another instance where an alert operator prevented a possible serious incident.

Reference Number of this Incident: P-19

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 20

Contamination - Foreign Material

Description: While adding Gianite "D" to the dynamite mix house screen, the operator noticed a piece of wire lying on the screen. He immediately removed the wire and reported the incident to the Dynamite Line Foreman. The round wire was in the shape of an "L" approximately 1-5/8 inch on the vertical, 1 inch on the horizontal and 3/32 inch thick.

Cause: In checking sources of contamination, the Ingredient Dry operation receives bales of S-Pulp and B-Pulp encased in burlap and held together with wire of this thickness. It is normally in a continuous piece around the bale, approximately 4 pieces per bale. Operators in this area said no small pieces had shown up but may have been in the baled material and got by the screen. It is hard to understand why the dope house magnet did not pick up this metal.

Preventive Measures:

1. It is felt the dope house magnet is unsatisfactory and is on the agenda to be replaced at the time the new chute is installed in the near future.

2. Incoming shipments are to be carefully inspected for contaminations.

3. Suppliers of ingredients have been reminded of the dangers of contaminated materials.

Reference Number of this Incident: P-20

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 21

Nitroglycerin Neutralization

Description: The foreman was notified by the nitroglycerin neutralizer operator that the charge was not settling out properly after neutralization. They proceeded to the tank (Tank No. 3) which contained a normal volume, but there was only about 5 inches of soda water above the nitroglycerin layer. After bringing the charge up with air again and "pulping" the same amount of soda water was above the nitroglycerin layer. On questioning the operator, the foreman learned that he had prepared Tank No. 4 to receive a charge of UNG, and the nitrator man called and said that he would ship the charge in 5 minutes. The operator turned the air agitation on, but turned the agitation on to Tank No. 3 instead of Tank No. 4. Shortly thereafter, he realized the air was on Tank No. 3 and the hose set to Tank No. 4, so he moved the hose to Tank No. 3 which had the agitation on. He proceeded about his work and then realized his error and threw the hose back to Tank No. 4 while the nitroglycerin was coming in. He neutralized the UNG in Tank No. 4 after bucketing about 4 inches of soda water from No. 3 Tank. It was later discovered that the thermometer was broken during these proceedings.

Cause: This was a case of an operator becoming confused, then panicking and trying to cover a mistake. The operator had just recently finished his complete nitroglycerin training.

Preventive Measures:

1. Operator was removed from job of nitroglycerin operator and placed on his permanent job of magazine helper, with understanding he would not work with nitroglycerin again. This incident emphasizes the importance of careful selection of personnel for critical jobs and the need for corrective measures when in doubt as to capabilities.

2. The building, tanks and hoses were washed several times with hot water in order to decontaminate from any spilled nitroglycerin or foreign materials.

Reference Number of this Incident: P-21

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 22

Derailment - Loaded Anhydrous Ammonia Tank Cars

Description: Two shipping and blending operators were switching four loaded anhydrous ammonia tank cars from Track 4 to Track 5 when the back tandem of the third car "split the point" of the switch. The back tandem of the third car and the front tandem of the fourth car were derailed. The first two cars in the string had gone through the switch and were still on rail. Luckily, the string of cars were just put in motion and there wasn't sufficient speed to overturn any of the cars.

Cause: Investigation showed that the switch had been thrown properly and that the switch arm was locked in the correct position. There was no indication of poor operation by the operators.

Reference Number of this Incident: P-22

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 23

Fire - Pelletizing Operation

Description: A mill stopped due to a bolt from the bulk flow going into the mill and causing the screen to jam the rotor blades. The drive motor kept running and the drive belts caught fire due to friction between the belts and the sheave. The first indication of the trouble was a smell of burning rubber. The crew immediately shut the system down, found the fire and extinguished it by turning on the water from the line directly above the mill. It had been kept clean so that there wasn't much ammonium nitrate in the immediate area at the time. After the fire was out, the mill was cleaned up and the screen replaced. A machinist installed new belts and the system was put back in operation.

Cause: Loose bolt from bulk flow causing screen to jam rotor blades in mill.

Preventive Measures:

1. All personnel have again been instructed to be alert for any signs of a stoppage and to keep the area clean.

2. All belts in the system have been checked and tightened, if necessary.

3. The bulk flow has been overhauled.

4. A study is underway to find a method for stopping the drive motor when the mill stops. This situation is difficult to correct since the mill stops very quickly when a screen is jammed and the drive motor cannot be stopped as quickly.

5. Elastic stop nuts may prevent loose nuts and bolts, and timing belt control for motor would give instant shutdown.

Reference Number of this Incident: P-23

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 24

Powder Spill

Description: A trucker was taking a hod of screened gelatin from the Holdover to No. 2 Talley when at the crossover near the JP the truck climbed the frog and dropped off the track. When it did, the straight bar side rail jumped out of its holder and let the hod roll off, spilling 150 pounds of gelatin down the side of the track bed. The spilled powder was cleaned up into waste sacks and sent to the burning ground. The immediate area was decontaminated with Nitroglycerin remover.

Cause:

1. Derailing of tram car.

2. Jolting of the side rail out of its holder, ensbling powder hod to spill.

Preventive Measures:

1. The Holdover tram car is a single side rail car with the supporting brackets straight up and down with no offset to keep the bar in if it was jolted or strained. This car was pulled out of service until a split side rail is installed on it.

2. The track and the tram car were checked and everything was in proper order. Further observations will be made of tram cars passing through the frog.

Reference Number of this Incident: P-24

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 25

Fire - Mixer Motor

Description: During a routine check of the Dynamite Mix House, a line foreman detected a strong odor of something burning as he entered the lower barricade. Upon reaching the building he checked the motor room and found it full of smoke. He notified the crew who shut off the Mix bowl and left the building. Returning to the motor room the foreman pulled the main switches on both motors and found the motor that drives the stirrers smoking with the brake end very hot. Supervision was notified, the building checked, and the plant Engineer assigned electricians to locate the trouble. During the interim two batches of mixed powder were removed from the building with one remaining in the Mix bowl.

Cause: The electricians found that the holding coil on the motor brake had burned out leaving the brake in an "on" position.

Preventive Measures: A new coil has been installed with the brake being locked into off position.

Reference Number of this Incident: P-25

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 26

Loose Clamp Ring - 8.5-inch Test Motor

Description: An 8.5-inch motor was being removed from a conditioning oven for firing when it was noticed that the clamp ring which holds the pressure take-off in the motor case was loose. The clamp ring did not engage the flange on the motor case. The operator reported this to his supervisor. The clamp ring, a Vee-type, should engage flanges on the case and pressure take-off plug. In this instance, one leg of the vee was between the flanges so that the plug was completely free except for the squeeze of the O ring. However, the construction of the clamp was such that the gap was completely hidden except for a narrow segment under the tightening bolt. The plug was in this position during casting and subsequent handling, since a small collor of propellant was found between the plug and the forward-end of the mandrel. The plug was removed from the motor using the following procedure: the forward end of the motor was filled with water to prevent accidental ignition and the plug was slowly withdrawn. There was no propellant between the plug and its mating surface in the case.

Preventive Measures: Each motor case will be checked for proper plug position before it is sent to propellant processing. The fact that this has been done will be noted on the inspection sheet. The group leader has been advised of this incident so that his group can also run a check before casting set-up.

Reference Number of this Incident: P-26

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 27

Truck Transporting Anhydrous Ammonia Overturned

Description: At approximately 8:15 AM, a tractor-semitrailer-full-trailer combination transporting 37,200 pounds anhydrous ammonia in bulk ran off the highway and overturned. The truck was traveling between 40 and 50 miles per hour as it neared the accident scene. Physical evidence indicates that the truck drifted to the right, off the pavement onto the unsurfaced shoulder, and that the driver attempted to bring it back onto the roadway by turning abruptly to the left. The three units of the combination then overturned, rolling completely over the top and landing on their left sides on the south shoulder of the highway. The tractor and semitrailer remained coupled, but the full trailer became separated from the combination. There was no cargo loss. Damage to the truck was approximately $6000.

Cause: Driver fatigue occasioned by excessive periods of on-duty time without the necessary rest. Investigation disclosed no mechanical defects which might have contributed to the accident.

Preventive Measures:

1. Further investigation of the practices of the carriers involved in this accident.

2. Continued emphasis that motor carriers of dangerous commodities have a special duty to the public and assume a high degree of responsibility. Lax practices and disregard for important requirements cannot be tolerated.

Reference Number of this Incident: P-27

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington 25, D. C.

ASESB Potential Incident Report No. 28

Dynamite Spill

Description: A shipping house operator noticed, after receiving 6 or 8 boxes of dynamite, that the belt on the overland conveyor was slowing down. The operator inquired if the hall machine house was not receiving material and was informed that the hall machine house was continuing to send boxes of dynamite to him. He immediately shut off the conveyor and the line supervisor investigated the situation. It was found that a ½" wide bronze metal strip running parallel on each side of the conveyor housing had sprung loose, penetrating one of the cases and jamming the other cases on the conveyor. Some of the sticks of dynamite from the box spilled onto the belt, and the other boxes jammed behind slowed down the conveyor.

Preventive Measures:

1. The strips on the overland conveyor have been secured to the conveyor by means of countersunk smooth head bolts.

2. An inspection schedule has been set up so that conveyors are considered part of the building and the inspection of the conveyor has been made a part of the shift pre-start-up house inspection schedule.

Reference Number of this Incident: P-28

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Potential Incident Report No. 29

Description: In attempting to pump a batch of crude chloro (an intermediate) from wash vessel to a filter, it became apparent that the transfer line was blocked with a sulfurous mass. After failing to clear the blocked line with air pressure, the usual procedure of steaming the line was followed. The line was steamed intermittently for approximately 6 hours without clearing the blockage. During the course of the steaming, the temperature of the chloro batch in the wash vessel rose from 135°F to 210°F. Reasonable safe temperature for crude chloro at this stage is approximately 160°F. The temperature rise of the batch was not noticed. After failing to unblock the transfer line with steam, the batch was pumped to an idle vessel. One hour later excessive pressure was built up in the idle vessel as indicated by a level gauge and by the rupturing of the gasket on the manhole cover of the vessel. At this point, the batch was intentionally discarded to the sewer to prevent a possible explosion. Due to the hazardous conditions existing, operations were suspended for 2½ hours and operations in adjacent buildings were suspended for one hour.

Cause: During the course of steaming the blocked transfer line, steam leaked up into the wash tank through its discharge valve which was not completely closed due to sulfur deposits in its seat. This steam heated the chloro batch in the wash tank to the point where it began to decompose. When the batch was transferred to the idle vessel it continued to decompose. Decomposition products blocked the flame arrestor cartridge in the idle vessel vent, and the ensuing pressure build-up ruptured the gasket in the manhole cover.

Preventive Measures:

1. Due to the instability of chloro at high temperatures, the importance of closely watching the temperature of chloro batches at all stages, especially during any steaming operations, was re-emphasized with all personnel connected with the chloro process. Under no circumstances will the temperature of the batch be allowed to rise above 160°F.

2. The use of air or steam to clear blockage will no longer be used. The pipes will be disconnected when a blockage occurs.

Reference Number of this Incident: P-29

Publication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Potential Incident Report No. 30

Removal of Safety Seal Assembly from Active Vessel under Heat and Vacuum

Description: A pipefitter assigned to the process expansion was instructed and shown by the area production supervisor and the group leader to remove a safety disc from the deactivated No. 1 still. This disc was to be used on a new vessel being installed. Approximately 6:00 PM, the pipefitter and group leader asked the process foreman if they could remove the designated disc. Permission was given, but it was not until 8:30 PM that the pipefitter, thinking he was working on the No. 1 still as previously shown, actually removed the safety seal assembly from the adjacent active No. 2 still. A blank was substituted but not securely bolted down. Fortunately, at the time, Still No. 2 was in the process of cooling prior to dropping the residue. At approximately 4:00 AM the next morning, an operator noticed that the safety disc had been removed when, upon purging the vessel with CO_2 prior to dropping the residue, fumes emitted from the loosely connected blank. Several hazardous conditions could have resulted if the No. 2 still was not in the cooling phase, such as: formation of hazardous decomposition products which are potentially explosive upon contact with air; building could have filled with flammable and explosive vapors; pipefitter could have been hit with hot vapors if No. 2 still was in stripping phase; sudden break of vacuum could have caused residue to erupt and spill out through pipe if source of heat was not turned off.

Preventive Measures:

1. Tag all vessels or parts of vessels that are scheduled to be worked on.

2. Identify all vessels clearly.

3. All maintenance foremen should be advised of the potential hazards in every process.

Reference Number of this Incident: P-30

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Potential Incident Report No. 31

Description: An incident occurred in a dynamite factory which could have been serious. The automatic cartridging machine was cartridging dynamite. The breakage of a wire of known gauge which secures the coupling between the two sides of a gap on the drive shaft of the agitators in the feed hopper caused the machine to stop. This breakage constitutes one of the safety devices on the machine. It occurs sometimes several times a day whenever the mixing load increases slightly (thick powder passing poorly) or when the wire breaks from strain. The replacement of a wire, normally, is very easy; it is sufficient to turn the driving disc slightly in order to bring it into a good position in relation to the driving device. However, that day, the shafts were jammed from the two sides of the gap and it was necessary to dismantle a part of the machine before starting it again. The explosive in the machine was then removed and cased in order to be transported to another building. Upon examining powder in these cases in the other location, the presence of a castellated nut was found. The examination of the stopped machine showed that a nut was missing on a piece of equipment which is activated by an alternate vertical movement driven by compressed air and located over the hopper box receiving the explosive to be cartridged. The nut is usually accompanied by a washer and secured in place by a bolt, but the washer and bolt have not been found, in spite of a complete screening of the powder. This incident has shown the effectiveness of the safety device which stops the machine as soon as mixer shafts encounter abnormal resistance. It has also shown that the bolting of the nuts is not a sufficient precaution if the state of the bolts is not regularly examined. Finally, it shows the vulnerability of machines in which a part of the mechanism is located, exposed, above the hopper box receiving the explosive.

Preventive Measures:

1. All nuts and bolts on the machine located above the hopper box were inspected and the machine was restarted without incident.

2. A linen cloth, intended to collect any objects which would come loose from mechanism, has been stretched above the hopper.

3. Instructions have been issued to inspect the bolting of all the nuts twice each month.

These measures apply to all machines in which any part of the mechanism is located above the hopper box receiving the explosive to be cartridged.

(Foreign source)

Reference Number of this Incident: P-31

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Potential Incident Report No. 32

Tank Incident -- Nitrogen Introduced Instead of Air

Description: The removal of a side entering agitator from the MOR wash water hold tank was necessary in order to make repairs to the shaft seal. The propeller had to be removed from inside the tank before the unit could be pulled. The tank is located outside the west wall of Building 91 with a manway adjacent to the second level exit platform. The tank dimensions are 11' straight side x 8'6" diameter. The required work was undertaken by the plant construction group in conjunction with a changeover for a defoamer run in the MOR equipment. The tank had been previously cleaned by boiling with Santomerse, boiling with Safety-Solv, and rinsing.

The maintenance foreman in charge of the work initiated a tank entry permit (work permit) at about 11:00 a.m. after checking the tank with an explosimeter and getting a safe reading. He noted under the "Protective Equipment" heading that safety glasses and a wrist harness were required. He took the permit to the Building 91 production foreman, who approved it after noting under "Special Precautions" that air was to be bled into the tank during the time that a man was inside. The Building 91 head operator then signed the permit. The maintenance foreman then gave the permit to the men who were to perform the work. He pointed out the air bleed requirement and left the immediate area to attend to other matters.

One of the men obtained a length of new rubber hose from the storeroom to use in providing the air purge and returned to the building. No one was readily available who could show him where to tie into an air supply so he took it upon himself to find a convenient source. He chose a 1/2" valved outlet on what he thought was the plant air header, connected the hose, put the other end into the tank, opened the valve and began to purge at about 11:45 a.m. In reality, he had unknowingly tied into a nitrogen header. The men left to perform a variety of activities which included eating lunch and having a tank ladder made up.

At about 1:45 p.m. the men returned to the job site and, with the nitrogen purge still on, one entered the tank with the other outside the manway. He entered without wearing a harness of any type. The man outside asked him if he wanted a wrist harness as he climbed down the ladder. He refused, stating he would only be a minute. (A wrist harness had been procured and was at the job site.) The man reached the botton of the tank, took a crescent wrench from his belt and started for the agitator. At this time, his vision began to "go black" and he felt dizzy. He immediately came back up the ladder and

managed to get his head and shoulders through the manway at which point the man outside helped him the rest of the way out. Total time in the tank is estimated at considerably less than one minute. The exposed man partially recovered upon reaching fresh air but some dizziness persisted. He reported to the dispensary at 2:20 p.m. where he was given oxygen and recovered completely.

Contributing Factors and Observations:

1. The exposed man did not wear a wrist harness upon entering the tank in direct violation of tank entry procedure and the specific instructions on the work permit issued for the job.

2. The time lapse between issuance of permit and actual entry was excessive.

3. Oxygen content in the tank was not determined at any time, not even at the time work was eventually completed after this incident.

4. Had oxygen content been determined before approving permit as is sometimes done, this incident would have still occurred.

5. Advisability of using plant air to provide safe breathing atmosphere is questionable due to possibility of contamination.

6. Pipe lines are not identified.

7. Availability of self-contained breathing unit for emergency use was not specifically checked before entry.

8. There was no deviation from normal practice with respect to preparations and testing before issuing or approving work permit; it can therefore be concluded that normal practice is not adequate.

9. Two process lines tied into tank were not blanked off.

10. Tank was well cleaned.

Cause: Inadequate Tank Entry Procedure.

Preventive Measures:

1. The following items should be made part of revision to the entry procedure now being prepared:

a. Make tests for explosive mixture, oxygen content and suspected toxic contaminants mandatory for all tank entries.

b. Limit time lapse between testing and actual entry; provide for continuous or periodic testing during and after entry.

c. Strengthen rule on use of safety harness.

2. Redesign work permit to serve as a check list for items required by revised entry procedure.

3. Prohibit use of plant compressed air for providing breathing atmosphere in vessels and maintain an adequate number of Lamb air movers or similar devices for this purpose.

4. Design "Tank Entry Kit" to include at least the following items:

a. Wrist harnesses and extra rope

b. Explosimeter

c. O_2 analyzer

d. Gas detector

e. Self-contained breathing apparatus

f. Communications device

g. Entry procedure in outline form

5. Provide training for appropriate members of supervision on all aspects of the new tank entry procedure.

Reference Number of this Incident: PI-32

Duplication of this report is authorized.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Potential Incident Report No. 33

How Safe is the Empty Reagent Bottle?

Description: Most laboratory technicians take the safety precaution of working with and handling only prescribed laboratory glassware, equipment, etc., which is considered to be safe and adequate for the intended purpose. However, safety does not stop with the using of the right equipment as a chemist at this Arsenal learned through an unfortunate mishap.

A reassigned chemist was performing the routine chore of dusting the reagent bottles he found stored on the chemical shelf of his new worksite. He removed the ground glass stopper of an empty reagent (250 ml) bottle which had previously held ether $(C_2H_5)_2O$. When he replaced the stopper, there was a sudden explosion which completely disintegrated the stopper, neck and shoulder of the bottle. Fortunately, no injuries or property damage (other than the bottle) resulted.

Cause: After careful investigation, it was learned that the explosion was caused by a residue of unstable peroxides and/or oxides of ether, which had formed in the ground glass portion of the bottle. Ignition was initiated by the friction heat generated when inserting the stopper.

Preventive Measures: All laboratory personnel should be constantly aware of the danger of allowing chemicals and empty chemical containers to accumulate and to remain on shelves indefinitely. Equipment and apparatus should be thoroughly cleaned after completion of work.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: PI-33

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Potential Incident Report No. 34

Anhydrous-Ammonia Handling

Date, Time & Place of Accident: March 30, 1965 - 11:15 A.M., Acid Department, Ammonia Storage Tank Area.

Injuries: None Equipment Damage: One 1-1/2" ammonia valve and the paint on 2 storage tanks.

Material Loss: 15,000 lbs. of anhydrous ammonia.

Description: About half-way through the unloading of a 40,000 lb. anhydrous ammonia tank truck, a stream of ammonia was noticed leaking out of the bonnet of the stop valve on the liquid unloading line at the tank. The truck was immediately taken off the line and the storage tank vented to the AN neutralizing pit to relieve its pressure.

In the meantime, the acid mechanic investigated the leak and determined that the bonnet on the valve was cracked and nothing could be done short of replacing the complete valve.

Considerable time and difficulty were encountered in reducing the pressure on the tank sufficiently to stop the flow of liquid ammonia as there is no shut-off between this valve and the tank. However, by using the Frick compressor and exhausting it to the atmosphere, the pressure on the tank dropped sufficiently to install a new valve with the aid of a Scott Air-Pak mask.

Investigation: This storage tank is part of a typical anhydrous ammonia system containing 4 storage tanks in all. Two of these tanks are used for the AN neutralizer through a separate piping system except for the liquid unloading line which is common to all. The tank in question plus the fourth tank are heated and segregated for AOP use.

Ammonia is received by tank truck and unloaded through a combination of the truck's liquid pump supplemented by the plant's Frick compressor. The pressure on the line at the time of the incident was estimated at 140 psi.

Valving on both tank systems are similar employing Vogt 120 series monia Valves (300 lb) and all valves are at ground level except emergency shut-off valves in the older AN neutralizer tanks which would have helped considerably in this situation had they been available on tank involved.

Examination of the valve afterwards revealed a 2-1/2" crack following the transition line between the rounded body and flattened bonnet flange with a bonnet stud in the center. For a closer examination of the 'break' metal, the cracked section was broken loose from the body requiring only

PI-34 - Continued

a light hammer tap. The thin white sections were bright metal and were all that held the valve together. The remaining area of the 'break' had been dulled somewhat but the absence of rust leads us to believe it was a 'fresh' break.

Conclusion: The incident was a result of a flaw in the valve coupled with an induced strain from excessive pressure on one of the stud bolts. The strain probably occurred when the valve was overhauled two months ago although the mechanic who did the job does not recall any difficulty. He has done the same job many times in the past.

Action Taken:

1. Publicize this incident as an illustration of the dangers in handling Anhydrous-Ammonia and the need for careful cleaning of gasketed surfaces and uniform take-up on holding nuts.

2. Install emergency shut-off valves on the liquid ammonia lines as close to the tanks as possible and set-up a schedule to test periodically to insure ease of operation during emergencies. These valves will also assist in the periodic renewal of the lead seats of the regular stop valves.

3. Replace all 300 lb valves in the liquid lines on the AOP (heated) storage system with 600 lb valves to provide a greater margin of safety. This is recommended in the engineering standards. Such valves are now in service on all ammonia lines in the AOP but were not originally specified on the storage tanks.

(REPORTED BY E. I. DU PONT DE NEMOURS & CO. THROUGH THE INSTITUTE OF MAKERS OF EXPLOSIVES)

Reference Number of this Incident: PI-34

Duplication of this report is authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Potential Incident Report No. 35

Safety Cable Pays Off

Description: A safety cable prevented a press motor from falling to the floor, and, in all probability, averted a serious injury.

This large motor has a safety cable that extends to the overhead structural steel of the building. The bolts supporting the motor and platform broke, allowing the unit to fall free of the press. However, the safety cable, installed to cope with just such an incident, limited the motor's fall.

All of the press motors are equipped with safety cables in the plant (non-AEC) in which this accident occurred.

(REPORTED BY AEC TO THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Incident: PI-35

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Potential Incident Report No. 36

Caustic in Aluminum Tank Trailer

Description: In the course of trying to recover some monochlorobenzene (MCB), we almost had a very serious accident.

The MCB has been stored in a tank for about two years. There was a trace of phosgene in the MCB when it was put in the tank, and it had slowly hydrolyzed. We used 25% caustic to neutralize the acid values, but ran into an emulsion. To break the emulsion, it was pumped through a filter into a mild steel tank trailer, starting on a Thursday.

On Saturday the trailer sprang one leak which was patched. Again on Sunday, it started to leak.

On Monday we called the tank trailer manufacturer and told them what the problem was and that we needed another mild steel trailer to replace the one we had. Later the same day the second trailer arrived. We then started to pump from the leaking trailer into the new one through a filter. After about ten gallons had been transferred, the filter started to leak.

It took about half an hour to repair the filter. As they were getting ready to start the filter pump back up, a supervisor climbed on top of the trailer to check the flow. He looked in the hatch cover and saw that the material in the trailer was boiling or effervescing. A closer inspection of the trailer showed that it was aluminum and the caustic was reacting to form hydrogen.

The contents of the trailer were dumped and nitrogen hose was used to purge the tank. Simultaneously, the trailer was washed with water.

(REPORTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION, INC.)

Reference Number of this Report: PI-36

Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington, D. C. 20315

POTENTIAL INCIDENT REPORT NO. 37

Liquid Hydrogen Storage Tank Stack Fire

During an early evening electrical storm, fire was detected at the terminus of the 2" diameter, 16' boiloff stack for a rented 1500-gallon liquid hydrogen storage tank. That the flame height varied between 2 to 12 inches was attributed to fluctuations of the flapper valve on the stack terminus.

Emergency personnel and two local fire companies responded to the scene. They were instructed to stay clear and permit the flame to burn. Responsible authorities arriving at the scene decided to allow the flame to burn until morning. Guards were posted to keep personnel from the area.

The following morning, advice was received from the hydrogen supplier, who was also the tank owner, to play water upon the stack to assure cooling and then to close the valve on the boiloff line to cut off the gas supply feeding the flame. After determining, from pressure gauge readings, that the tank had not been affected and after application of water spray to the vent until it felt cool when touched, the valve was closed and the fire snuffed out. The stack was sprayed again to assure cooling and, following a five-minute waiting period, the boiloff valve was reopened. No reignition occurred.

Following the incident, a conference was held with the hydrogen supplier. It was agreed that the supplier would provide a nitrogen-pressurized water tank connected to a water spray system to afford added hydrogen storage tank protection in the event of a fire.

(REPORTED BY MANUFACTURING CHEMISTS' ASSOCIATION, INC. FROM AEC)

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Duplication of this Report is Authorized.

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Nassif Building
Washington D. C. 20315

Potential Incident Report No. 38

Fluorolube - Aluminum Detonation Point

The following information was received from a participant and includes information which was developed by test to solve the subject problem.

Introduction: Fluorochloro-lubricants have been known to detonate while being used on aluminum fittings. Information concerning this reaction has been gathered from correspondence with other laboratories and discussion with plant personnel who have experienced such a reaction. The following is a resume' of the knowledge of this phenomena known before the subject test.

1. An explosive reaction may be encountered when fluorochloro oils or greases are in contact with aluminum under high loads.

2. Fresh aluminum, e.g. rubbing of bearing surfaces under heavy loads, free from oxide coating is required for a reaction to occur.

3. The reaction seems to occur when Fluorolube is contained in a confined aluminum space and a pressure is applied. According to one source this reaction between Fluorolube and aluminum may be induced if a small amount of Fluorolube is placed in a freshly bored aluminum cylinder and a slight pressure with an aluminum piston is exerted.

4. Another reported method of causing this detonation is to exert pressure with a spinning aluminum rod on an aluminum surface smeared with Fluorolube.

A detonation of the Fluorolube-aluminum type occurred in Building 4 of Plant I when a worker cross threaded an aluminum rod into a short dural tube using Fluorolube as a lubricant. The tube was closed on one end.

Object: To investigate the nature of the Fluorolube-aluminum detonation in regard to the following factors:

a. To what extent does heat and friction induce the reaction.
b. What effect does pressure have on the reaction.
c. Is it possible for the reaction to take place during normal operations such as the tightening of tubing nuts on unions, etc.

Conclusions: The results of the test have not been completely successful in revealing the exact nature of the reaction, but the following general conclusions can be formulated:

a. Heat alone does not cause the reaction. A temperature of 1500°F did not cause the reaction but the detonation did take place around 100°F when the spinning aluminum rod test, cited above, was reproduced.

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Likewise, heat generated by friction cannot of itself produce the reaction in question. This fact was brought out by an absence of the detonation under excessive galling and seizing of aluminum fittings lubricated with Fluorolube.

b. Pressure is the important factor necessary for the Fluorolube-aluminum detonation. The precise nature of the physico-chemical mechanism of this reaction was not determined due to the limited nature of the test request.

c. From the results of this test it seems very improbable that this reaction is likely to occur during normal operations. However, the fact remains that the detonation has occurred in the plant, indicating that there is a slim possibility of its recurrence.

d. It was also noted during the test that another fluoro-chloro lubricant, Kel-F, was sensitive to the same type of detonation.

Recommendations: Both Fluorolube and Kel-F oils and greases should be avoided as aluminum lubricants.

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