



DOW CHEMICAL U.S.A.

LOUISIANA DIVISION
P. O. BOX 150
PLAQUEMINE, LOUISIANA 70765-0150
804 389-8000

SAFETY INCIDENT AND EXPERIENCE MANUAL FOR LOUISIANA DIVISION
CHLOR-ALKALI GROUP

This is an updated version of the June, 1975 manual issued to all Chlor-Alkali plants at that time. The major updating of this manual involves the addition of material that has a direct impact upon the Louisiana Division plants. The manual covers disabling injuries, potentially serious injuries and accidents, serious gas releases, serious mechanical failures and property damage.

The purpose of this manual is for engineers and supervisors to know what type of accidents/incidents can occur in their respective areas. By having a ready reference of this information, we hope to even further eliminate the chance of an accident or serious incident occurring.

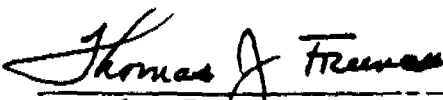
The manual is broken down into two sections: Section I, Headlines; and Section II, Incident Descriptions. The headlines consist of a very brief description of the incident or accident. The incident descriptions give additional details.

The manual begins with some OSHA Recordable Safety Statistics to acquaint the reader with what type of accidents occur in the various plants and the trends of the various plants and how they compare with Division performance. Also, statistics on what groups of people are more likely to have OSHA Recordable injuries.

We strongly suggest that you look over the sections that are related to your work. It will surprise you at the type and variety of accidents that occur from even the most common and routine jobs.

Thanks to all that have helped with this updated version.


Bruce Heinze


Tom Freeman

BREAKDOWN OF OSHA RECORDABLES* BY TYPE OF INJURY

FINGER/ARM	12
CAUSTIC BURNS	11
ANKLE SPRAINS	7
RIB AND TORSO INJURIES	6
CHLORINE INHALATION	1
EYE ABRASION	1
HEAT EXHAUSTION	<u>1</u>
	39

*COVERS 1979 - 1982 PERIOD

DO 072742
CONFIDENTIAL

OSHA RECORDABLE INJURIES

YEAR	TOTAL DIVISION	C/A	BRINE PROD.	CAUSTIC	CL ₂	CELL SERVICE	CA II
1982	57	9	1	3	3	-	2
1981	75	10	0	4	2	-	4
1980	80	11	0	2	3	1	5
1979	97	9	0	3	3	1	2
1978	94	22	0	4	8	1	9
1977	99	16	1	3	4	1	7

C/A OSHA Recordable Injuries as % of Division = 15.78% (14.75% if less 1978 & 1979)

C/A OSHA Recordable Injuries as % of Division:

1982	15.78%
1981	13.33%
1980	13.75%
1979	9.27%
1978	23.40%
1977	16.16%

Using Division 1980 as Basis:

1981	6.3%	Reduction from 1980 in OSHA Recordables
1982	24%	Reduction from 1981 in OSHA Recordables

From 1980 to 1982:

Division saw a 29% reduction in OSHA Recordables
C/A Group saw a 18% reduction in OSHA Recordables

From 1981 to 1982

Division saw a 24% decrease in OSHA Recordables
C/A saw a 10% decrease in OSHA Recordables

Based on Division Statistics:

	OSHA RECORDABLES THEO. INJURIES	ACT. INJURIES
--	------------------------------------	---------------

If 1980 is Base	7.84	9
If 1981 is Base	7.6	9

DO 072743
CONFIDENTIAL

INJURIES - OSHA RECORDABLES

OSHA RECORDABLES C/A GROUP (1979 - 1982)

TIME ON JOB

14
14
7
0
4
0
39

0 Mos. - 6 Mos.
6 Mos. - 2 Yrs.
3 Yrs. - 5 Yrs.
6 Yrs. - 10 Yrs.
11 Yrs. - 20 Yrs.
21 Yrs. - 30 Yrs.

TIME AT DOW

7
13
8
0
9
2
39

OSHA RECORDABLES BASED ON TIME IN CLASSIFICATION

77%	Those	0 - 2+ Yrs.
13%	Those	3 - 5 Yrs.
10%	Those	6 - 30 Yrs.

OSHA RECORDABLES BASED ON TIME AT DOW

51%	Those	0 - 2 Yrs.
21%	Those	2 - 5 Yrs.
28%	Those	6 - 30 Yrs.

DO 072744
CONFIDENTIAL

INDEX
SECTION I - HEADLINES

- A. Power Generation and Utilities
 - 1. Turbines and Generators
 - 2. Boiler and Heat Recovery Units
 - 3. Air Compressors
 - 4. Steam and Condensate
- B. Brine Treating and Brine Production
 - 1. Miscellaneous
 - 2. Pressure Releases from Wells
- C. Chlorine Cell Operation
 - 1. D.C. Power (Transformers and Rectifiers)
 - 2. Chlorine-Hydrogen
 - 3. Hydrogen
 - 4. Cell Effluent
 - 5. Materials of Construction
 - 6. Miscellaneous
- D. Chlorine Collection, Cooling, Drying and Compression
 - 1. Intercoolers
 - 2. Sulfuric Acid
 - 3. Hydrochloric Acid
 - 4. Compressors
- E. Chlorine Liquefaction Loading and Distribution
 - 1. Chlorine-Iron
 - 2. Lines, Valves, and Vessels
 - 3. Emergency Block Valve Failures
 - 4. Laboratory
 - 5. Loading and Unloading
- F. Chlorine Cell Manufacture and Maintenance
 - 1. Fork Lift Trucks
 - 2. Cranes, Hoists, and Associated Equipment
 - 3. Cathode Drawing, Baking, and Cleaning
 - 4. Series Erection and Dismantlement
 - 5. Cell and Cover Manufacture
 - 6. Miscellaneous
- G. Caustic Operations
 - 1. Evaporation
 - 2. Salt Removal and Filtration

DO 072745
CONFIDENTIAL

- 3. Iron Cells
- 4. Low Salt Operations
- 5. Loading and Unloading
- 6. Miscellaneous

H. Caustic Finishing

- 1. Evaporation
- 2. Loading and Storage
- 3. Miscellaneous

I. Maintenance

- 1. Falls
- 2. Material Handling
- 3. Electrical
- 4. Burning and Welding
- 5. Miscellaneous

J. Hydrogen Collection

- 1. Motors and Compressors

DO 072746
CONFIDENTIAL

SECTION I - HEADLINES

I. A. Power Generation and Utilities

1. Turbines and Generators

- a. Gas turbine trip resulted in chlorine release.
- b. Employee burned by condensate.

2. Boilers and Heat Recovery Units

- a. Fingers caught between lid and mud drum.

3. Air Compressors

- a. Fingers caught between belts and sheave.
- b. Reciprocating compressor threw counterweight.
- c. A compressor discharge line caught on fire when some diesel got into the line.
- d. A handcrank struck an operator on the elbow when he failed to get clear of the motor.

4. Steam and Condensate

- a. Man burned with condensate when conductivity probe forced from line.
- b. Earth collapses and man's foot and leg burned by condensate.
- c. Repairing condensate leak man sprayed with hot caustic when valve accidentally opened.

B. Brine Treating and Brine Production

1. Miscellaneous

- a. Pickup truck struck from rear resulting in a severe neck strain.
- b. Mowing grass - tree fell across tractor.
- c. Employee slipped from lines and fell.
- d. An operator pulled a nail off his finger when his hand got caught between the pulley/cable.

2. Pressure Releases from Wells

- a. Operator receives a severe fractured elbow when a pipe at high pressure strikes him.

C. Chlorine Cell Operation

1. D.C. Power (Transformers and Rectifiers)

- a. Man fell into high voltage from transformer.

- b. Man fell from platform after receiving electrical shock.
- c. Electrical shock lancing anode compartment.
- d. Man fell after electrical shock.
- e. Electrical shock from contacting steel support.
- f. Electrical shock with air rod.
- g. Electrical "tingle" between buses.
- h. Electrical arc taking cell voltages. ~~4-4-73~~
- i. Regulating transformer ruptured from three-phase fault.
- j. Possible electrical shock at buses.
- k. Cathode terminal connections melted.
- l. Switching error left end of series energized.
- m. Tool shorted across bus.
- n. Closed wrong switch caused flash resulting in burns.
- o. Rectifier improperly tagged.
- p. Man fell after electrical flash fracturing ankle.
- q. Burns occurred when man closed wrong switch.
- r. Closing wrong switch resulted in flash burns.
- s. Rectifier explosion and fire.
- t. Rectifier trip resulted in chlorine release.
- u. Lightning strikes a D.C. bus on the chlorine cells causing severe damage.
- v. A water leak inside a rectifier causes severe damage.
- w. A rectifier was damaged when several diodes ruptured simultaneously.

C. Chlorine Cell Operation

2. Chlorine-Hydrogen

- a. Cell cathode failure caused explosion.
- b. Explosion after a patch job.
- c. Reaction resulting from putty falling.
- d. Low brine level from brine filter salting up.
- e. Same as above.
- f. Explosion resulting from hydrogen analyzer problems.
- g. Explosion resulting from low head.
- h. Explosion resulting from hole in cell body.
- i. Explosion resulting from low head.
- j. Explosion resulting from low head.
- k. Explosion resulting from communication error.
- l. Cell holes resulted in low level and an explosion.

3. Hydrogen

- a. Explosion in series being dismantled.
- b. Ignition under roof of cell building.
- c. Explosion in cooling water trench.
- d. Several fires and a hydrogen head explosion.
- e. Large quantity of air into Plant B hydrogen system.
- f. Ignition in out-of-service water line.
- g. Explosion under series after erection.
- h. Explosive mixture where work being performed.

- i. Explosion in hydrogen header from overhead burning
- j. Air into Plant B hydrogen system.
- k. Ignition under series at cathode end.
- l. Terminal insulator failure apparently led to fire.
- m. Arcing and missing backstopper resulted in fire.
- n. Fire when cleaning hydrogen outlets.
- o. Torch ignited hydrogen at cathode.
- p. Man fell when installing hydrogen boot and broke elbow.
- q. A sewer exploded when the H₂ vent became plugged with brine.
- r. Multiple explosions occurred when high H₂ levels were generated by startup with cold brine and poor salt precipitation.

4. Cell Effluent

- a. Man stepped in trench; received leg burns.
- b. Employee fell in trench sustaining cuts and burns.
- c. Employee bruised from fall at truck.
- d. An operator had caustic and H₂ blown into his face when removing cell putty from an H₂ outlet.

5. Materials of Construction

- a. Shoulder fracture when wooden walkway collapsed.
- b. Man fell through wooden walkway breaking bone.

6. Miscellaneous

- a. Chemical goggles slipped from hand striking his eye.
- b. Missing step on ladder resulted in fall.
- c. Guard slipped and caught fingers.
- d. Cylinder catches on fire and man burned.
- e. Man slips and falls injuring shin.
- f. An operator opened a valve to a cell that was red tagged.
- g. An open bottle of a chemical was left on the cell and it caused a fire when spilled.

D. Chlorine Collection, Cooling, Drying and Compression

1. Intercoolers

- a. Intercooler chlorine-copper reaction resulted in chlorine release.

2. Sulfuric Acid

- a. Man burned from sulfuric acid in air hose.
- b. Expansion joint failure at pump discharge.
- c. Chlorine inhalation at drying towers.
- d. Sulfuric acid splattering on man from overflow line.
- e. Pressured acid released through hole in line.
- f. Hose slips from connection at sulfuric acid truck.

3. Hydrochloric Acid

- a. Dome blown off hydrochloric acid truck.
- b. A graphite block in a HCl absorber was damaged when an explosion occurred in the HCl burner.
- c. An acid gathering tank in the HCl burner area had its lid pop off when liquid chlorine entered the burner.

4. Compressors

- a. Compressor thrust bearing failed.
- b. Iron-chlorine reaction results in chlorine release.
- c. Positive displacement-compressor valve failure.
- d. Broken crankshaft on positive displacement compressor.
- e. Metallized crankshaft fatigue failure.
- f. Positive displacement compressor crankshaft failure.
- g. Galvanized crankshaft failure.
- h. Positive displacement compressor sheave failure.
- i. Fire in crankcase of P.D. compressor.
- j. Chlorine and iron reaction in high stage P.D. compressor results in chlorine release.
- k. Freon compressor high temperature causes reaction.
- l. A compressor failure caused a 500 ppm release of chlorine for several minutes.
- m. A wet chlorine compressor was destroyed by a dry chlorine and titanium reactor.

E. Chlorine Liquefaction, Loading and Distribution

1. Chlorine-Iron

- a. A positive displacement compressor failed.
- b. A centrifugal compressor failed.
- c. A centrifugal compressor failed.
- d. A centrifugal compressor failed.
- e. A centrifugal chlorine compressor failed.
- f. Lawrence pump bearing failure.
- g. A sea water exchanger ignited.
- h. Steel packing in a chlorine recovery column ignited during startup.
- i. A major chlorine release occurred when a liquid chlorine pump erupted causing surrounding pipe damage.
- j. A chlorine-hydrogen fire occurred in a chlorine absorber when chlorine gas contacted with H_2 from packing.
- k. A liquid chlorine tank caught on fire when a hot bearing on a pump burned a hole in the tank.

2. Lines, Valves, Exchangers

- a. Liquid chlorine line leak from hydrochloric acid corrosion.
- b. Exposed underground line leaks chlorine.
- c. Liquid chlorine line leak from external corrosion.
- d. Liquid chlorine line leak at support points.

DO 072750
CONFIDENTIAL

- 10
- e. Chlorine leak from corroded intercooler nipple.
 - f. Chlorine leak from sniff line.
 - g. Chlorine leak from intercooler.
 - h. Chlorine leak at tank car loading results in inhalation.
 - i. Valve bonnet bolts removed permitting liquid chlorine to escape.
 - j. Chlorine release when reboiler tube bundle removed.
 - k. Chlorine valve "exploded" from reaction with grease.
 - l. Liquid chlorine valves tagged open by mistake.
 - m. Ball valve aluminum operator broken.
 - n. Chlorine pressure gauge removal resulted in inhalation.
 - o. Chlorine leaks from defective hose.
 - p. A taffy pot exploded due to a runaway exothermic reaction.
 - q. A reboiler exploded due to a runaway exothermic reactor.
 - r. A tail gas line split open and burned due to a high hydrogen concentration.
 - s. A chlorine-hydrogen fire occurred in a line that had been improperly prepared for service.
 - t. A air-hydrogen explosion occurred in a chlorine tail gas scrubber when the chlorine was scrubbed out a H_2 -air mixture remained.
 - u. A chlorine-iron fire occurred when a solution of $FeCl_3$ corroded a line fast enough to cause a fire.

3. Emergency Block Valve Failures

- a. Nitrogen leak activates emergency block valve.
- b. Aluminum-chlorine reaction results in liquid chlorine release.
- c. Blown fuses activate emergency block valve.
- d. Chlorine evaporator overpressure causes gas release.

4. Laboratory

- a. Chlorine-caustic reaction results in burn to foot.
- b. Chlorine-carbon bisulfide explosion.
- c. An operator burned her eyes with caustic after running some laboratory samples.
- d. A plant operator had a tantalum cylinder explode due to improper sampling procedure.

5. Loading and Unloading

- a. Truck driver overcome by sodium hydrosulfide.
- b. Changing valves results in a chlorine release.
- c. A loaded chlorine tank car nearly collided with a train engine due to lack of communication.

F. Chlorine Cell Manufacture and Maintenance

1. Fork Lift Trucks

- a. Operator struck by fork lift truck.
- b. Fork lift truck partially fell from ramp.
- c. Fork lift truck started and moved with no driver present.

- d. Load on fork lift truck strikes man.
- e. Fork lift truck smashes starter fluid can.
- f. Caustic splashed forehead of fork truck driver.
- g. Employee hand caught between tubs.
- h. Fork truck driven into stream line support.

2. Cranes, Hoists, and Associated Devices ~~XXXXXX~~

- a. Chains pinch employee's fingers.
- b. Hand caught between cell frame and lifting device.
- c. Man's hand caught by inner cell casting form.
- d. Bouncing cell catches man's thumb.
- e. Cathode slipped slicing finger.
- f. Cathode swings striking crane operator's foot.
- g. Man's hands mashed under timber.
- h. Crane pendant control shorted and moved by itself.
- i. Lug slipped off knob resulting in broken cell.
- j. Crane lever fails to stop crane.
- k. Crane rail breaks.
- l. Shorted pendant moves crane.
- m. Wheels drop off bridge rail.
- n. Cab crane runs off bridge.
- o. Crane cab falls to floor.
- p. Cable broke when lifting cell.
- q. Yoke and chain wheel fell to floor.
- r. Cable snaps when packing up cells.
- s. Motor falls bouncing through wall.
- t. Yoke fell and hit man on head and shoulder.
- u. Man caught between cell bodies.
- v. Cable breaks dropping cathode into draw tank.
- w. Outer cell body form falls.
- x. Hand caught between cell frame and lifting device.
- y. Crane began moving by itself.
- z. Crane cable breaks while changing position of a cell.
- aa. Crane control does not stop travel.
- bb. Crane rail breaks at welded joint.

3. Cathode Drawing, Drying and Cleaning

- a. Liquid entering top of boots results in chemical burns.
- b. Man working without protective apron.
- c. Electrician's hand got caught in moving equipment.
- d. Damaged boot results in acid burn.
- e. Man's heel fractured after slip from ladder.
- f. Finger caught between cathode jig frame and I-beam.
- g. Unplugging pressured line causes loss of vision in eye.
- h. Handle of cathode lifter struck man's cheek.
- i. Cathode falls from lifter onto employee's foot.
- j. Cathode fell to floor.
- k. Pendant shorted and crane moved down rail.

4. Series Erection and Dismantlement

- a. Man stepped backward from cell and fell.
- b. Latch box on squeezer broke.
- c. Iron timber clamp fell on man's foot.
- d. Foreign body in eye.
- e. Fingers caught between squeezer and hook.
- f. Employee stepped on back up; it slipped off cover hitting his leg.
- g. Man's fingers were caught between cover and the floor.
- h. Failure of lugs on cell squeezer.
- i. Dummy fell backward off skid.
- j. Chain link breaks.
- k. Cell knob failure.
- l. Employee shocked.
- m. Cell knob failures.

5. Cell and Cover Manufacture

- a. Employee fell and cover partition landed on foot.
- b. Man fell from sand hopper car shattering wrist.
- c. Chemicals in eyes.
- d. Finger pinned by lining pin.
- e. Cutting blade rips shirt off employee.
- f. Angle iron strikes man.
- g. Chemicals ignite and burn employee.
- h. Fingers caught in gears of saw.
- i. Man mashed finger while opening tail gate of truck.
- j. Plate slips and struck employee's finger.
- k. Piece of bearing flew out and lodged in man's forearm.
- l. Electric truck rolled on man's foot.
- m. Plates fall through rack striking man on shoulder.
- n. Plate falls out of cell and cuts man's lip.
- o. Abrasive disc broke and struck employee.
- p. Grinder kicked back striking let.
- q. Falling box of copper hits employee on foot.
- r. Graphite board falls on man's foot.
- s. Improper tool used cutting band.
- t. Glancing hammer fractures finger.
- u. Form slips off cell and employee's hand gets caught between form and concrete.
- v. Lug slipped off cell knob.
- w. Valve breaks and employee sprayed with chemicals.

6. Miscellaneous

- a. Window drops on employee's finger causing finger to be amputated.
- b. Chisel flips up fracturing employee's cheek bone.
- c. Glove caught by drill bit and injures employee's arm.
- d. A-frame collapses on floor sweeper.
- e. Pivot arm falls on employee's foot.
- f. Saw amputates finger.

G. Caustic Operations

1. Evaporation

- a. First effect evaporator ruptured.
- b. Pressure blew out stopper and caustic hit man in face.
- c. Man sprayed with hot caustic when removing circulating pump.
- d. Caustic sprays through open valve striking man.
- e. Employee stepped into open trench burning ankle and foot.
- f. First effect heat exchanger ruptured on steam side.
- g. Expansion joint without stay bolts.
- h. Level control failed and caustic sprayed to atmosphere.
- i. Hot caustic spilled out of evaporator when opened.
- j. Caustic vented from cyclone.
- k. Caustic sprayed from drain valve and employee burned.
- l. Caustic splashing at cyclone.
- m. Pump discharge line cracks and 50% caustic sprayed the area.
- n. An operator broke his finger when he got the finger caught between the wrench and spool piece.
- o. A gasket blew caustic and ammonia 20 feet into the air.
- p. A pipe nipple broke off a caustic feed line dumping several thousand pounds of caustic.
- q. An expansion joint ruptured allowing 145 gpm of NaOH to contaminate a seawater flume.
- r. An operator incorrectly blocked in valves to wash a caustic feed line and was sprayed with hot caustic.

2. Salt Removal and Filtration

- a. Employee burned with caustic when removing hose.
- b. Pump coupling broke and knocked guard off base.
- c. Steam hose ruptured spraying hot condensate on man's leg.
- d. Hot condensate strikes employee's leg.
- e. Finger caught between pipe and hand rail.
- f. Coupling fails and caustic splashed on man causing burns.
- g. Machine runs backwards.
- h. Caustic sprays in employee's eyes.

3. Iron Cells

- a. Acid was being added to iron cell and material was sprayed over everything.
- b. Pyrophoric iron flashes in iron cell.

4. Low Salt Plant

- a. Maintenance employee fell over drain line and sustained fracture to his leg.
- b. Nozzle separates at weld and caustic-ammonia mixture sprayed into air.
- c. Depressuring line and ammonia suddenly blew out of hose.
- d. Ammonia released during shutdown.
- e. Employee sprayed when walking on walkway.

5. Loading and Unloading

- a. Unloading hose blown out of storage tank and spraying caustic.
- b. Men sprayed with cell effluent as loading line removed.
- c. Hot water burns employee washing caustic from hand.
- d. Caustic splashed from storage tank and got behind man's chemical goggles.
- e. Valve wheel and chain operator fell striking man on head.
- f. Caustic spilled from truck.
- g. Expansion joint ruptures and area sprayed with caustic.
- h. Chock slips and car rolls.
- i. Pressured line slips and sprays employee.
- j. Hose blew off spraying caustic.
- k. Caustic blows out of dip pipe.

6. Miscellaneous

- a. "Water hammer" damages line.
- b. Operator steps into small hole and got caustic in shoe.
- c. Ladder fell off rack and knocked man down.
- d. Aluminum wrench breaks.
- e. Bonnet blew off valve spraying men with cell effluent.
- f. Operator violates "red tag" rule.
- g. Portion of line pressured by mistake and contractors splattered with cell effluent from water line.
- h. Man caught fingers between fan and housing.
- i. Employee's sleeve caught on wire holding socket on air motor shaft.
- j. Employee loosened valve bonnet and sprayed with caustic.

H. Caustic Finishing

1. Evaporation

- a. Employee sprayed with caustic from top of level control tank.
- b. Hole in hot water hose results in burns to foot.
- c. Hot caustic sprays out between flange on dust collection system.
- d. Employee putting on chemical goggles when material blown into eye.
- e. An operator was sprayed with hot caustic when a centrifuge tripped out.
- f. A flange on top of a tank blew out hot caustic on people below.
- g. An explosion occurred in a reaction of carbon steel and hot caustic on a tank.

2. Loading and Storage

- a. Hose lining failed and caustic sprayed out between flanges.
- b. Steaming lines and blew onto employee.
- c. Thawing line and end of loading arm swung around knocking man unconscious.
- d. Filling drum with spout above drum and caustic splashed on an employee.
- e. Finger broken when caught between capper and lip on drum.

- f. Drum fell from conveyer and seam burst spraying molten caustic over area.
- g. Man slipped and brushed forearm across hot drum.
- h. When inserting lid, caustic popped onto man's arm, neck, and head.
- i. Caustic came out a small slot in protective shield and burned man's hand.
- j. Loading spout hung on drip pan and caustic splattered on employee's thigh.
- k. Water added to caustic drum and caustic erupted from drum onto man.
- l. Employee moving drum with 2"x4", drum fell splattering him on arms and chest.
- m. Drum torn by ram and molten caustic ran out striking his stomach and hands.
- n. Ram retracts and pinned man's arm against housing.
- o. Employee was placing lid on a solid caustic drum when he was splashed with hot molten caustic.
- p. Water was introduced into a caustic tank and steam generated pressured tank.
- q. Nitrogen pressure on hopper trailer blew camlock cap into employee's face.
- r. Valve handle and chain assembly fell striking man on head and stomach.
- s. A deflector head punctured a drum, spraying molten caustic on operator.
- t. A drum filled with molten caustic overflowed and splashed on a man.
- u. Wooden pallets ignited by hot caustic drums.
- v. A tank car released caustic/water through a vent due to the dilution of 73% caustic with water.
- w. A tank car that was to be loaded with caustic was found to have some acid in the bottom.
- x. An operator was overcome by breathing NH_3 after he began to load caustic in a tank car that had 70 gallons of an ammonia-based product.
- y. Operators blew a tank of 50% hot caustic when trying to unplug a 50% line with condensate.
- z. A major NH_3 spill occurred when a tank car that was pumping out NH_3 encountered mechanical difficulties.

3. Miscellaneous

- a. Employee fell as a result of a loose step.
- b. The yoke and chain wheel for transverse movement fell to the floor.
- c. Valve yoke broke and assembly fell.
- d. Employee attempted to use a crane that was attached to a line.
- e. Fan wheel falls to floor when shaft breaks.
- f. Pry bar slips and man's finger was pinched and broken.
- g. Foot flipped into conveyor and he fell.

I. Maintenance

1. Falls

- a. Employee stumbled and pushed wooden shelf on another employee.

DO 072756
CONFIDENTIAL

DO 072757
CONFIDENTIAL

- b. Inspector falls from a chain ladder.

2. Materials Handling

- a. Employee's finger caught between shaft and hard toe of his boot.
- b. Cherry picker tilts against highline pole.
- c. Fingers smashed between condor lift and crane.
- d. Cranes almost decapitate man.
- e. As a walkway was being removed from its support columns, the support column tilted over.

3. Electrical

- a. Broken switch does not open circuit in open position.
- b. When attempting to pull down main disconnect breaker arm, an explosion occurred.
- c. Power on electrical leads to control cable which was being worked on.
- d. Bus not labelled correctly.
- e. 440 volt insulated motor lead flashes and burns hand.
- f. Handle for disconnect turns without opening disconnect.
- g. End bell blown off crane motor.
- h. An electrician was killed when his sprayer came in contact with a switch, creating a short circuit.

4. Burning and Welding

- a. Delayed roof fire after torch used to thaw lines.
- b. Welding machine not grounded properly.
- c. Acetylene bottle catches fire.
- d. Hot tap done on wrong line.
- e. Valve stem in a tank cut and ammonia fumes fill tank.

5. Miscellaneous

- a. Finger caught between belts and sheave.
- b. Employee wearing safety glasses got flake of caustic in his eye.
- c. Pipe pinwheeled and struck man above left eye.
- d. Pipefitter tightened plug on leading safety valve and it blew out.
- e. Hot water in eye bath had steam tracing on it.
- f. Hydrogen blower belts caught on fire.
- g. Finger mashed between wrench and pump housing.
- h. An operator in chlorine suffered heat exhaustion when getting overheated in the chlorine loading area.
- i. An operator had a wrench handle fall 20' to strike him on the forehead.
- j. An operator jumped out of a piperack and suffered a minor fracture to the pelvic area.
- k. Two jobs inside a vessel did not realize other was taking place.
- l. A gasket blew out a salt slurry solution causing chemical burns to both eyes.
- m. An operator fell 6' when he used a wooden handrail to use as a prop to gain leverage on a valve.

n. A piece of equipment at a sump was started when it was red-tagged.

J. Hydrogen Collection

1. Motors and Compressors

- a. A motor was severely damaged due to the lack of knowledge about the motor.
- b. A hydrogen-air explosion occurred when a compressor lost positive pressure.
- c. Two lower power explosions took place during startup due to faulty instrumentation.

INDEX
SECTION II - INCIDENT DESCRIPTION

- A. Power Generation and Utilities
 - 1. Turbines and Generators
 - 2. Boiler and Heat Recovery Units
 - 3. Air Compressors
 - 4. Steam and Condensate
- B. Brine Treating and Brine Production
 - 1. Miscellaneous
 - 2. Pressure Releases from Wells
- C. Chlorine Cell Operator
 - 1. D.C. Power (Transformers and Rectifiers)
 - 2. Chlorine-Hydrogen
 - 3. Hydrogen
 - 4. Cell Effluent
 - 5. Materials of Construction
 - 6. Miscellaneous
- D. Chlorine Collection, Cooling, Drying and Compression
 - 1. Intercoolers
 - 2. Sulfuric Acid
 - 3. Hydrochloric Acid
 - 4. Compressors
- E. Chlorine Liquefaction Loading and Distribution
 - 1. Chlorine-Iron
 - 2. Lines, Valves, and Vessels
 - 3. Emergency Block Valve Failures
 - 4. Laboratory
 - 5. Loading and Unloading
- F. Chlorine Cell Manufacture and Maintenance
 - 1. Fork Lift Trucks
 - 2. Cranes, Hoists, and Associated Equipment
 - 3. Cathode Drawing, Baking, and Cleaning
 - 4. Series Erection and Dismantlement
 - 5. Cell and Cover Manufacture
 - 6. Miscellaneous
- G. Caustic Operations
 - 1. Evaporation
 - 2. Salt Removal and Filtration

DO 072760
CONFIDENTIAL

3. Iron Cells
4. Low Salt Operations
5. Loading and Unloading
6. Miscellaneous

H. Caustic Finishing

1. Evaporation
2. Loading and Storage
3. Miscellaneous

I. Maintenance

1. Falls
2. Material Handling
3. Electrical
4. Burning and Welding
5. Miscellaneous

J. Hydrogen Collection

1. Motors and Compressors

DO 072761
CONFIDENTIAL

SECTION II - INCIDENT DESCRIPTION

A. POWER GENERATION & UTILITIES

1. Turbines and Generators

- a. Loss of purchased motor power transfers motor load to internal power generated by a gas turbine. A malfunction in the current differential trip tripped the 12.8 KV transformer and resulted in loss of all internal motor power. Both gas turbines were tripped as boiler feed water pumps were down. The chlorine compressor's steam pressure decayed and began slowing down but did not trip. Chlorine line pressure backed through the compressor and was released through the emergency scrubber because the caustic pumps had no power. The emergency block valves were not activated until the compressor was tripped.
- b. While draining low points of condensate prior to turbine startup, an employee removed cap on check valve located ahead of condenser pump. Pressure in line resulted from open valve for pump operation and employee was sprayed with hot condensate and steam when cap was removed.

2. Boilers and Heat Recovery Units

- a. Removing manway cover on mud drum at heat recovery unit. Bolts were removed and when injured pushed lid to free it from drum, the lid fell catching caps of ring and middle finger. Deep laceration to distal point of ring and middle finger was the result.

3. Air Compressors

- a. Employee was turning an air compressor by pulling on "Vee" belts while co-worker checked head clearance. When piston started down compressor rotated rapidly catching fingers between belts and sheave. Third finger on left hand was cut, mashed, and bruised.
- b. A reciprocating compressor in air service threw a counterweight, breaking the crank housing. The machine had been checked about an hour previous to the incident and no unusual operating circumstances had been noted. The machine threw the weight and continued to operate until the operator heard the noise and shut it off. The bolting material was checked and was found to be within the manufacturer's specifications.
- c. A compressor discharge line caught fire when diesel contaminated the discharge line of the compressor. This happened when a diesel compressor was put into service temporarily along with the regular compressor. The explosion happened after 4 days of operating with the 2 compressors.

- d. A hand crank had been used to help resolve a rotation problem on #2 motor. The motor was started by a miscommunication between the boardman and the field operators. The motor was started while the man was in close enough proximity to be struck on the elbow by the crank.

4. Steam and Condensate

- a. Employee was removing a conductivity cell from a 4" hot condensate line. A shield that protects the probe and also serves as a stop against the packing ring (so that the cell cannot be removed until the valve is closed) had apparently vibrated off. As the employee held the cell in the piping assembly, he attempted to close the valve. Pump pressure in the line forced the cell out of the assembly, splashing hot condensate (approximately 20°C) on the man. He sustained first and second degree thermal burns to the left side and left hand.
- b. While attempting to locate a faulty steam trap, employee stepped on ground immediately outside condensate drainage tile. The earth collapsed immersing his right foot and leg in hot condensate. Ground surface appeared normal; however, condensate passing down through tile and coming to surface outside tile had created a pocket immediately under the surface. This pocket was filled with hot water. Employee sustained second degree burns to right leg and foot from knee down; also minor cut requiring three stitches on right side of face.
- c. Employee was assisting a second man in stopping a condensate leak. He was working from a scaffold in piperack (10" elevation). As he stepped from the scaffold to a pipe, his foot inadvertently struck the handle of a 1" ball valve located on top of the pipe. Employee was sprayed with hot caustic (50%). He sustained caustic burns to the trunk of his body and to his buttocks; in addition, he fractured his ankle when he jumped from the scaffold to ground level.
- d. A screen for a river water pump was being pulled to clean. An operator accidentally got his finger caught between pulley and cable and caused the nail to be pulled off.

2. Pressure Release from Wells

- a. An operator received a fractured elbow when a pipe unscrewed from a line. This is the result of 1000 psig gas escaping through a line/valve that operators had opened in an attempt to bleed off well pressure. The operator had opened the valve a little to check for pressure, and when he felt no pressure, he opened the valve some more. When he did this, an apparent obstruction in the line broke free causing a large volume of gas to escape. This made the pipe "helicopter" around and struck the man on the elbow causing a severe fracture.

B. BRINE TREATING & BRINE PRODUCTION

1. Miscellaneous

- a. The injured was returning to his headquarters. His pickup was travelling north in the right lane of traffic; another car at a higher speed was some distance behind this Dow pickup. As the injured approached a bridge, he saw a car being backed up in his lane and he cut over into the left lane to pass as did another driver ahead of him. The faster moving car, that was following in the same lane, also tried to pass the backing car but failed to slow down enough to keep from hitting the Dow pickup in the rear. Employee suffered a severe neck strain.
- b. At Brine Production, an employee was mowing grass with a 15-foot wide cutter behind a tractor. He stopped the tractor, raised one of the wings on the mower to clear a dead tree -- the tree fell across the tractor, bending the fender and steering wheel and narrowly missing the employee. The fall appeared to be caused by vibration of the heavy equipment or possible contact of the tree by the wing.
- c. Climbed up on pump housing and valve in attempt to get to 8" valve approximately 8' from floor, to close it. Brine was spraying from valve packing gland, so operator was climbing up from back side of lines to avoid brine spray. His foot slipped from pump housing and he fell. He sustained a deep laceration to back of head and severe bruises on back.

C. CHLORINE CELL OPERATION

1. DC Power (Transformers and Rectifiers)

- a. An electrician, while changing radiators on top of a rectifier transformer, fell backwards and contacted a high voltage power source resulting in a fatal injury.
- b. An operator, while holding onto a valve, reached from an insulated platform to a handrail on a series. He received an electrical shock and fell to the floor below, fracturing his right elbow.
- c. An operator was lancing the anode compartment on a series which had been shut down for three days and received a DC shock.
- d. A cell maintenance operator, while engaged in dismantling a series, felt a shock and attempted to move away. He slid off the series and landed on the skidway, cutting his right temple.
- e. A carpenter was removing bolts from a fiberglass platform at a series. He was standing on the series and reached across the underside of the platform coming into contact with the grounded steel support. He received an electrical shock. Rubber gloves had not been specified.

DO 072764
CONFIDENTIAL

- f. An operator was attempting to blow a cell with an air rod. In forcing in the stopper, the plastic pipe slid through the stopper and the valve would not operate. He attempted to pull the valve away from the stopper but it came out and sprayed brine causing him to receive an electrical shock.
- g. A carpenter was erecting a scaffold under a positive bus and felt a tingle when he put one hand on the positive bus and the negative bus. Voltage to ground on both buses had been checked at 25 volts but the voltage between buses had not and was 70 volts.
- h. An operator started to take cell voltages, grabbed the lead wire on an anode cell with pliers and probably touched a fence post. The arc burned the pliers and the lead wire.
- i. A three phase fault in a regulation transformer caused it to rupture and most of the oil spilled out. There was no injury.
- j. An operator working in the cell area died from strangulation by inhaling his own vomitus. There was no evidence of electrical shock but the possibility existed.
- k. Electrical connections at cathode-terminal of a series completely melted off. The vertical stub off the main bus log and the end of the aluminum flex connecting onto the stub were not DETA clad. A plate of copper had simply been welded onto the aluminum.
- l. During the switching procedure to remove a series from the rectifier, an error was made which allowed the north end of series to be at line voltage. The south end cables had been disconnected. The error was discovered four days later. The proper use of tested rubber boots and gloves prevented injury to those Cell Service personnel working around the series.
- m. Closing the bus on the roof was started using a 30 inch "pinch bar" to open the bus up through the roof. Inadvertently, contact was made between the negative and positive bus with the pinch bar. This resulted in an electrical explosion which burnt off one end of the pinch bar and slightly damaged the roof bus.
- n. Two employees were bringing a series of cells back on line. They were opening and closing the designated switches. The second employee without the proper protection gear decided to speed things up by closing a switch. He closed the wrong switch allowing a feedback from the cells that caused an electrical flash, splattering molten copper on him causing burns to the neck, arms, and face.
- o. Electrician was working on a rectifier that was improperly tagged with main breakers at power plant still closed and could be energized. Another rectifier had its switch gear racked out and tagged with the tags for the one he was working on.

DO 072765
CONFIDENTIAL

- p. Employee was standing on a wooden ladder tied to M-62 cell knob and fixing brine leak. Electrical flash startled him and he fell or jumped four feet to the concrete floor fracturing his right ankle.
- q. A series of cells was to be placed on the line. An employee attempted to close the wrong switch which placed a direct short across the cell series. The arc flashed into the injured's face and caught the top of his shirt on fire and he sustained burns to his face and neck.
- r. For a series switch the switching sequence was prepared and an employee closed the wrong switch which shorted out a series and caused a flashover. Employee sustained first and second degree burns to the right arm and shoulder area.
- s. A cell circuit was brought on line. About 2 1/2 hours after the rectifier was brought on, the rectifier tripped on instantaneous overcurrent. There was an explosion and fire. Time to extinguish the fire was extended by DC current feeding back from the cells to the rectifier. Property damage \$250,000. Business interruption \$787,000.
- t. Two loose uninsulated cables contacted the power cabinet wall causing a short circuit and an automatic shut-off of a rectifier. This resulted in back pressure to the series and a chlorine release.
- u. Lightning struck on or near a D.C. bus of a chlorine cell. This tripped out the rectifier - transformer. Several resistors, fuses and pulse amplifiers were damaged in the rectifier section. Also upon startup, the concentric secondary coil was damaged.
- v. A rectifier was destroyed within 2 or 3 minutes after startup. The reason was that a water leak existed inside the rectifier.
- w. A rectifier received extensive damage when one or more diodes ruptured. The diodes ruptured probably from age although better insulation could have provided for more protection.

2. Chlorine-Hydrogen

- a. An explosion occurred on the end of a series scattering concrete cell cover parts but causing no injury or gas release. Hydrogen in chlorine resulted from a cathode failure. No injury or gas release occurred.
- b. A series had been down for about 3 weeks for a patch job. It was put on and had about 16,500 amps on it when an explosion demolished the cell covers over the anode half of the series. An operator had gotten a sample from the covers and was in the control room when the explosion occurred. The sample contained 9.6% H₂ and 18% inerts. The series was under water until the repair was started and the repair took 2 days.

DO 072766
CONFIDENTIAL

- c. A series was shut down for a patch job and was put back in service in about one week. An operator was pulping the new cells when there was a "rumbling noise" and the cover lifted, cracked and moved about 2 inches. One hydrogen head was found to be plugged. The series was put back on but 10% H₂ was found under the cover so it was shut down and the end cells dismantled. The putty between two cells had fallen out and was resting on the copper connectors. This permitted hydrogen to enter the chlorine compartment. Subsequently it was determined that a substitute cell had been used because of a lifting knob failure and this cell's putty had not had time to set with the epoxy.
- d. The brine level in a series dropped probably because the brine filter salted up. The alarm horn failed to function but the low level alarm warning light flashed. The load was being dropped when an explosion occurred. As the damper was being closed another small explosion occurred. Two covers were broken.
- e. A brine filter salted up, the level dropped and there was an explosion. The foreman thought he noticed an extra light in the low level alarm panel and he was checking the reset button when the explosion occurred. The reset button had hung and had reset the flasher immediately.
- f. A series was taken off the line for about 14 hours and as it was being put on a "pop" was heard. The operator went onto an adjacent series to look and there was a reaction cracking several covers. Investigation revealed the hydrogen analyzer was inaccurate, unreliable, and inoperative.
- g. A series was shut down for just over 45 minutes and was being brought back on when an explosion occurred. The hydrogen head was being purged with CO₂ and the series was up to load. The anode and cover was broken by the reaction. The head was checked on one end only.
- h. Six covers on the positive end of a series were shattered by an explosion about 5 hours after being brought on line. An operator reported seeing sparks or fire at or near the trap side of a cell just after the reaction. He also observed a hole in the bottom of the anode compartment of the same cell. It was concluded the catholyte in this cell was below trap level when the explosion occurred as a result of a low anolyte level because of the hole in the cell.
- i. A rectifier had been on and off because of anolyte foaming but the load was up to 11,000 amps for about 4 hours when the rectifier started backing down. About 5 minutes later at a load of about 8,000 amps, there was an explosion in one of the series. It is felt the sight glass was in error and there was a low head.

DO 072767
CONFIDENTIAL

- j. A series was being started after a patch job. During the startup there were several low head alarms and the electrodes were replaced. An explosion occurred on the same end as the patch job. It was felt there was a low head.
- k. The series was changed from the regular brine system to the emergency brine. The impulse line to the level sensing transmitter was broken and valved off. This was communicated verbally at shift change. The level transmitter was rechecked with the impulse line valve off and the regular brine system put back into service. The brine level dropped below minimum and the rectifier was shut down. When the brine level was re-established the rectifier was started. A hydrogen-chlorine detonation occurred causing extensive damage to the process piping and acid driers.
- l. A series had 14 bad cells with holes and was using an excessive amount of brine. The series was removed from operation and switched from brine to water. The level dropped below the sight glass. An explosion occurred under the covers disintegrating the complete set of covers on this series damaging the chlorine damper, brine feed-piping and chlorine piping of adjacent series.

3. Hydrogen

- a. A series was taken off the line for an anode terminal cell repair and the cells were filled with water to a level of 2-3 inches in the covers. About 24 hours later the gas log was removed and water was drained from the 13 cells on the anode end of the series. Two men hooked the first cover on the cathode end of the series to the overhead crane. They stood on the second cover as the first was removed. A piece of hot scale fell from the crane rail and ignited the area where the cover had been removed. An explosion then occurred shattering the second and third covers. The two men ended up on the ground and one man was a D.I. It was subsequently determined the series had not been isolated from the hydrogen collected system or vented. Hydrogen at about 1" water pressure backed into the hydrogen head and through the diaphragm and cell throat holes into the covers.
- b. A maintenance employee was changing light bulbs in the cell building. Hydrogen had collected under the ceiling and was apparently ignited by the action.
- c. A hydrogen stack was being modified for a new type hydrogen boot. The welder made a cut and a spark ignited hydrogen in a cooling water trench. The explosion cracked the concrete trench cover.
- d. A hydrogen fire occurred so two rectifiers were dropped and the fire extinguished. Another fire occurred on two other series so two rectifiers were tripped and the fire extinguished. A short time later a hydrogen boot caught fire on still another series. This rectifier was tripped and another rectifier was tripped as a precaution. It was thought there was AC current on the DC system because of the arcing. Rectifiers were put on and taken off and

DO 072768
CONFIDENTIAL

then a switch was found which had gone to ground. It was opened and hydrogen boots were repaired. One series which had been ff for boot repair about 2 1/2 hours was put back on and there was a hydrogen head explosion. The latter was a result of inadequate purging.

- e. A large quantity of air was sucked into the Plant B hydrogen collection forwarding system while installing a blind flange. The chlorine liquefaction unit developed high pressure, 7 rectifiers were shut down, the system went on high suction and the blower finally tripped off on low hydrogen percent. The air was pumped through the ammonia plant gasholder and into the furnace causing a 20°C temperature rise.
- f. A softened-water line was taken out of service to weld on a new connection. A take-off ahead of this point was left open to the hydrogen sprays in the header allowing hydrogen to back into the line. Ignition occurred when the weld-neck was being tacked on after cutting open the lines.
- g. A new series was started and the hydrogen was placed in collection. About 20 minutes later an explosion occurred under the series. Subsequently it was found the putty between two cells had fallen out between the skid timbers allowing the cathode compartment of one cell to drain and hydrogen to be vented under the series.
- h. A butterfly valve isolating hydrogen headers was closed while work was performed on a circuit out of service. Later a nozzle was to be installed on a spool. While the work was in progress, gas was noticed coming from the nozzle. The butterfly valve was found to be open.
- i. A man was burning insulators from a crane rail above a series which had been shut down and cleared. The hydrogen vent valve was open and the collection valve closed but no tags were hung. Another job to be done was installing a blind flange with purge valve on the hydrogen vent. This restricted the flow from the vent and the collection valve leaked through allowing hydrogen to enter the series header. An explosion occurred which blew the ends out of the heads.
- j. The chlorine liquefaction unit had to be shut down and in the process of taking off rectifiers there were operational problems. The hydrogen blowers were put on manual control as rectifiers were tripped in an effort to preclude tripping the blowers. All rectifiers tripped, the hydrogen blowers suction pressure went negative and in the confusion air was sucked in for about 2 minutes. The ammonia plant experienced difficulties as mentioned in "e" above.
- k. The combination cathodes and cathode dummy on an operating series developed a bow and allowed liquid and then hydrogen to lead from the bottom. The "pop" was heard, the location was found, the series was shut down and the fire was extinguished.

DO 072769
CONFIDENTIAL

- l. A failure in a terminal insulator apparently led to a hydrogen fire on a series. Some electrical cables were burned.
 - m. Arcing caused the rubber matting and cables at the south end of a series to catch on fire. A missing backstopper from cell #55 fell out after this fire started and made putting the fire out more difficult. After the fire was out, the rectifier was shut down and a fireman inhaled chlorine.
 - n. Hydrogen outlets were being cleaned with a steel tube together with a waterhose for flushing. A spark developed between the steel tube and a cover brace on the series and ignited the hydrogen. Wind caused the fire to spread to all 50 open outlets.
 - o. A series was shut down and the hydrogen collection system surged for 2 hours with carbon dioxide. Several explosion tests were made in the work area and beneath the covers. When the worker ignited his torch, a deflagration happened at the upper hole on cathode-end-cell.
 - p. An employee was installing a hydrogen boot on a series. He was standing on the third rung from the top of a step ladder. One end of the rubber boot was connected to the hydrogen stack, the other was loose and he was attempting to push the hose end of the boot over a nozzle. He leaned too much on the boot, it collapsed causing him to lose his balance and fall. He fell on his right arm breaking the bone at his elbow.
 - q. A cell series received extensive property damage when the hydrogen vent became plugged with brine. This caused a backpressure of a series causing an explosion. The covers received the most damage to the main chlorine gas log. This caused all series to be shut down.
 - r. A series of explosions occurred in the cell area and gas drying area. High H_2 levels existed due to start-up with cold brine and poor precipitation of Mg and Ca salts.
4. Cell Effluent
- a. An operator received severe burns to his legs when he stepped into a trench filled with hot caustic. Grating covering the trench had been removed so that salt could be flushed along the trench.
 - b. Employee was walking in cell building and a piece of grating tipped, causing him to fall in the trench. In falling, he cut his leg, bruised his arm, and was burned by cell effluent in the trench.
 - c. While making normal round of area, operator had to walk across an open trench under construction. The only passage was a narrow board over the trench. His boots were wet and muddy and he stepped over the trench and slipped, falling into the sidewall of the trench and sustained bad bruises to his leg.

DO 072770
CONFIDENTIAL

- d. An operator was removing old cell putty from a H₂ outlet to repair a leak. When he removed the putty, caustic and hydrogen blew out onto the man's face. No face shield was worn or any thought of cell effluent blowing out was considered.

5. Materials of Construction

- a. A maintenance repairman was renailing 2 x 4 uprights which were loose. He kneeled on wooden walkway when the 8 ft. stringer suddenly broke at both ends. He fell 7 feet and suffered three fractures and torn tendon to his shoulder. The nails had corroded between the boards.
- b. An operator stepped from the top of an M-82 cell onto the wooden walkway and fell through to the ground. He suffered a broken bone in his left hand and minor contusions and abrasions. Caustic had attacked the boards.

6. Miscellaneous

- a. Employee was wearing his chemical goggles on his hard hat. As he left the control room to enter the cell building, he pulled his chemical goggles away from the crown of his hard hat, stretching the headband to clear the visor of his hat. The goggle slipped from his hand, and tension on the headband snapped them back into his eye. He sustained a contusion and abrasion cornea of left eye.
- b. Employee was opening a valve (3/4") while standing on a 10 foot step ladder. In descending the ladder, his foot hung and he fell about 8 feet to the platform. Subsequent investigation showed that the first step down from the top and the third step of the ladder were missing. He was working from the second step down.
- c. There was an emergency plant shutdown. In order to secure and clear the plant, the sniff compressor was required. The shift foreman and an operator attempted to place C-205 in service, but it would not operate. Both men started to remove the guard so that it could be rolled manually in an attempt to free the machine. The operator was called to the intercom and the shift foreman continued removing the guard by himself. The guard slipped and caught the fingers of his right hand between the guard and motor sheave. The right little finger was cut severely. The guard weighs approximately 80 pounds. The motor sheave was very sharp because the guard had been rubbing it.
- d. The operation of the liquid metal switches requires that they be heated externally. This is done by using MAPP gas and oxygen in a conventional oxy-acetylene torch with a rosebud tip. To facilitate this operation, the Cell Manufacturing foreman, requested the maintenance foreman to fabricate four (4) oxygen manifolds to accommodate three (3) cylinders each. This would reduce cylinder switching for the heating operation. During the cell switching operation, he was proceeding to switch from oxygen cylinder #1 to cylinder #2 by closing the cylinder valve. At which time a valve

ignited resulting in burns to his left hand, chest, and minor burns to his right hand. Investigation disclosed oil in several of the other valves.

- e. Employee was walking on the shoulder of a chlorine cell and attempted to step up (approximately 22") to the top of the cover. His foot slipped causing him to fall striking his right shin on the cover. The employee did not think he was injured at the time. He completed the shift, then went home and applied medication to a small abrasion to the shin. He was off duty the next two days. Late in first shift on his return, his leg began to ache and became painful. He required hospitalization for infection of the leg.
- f. Operator mistakenly opened a valve to a cell that was red-tagged, thinking he was blocking in another line. This caused another operator to be sprayed with salt.
- g. An open 8 oz. bottle of MEKP was left on top of a chlorine cell for a week. The bottle was knocked over. Within 10 minutes, a piece of plywood fell on the spilled liquid and a fire broke out.

D. CHLORINE COLLECTION, COOLING, DRYING, AND COMPRESSION

1. Intercoolers

- a. The intercooler for the intermediate stage chlorine compressor with chlorine on the shell side and water on the tube side was being returned to service after having been down for routine cleaning. The shell side pressure was 20 psig and its temperature was less than 122°C when it ignited and burned resulting in a major chlorine release and plant shutdown. It is thought that chlorine reacted with a film of the cleaning agent and the copper tubes.

2. Sulfuric Acid

- a. Air hose was hooked to the bottom of a filter to purge sulfuric acid system. The acid in a low spot drained into the hose overnight. He closed valve on bottom of the filter and air supply. The next day, he disconnected the hose from filter and was sprayed with sulfuric acid and sustained 1st and 2nd degree burns to his face, neck, arm and hand.
- b. A Teflon expansion joint in the discharge of a pump failed spraying 98% sulfuric acid about 18" - 24" above the floor toward a drying tower. There were no injuries. It was felt this joint was stretched longer than its normal length when installed.
- c. Employee was removing a stopper from a vent line at drying towers normally under vacuum. Chlorine blew out and was inhaled. Respiratory ailment developed.

DO 072772
CONFIDENTIAL

- d. Pipefitters were replacing a sulfuric acid pump. They were both in a squatting position next to an overflow line from the drying tower. The liquefaction plant had high pressure and an indication of liquid going into the tail gas line. Chlorine personnel dropped three rectifiers. The drying tower normally operates at 1-inch Hg suction. When three rectifiers were dropped, the centrifugal compressor began bypassing gas which caused the suction to decrease on the drying tower allowing 60% sulfuric acid to run out of the overflow line into the shallow ditch. The acid splattered on the back on one man. Both pipefitters were wearing slicker suits, rubber boots, rubber gloves, monogoggles, respirator, and a hood. There was no injury.
- e. 98% sulfuric acid cars --pressuring car up and acid was forced up into unloading line and out of piping through hole below top flange of reducer. No injury.
- f. A hose being used to transfer sulfuric acid from a tank truck to storage slipped off the connection at the truck causing 98% acid to be discharged to the ground. The hose had only one band clamp on the connection at the truck. This band was corroded and failed allowing the hose to slip from the connector.

3. Hydrochloric Acid

- a. The dome of an HCl truck was blown off while a truck was unloading HCl into the storage tank. Failure occurred due to a faulty weld on the single hinge of the dome.
- b. Hydrochloric acid burner converts Cl_2 gas to HCl by reaction with hydrogen gas. During a field test of the burner, H_2 was allowed to enter burner. Before the hydrogen was purged, the flame ignition system was tested. This caused an explosion damaging the graphite block in the HCl absorber.
- c. An acid gathering tank in the HCl burner area had its lid pop off when a slug of liquid chlorine entered the burner. When the burner went down, the liquid chlorine went into the tank. When the burner started up, excess H_2 formed an explosive mixture in the vapor space.

4. Compressors

- a. A high stage chlorine compressor's thrust bearing failed and the rotating assembly rubbed on the diaphragm. A fire ensued and the resulting vibration destroyed the seals and bearings allowing oil to spray out and burn. The trip mechanism would not stop the compressor, so the stem inlet valve had to be closed.
- b. A chlorine user plant cut chlorine use by 1.4 million lbs/day to liquefaction. This overloaded a Freon unit which tripped off, high pressure chlorine compressor pressured up and tripped and caused the second stage compressor to dead head for several minutes. This apparently broke the seals releasing chlorine, the shaft heated up

DO 072773
CONFIDENTIAL

and a hot metal chlorine reaction developed. The reaction continued until the temperature was reduced with a water fog and the chlorine supply blocked.

- c. Machinists were working on C-6 when they noticed C-12 was knocking. They notified the shift foreman who took C-12 off the line. Investigation showed that the head of a center bolt in a suction valve had fragmented and gotten into the cylinder. No apparent damage was done.
- d. Ultrasonic tests on a crankshaft indicated a crack. It was then checked using magnaglo but not on the sheave side. The crankshaft broke on the sheave side. Further investigation showed the shaft had been cracked for some time. It had been rebuilt.
- e. Another crankshaft broke on the sheave side. This was a fatigue failure of a shaft which had been metalized and ultrasonically tested. It broke in the threads.
- f. A minor crack in a crankshaft was determined by ultrasonics. It was decided to operate the compressor as necessary until the shaft could be replaced. It broke between the housing and driven sheave.
- g. A used crankshaft (from a salvage company) inspected and tested with magnaglo and ultrasonics failed after about 5 month's service. It was found this shaft had been repaired by overlay welding with no pre- or post-treatment so there were hard brittle areas in the heat affected areas.
- h. A sheave came off the crankshaft of a PD compressor and rolled several feet before striking a surge bottle and coming to rest. It was subsequently determined the fit between the key and keyway was poor so even though the bolt was tight the sheave and key could move off the shaft.
- i. About 4 hours after starting a PD compressor, a fire occurred in the crankcase. The machine had been out of service about 2 weeks for cylinder replacement and installation of crankshaft counter-weight bolts. It was felt there was a lack of lubrication because of debris blocking an oil tube. The debris could have been left during crankcase cleaning. Another possibility was an overheated bearing causing an ignition of the hot oil vapor-air mixture.
- j. A high stage PD compressor was off because it was running hot. It was put on line twice to help overall operation. The second time the chlorine-iron reaction occurred in the discharge piping resulting in a massive chlorine release. An emergency block valve failed to operate and had to be closed manually.
- k. The equipment involved in this incident was a centrifugal Freon-12 compressor. The unit is part of a refrigeration system used to liquefy chlorine gas through an indirect system. Upon completion of the addition of oil, the unit was started up. After approximately

fifty seconds of operation, the compressor head discharge thermal trip set at 250°F., tripped the machine. However, it was determined that within 40 seconds after start-up, the temperature within the compressor rose to approximately 1200°F. with the discharge valve closed. This temperature heated the Freon, causing fluorine compounds to form and this caused a disintegration of the aluminum rotor of the compressor.

- l. When a compressor tripped, the generator did not run back and chlorine escaped from a scrubber at 500 ppm for a few minutes. Also, 6 stoppers blew from cell covers and chlorine escaped. The block perimeter did not exceed 500 ppm.
- m. A wet compressor was destroyed by a dry titanium and chlorine reaction. The water necessary to keep the chlorine wet was shut off. The compressor began to vibrate excessively as dry chlorine and the titanium reacted. The impeller and casing was destroyed by the reaction.

E. CHLORINE LIQUEFACTION, LOADING, AND DISTRIBUTION

1. Chlorine-Iron

- a. A positive displacement compressor taking chlorine at 50 psig and discharging at 130 psig failed. The reaction proceeded from the compressor into the inlet pipe after the compressor failed. A major gas release resulted in two disabling injuries and several inhalations. There was an inadequate temperature alarm system and no workable emergency block valve system. The 50 psig chlorine distribution system and the liquefaction plant discharged to atmosphere before the manual block valves were closed.
- b. A centrifugal compressor surged resulting in a failure of the compressor shaft at the impeller nut. Friction caused enough heat to initiate the reaction and imbalance destroyed the bearing housing and broke the lube oil lines. The oil also burned and there was a major chlorine release resulting in five inhalations. It is thought the initial surge was caused by an electrical malfunction of the control circuits closing the non-return valve.
- c. Another centrifugal surged and the reaction was initiated. Three possible causes were developed: 1) the thrust bearing failed allowing the impeller to rub; 2) the impeller rotated on the shaft (impeller and shaft taper-fit, no key); 3) the surge caused the temperature rise to the ignition temperature.
- d. The same machine failed again but shut down before being consumed by the reaction. The closed impeller was partially consumed - the impeller nut and part of the back wheel were left. The impeller seal ring was left out when the compressor was assembled allowing an internal bypass and increasing the thrust bearing load.

DO 072775
CONFIDENTIAL

- e. A centrifugal compressor in Liquefaction Plant failed and the reaction was initiated. There were thirty-seven inhalations. Ten emergency block valves failed to function.
- f. A hot spot in the middle bearing of a Lawrence pump initiated a chlorine-iron reaction and as a result burned a hole in the top of the pump tank. A major chlorine release occurred before vaporization of the liquid chlorine could be brought under control.
- g. A sea water exchanger ignited as the result of a chlorine-iron reaction and there was a massive chlorine release.
- h. Steel packing in a chlorine recovery column ignited during startup. The tower recovers chlorine from taffy pots. The steel packing which was used, reacted with the chlorine. The fire was stopped by shutting the feed down but some of the column's insulation was burned off.
- i. A major chlorine release occurred when a chlorine pump that was pumping liquid chlorine to the chlorine evaporators erupted causing metal fragments to pierce the liquid chlorine and several gas chlorine lines. The explosion occurred when the oil in the lubrication system of the pump entered the nitrogen purge chamber. Due to the high pressure on the tank, some liquid chlorine leaked into the chamber causing the explosion.
- j. A chlorine-hydrogen fire occurred in a chlorine absorber when the chlorine gas was left in a vessel after a rupture disc blew causing the absorber to become inoperable. The fire was believed to be caused by corroded steel pall rings that allowed a reaction of chlorine and H_2 to be taking place.
- k. A liquid chlorine tank caught on fire. The top bearing on a submerged loading causing a chlorine-iron fire. A hole was burned into the tank.

2. Lines, Valves, Exchangers

- a. Localized exterior corrosion of a 3" liquid chlorine line by hydrochloric acid caused a leak resulting in a massive gas release, five disabling injuries and over forty inhalations. The line runs from a liquid storage area to a tank car loading rack. Flanges in an HCl line directly over the point of failure had leaked causing the local exterior corrosion.
- b. A chlorine leak developed in a ditch with much bubbling and spewing of water. A 9"-100% chlorine line and a 6"-95% chlorine line crossed the ditch at this point. The leak was found to be in the 9" line. Both lines were supposed to have been underground.
- c. A 3" liquid chlorine line from the storage tanks to the evaporator developed a leak from external corrosion in a straight run of pipe between two cells.

- d. A leak developed in a liquid line going to the drying tower area. The condition of the line was poor especially at support points.
- e. A leak was located in a corroded 1" bleed nipple in a blind flange on the bottom of a 30 psig intercooler. The nipple and valve blew off while looking for the leak. The plug cock valves would not close so the plant was shut down, emergency block valves were closed and plant pressure was bled down through the 1" nipple.
- f. A neighboring department evacuated because of chlorine in the air before a leak was found in a sniff line south of the liquefaction structure. The north wind carried it from the block. External corrosion had caused a hole to come in the sniff line.
- g. A leak was detected in an intercooler. The leak was getting progressively worse so the plant was shut down. The leak occurred at a point where the distribution trough contacted the intercooler and gradually wore a hole in the pipe.
- h. An employee loading a chlorine car shut off the loading pump to repair two leaking hammerlock unions on the one inch loading line. He blew out the three load lines with air, back to the car and closed the valves at the ramp and at the car. After changing the unions, he walked into a cloud of chlorine which was leaking from the vent line. The valve had not been closed on the tank car. He was released next morning from the hospital.
- i. A maintenance mechanic was to tighten the packing on a 4" Durco G-411 gear operated plug valve. Rather than tightening the valve packing gland, the journeyman mechanic removed the bonnet bolts permitting liquid chlorine to escape from the high pressure system through the loosened valve bonnet.
- j. A reboiler in the taffy area was to be cleaned. The level indicator showed the shell was empty. When channel and tube were removed taffy spilled to the ground causing a gas release.
- k. An employee attempted to open a 1 1/2 inch Rockwell plugcock with an 18-inch crescent wrench without success. He pumped in five or six shots of grease and tried to open the valve again. He was about to grease the valve again when it "exploded". One side of the valve blew out and the gas blew the man's hat off. He had goggles and respirator on and did not inhale any gas.
- l. A job was being accomplished involving repair of a leaking chlorine line --5 liquid drain valves were tagged "open" in error by an operator. It was later discovered that there was pressure on line when they went to break flanges.
- m. Attempting to close 6-inch Jamesbury ball valve with a ST-600 cylinder-type operator. Valve stem broke, rotary mechanism hit stop, and knocked out stop bolt and piece of the aluminum housing.

DO 072777
CONFIDENTIAL

- n. A liquefaction operator was exposed to chlorine vapors as he attempted to replace a gauge that he thought was not reading properly. Valve between the gauge and chlorine evaporator was closed. The sample line valve was in the open position. The valve at the end of the sample line was partially plugged. When the operator removed the gauge, pressure forced liquid chlorine and vapor out of the sample line, spraying on the operator. Inhalation of chlorine resulted in chemical pneumonia.
- o. Operator was purging out a liquid chlorine line with compressed air after the line had become restricted in service. The line was depressured and the operator connected a compressed air hose to a purging point on the chlorine line. He opened the purge point valve on the chlorine main before opening the compressed air line valve. When the chlorine purge valve was opened, chlorine gas was evolved from the split in the hose due to some liquid chlorine remaining in the line. The assistant operator suffered chlorine gas inhalation from the exposure.
- ✓ p. A "taffy pot" blew up when a runaway exothermic reaction occurred. This is probably the result of an explosive mixture of nitrogen trichloride and perchlor. The perchlor was introduced into the system through leaks in the block valve system between the two taffy pots in service. The nitrogen trichloride is normally in the system as a part of the taffy residue.
- ✓ q. A reboiler exploded when a runaway exothermic reaction occurred. This caused an emergency shutdown of a large part of the complex. The runaway reaction occurred when the reboiler was being taken out of service so the chlorinated organics could be removed. This is done by isolating the reboiler, then taking a vacuum hose and drawing a slight vacuum on the reboiler and flashing off the liquid chlorine left. The remaining organics are then removed after the vacuum is removed. While this was being done, the temperature rose from about 40°F to ambient. The explosion was caused by a cone of NCl_3 due to the rise in reboiler temperature and at a certain temperature and concentration, a self heating exothermic reaction occurred. This reaction generated gas at such a fast rate, the vent was effectively "choked off" causing a buildup of pressure.
- r. A tail gas in line in a Chlor-Alkali Plant split open and burned due to high H_2 concentration in the vent gas after chlorine liquefaction.
- s. Chlorine-Iron fire in a 2" chlorine line from Chlorine to the clarifier occurred when the line was improperly prepared for service. Eventual ignition could have resulted from residual moisture or could have been caused by a failure of heat tracing.
- t. An H_2 -air explosion occurred in the chlorine tail gas scrubber. This happened when some hydrogen got mixed in the chlorine and when the chlorine was scrubbed out, the H_2 -air mixture that was left exploded.

DO 072778
CONFIDENTIAL

- u. A chlorine-iron fire was caused by a chlorine/water corrosion of a 2" mild steel line. A wash of the chlorine distribution line was taking place. An iron (III) chloride solution was formed and corroded a blind. This allowed the solution to come in contact with mild steel that corroded so fast, the reaction generated enough heat to cause a fire.

4. Laboratory

- a. An employee poured a flask of liquid chlorine into a container with caustic in it. This caused a violent reaction of the liquids and caustic splashed on his foot. He suffered a second degree burn to his instep.
- b. An employee was attempting to mix liquid chlorine and carbon bisulfide for use with infrared equipment to determine chlorine impurities. 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 the hand near the index finger.
- c. An operator, on running samples in the Lab, did not thoroughly wash her hands in sink afterwards. She rubbed her eyes with her hands and caused chemical burns to both eyes.
- d. A plant operator had a tantalum cylinder explode when he tried to take a sample of liquid chlorine. The cylinder had been washed with acetone and dried with air for 2 hours before the sample was taken. Residual acetone and insufficient drying caused an explosion.

5. Loading and Unloading

- a. A tank truck driver was overcome by sodium hydrosulfide (NaHS) fumes while unloading his truck. It is thought that the driver climbed on top of the tank truck, opened the latch and fell to the ground when he was overcome by the fumes. He had several broken ribs.
- b. Tank car loader was changing valves on top of a tank car in preparation for loading with liquid chlorine. He had changed three of the valves while suction was applied to the car. In the process of changing the fourth valve, chlorine gas escaped from the opening. Employee inhaled a large amount of chlorine gas at this point. He made his way, with difficulty, from the loading platform to the building adjacent and was found lying on a bench by his fellow workers. Employee sustained severe chlorine inhalation.
- c. A loaded chlorine tank car nearly collided with a train engine that pushed 2 empty cars passed the Chlorine Block. This almost happened as a total lack of communication resulted between the Chlorine operator and the flagman. The lack of communication resulted from the operator not being able to receive signals on the trackmobile operator's radio. The trackmobile operator did not realize that there were cars on the mainline. He slammed on the brakes and when he did, one of the loaded cars became uncoupled and started going

down the track towards the engine on the mainline. It just stopped a few feet short of colliding.

F. CHLORINE CELL MANUFACTURE AND MAINTENANCE

1. Fork Lift Trucks

- a. An operator taking cell readings stepped from between the cells into the aisle in front of an oncoming fork lift truck carrying two concrete troughs. The driver was unable to stop in time and the operator received four fractured ribs.
- b. An operator was driving a fork lift truck onto a ramp into a box car. The ramp slipped allowing the back wheels to fall off but the fork lift hung in that position. The driver hurt his back when he jumped from the fork lift.
- c. An electrician was working from a portable platform raised and supported by a fork lift truck. He asked the driver to go get him some material so the driver parked the fork lift in reverse gear and left the area. The fork lift moved about 20 feet before the driver could get back and stop it. Subsequently three self-starts were witnessed.
- d. A cell maintenance operator was working on a cathode and moved just as a fork lift truck passed carrying a wooden pallet. The corner of the pallet struck the man on his arm.
- e. A fork truck was in the process of moving pallets, a spray can of starter fluid fell from the truck and rolled under the rear wheels. The can was smashed and the bottom of the can was blown some thirty feet through the air.
- f. Employee was removing a pallet of caustic drums from a flat bed truck with a forklift. Some liquid from top of one of the drums splashed to forehead and ran behind chemical goggles, entering his right eye.
- g. An employee was using a fork truck to put a tub under a saw. There was a trash tub sitting too close to get the notch tub under the saw. When letting the notch tub down so he could help move the trash tub, the right hand of the other employee got caught between the notch tub and the trash tub.
- h. Fork truck operator was coming out of the asbestos storage warehouse. He pulled overhead door without getting off truck, and then drove into stream line support in the alley. The support fell away from him and the stream line was not damaged. No injuries resulted.

DO 072780
CONFIDENTIAL

2. Cranes, Hoists, and Associated Devices

- a. The squeezer mechanism to be lifted by an overhead crane was attached by its knob to the chain hook and the operator held the bottom of the hook to keep it in place while the load was being raised. As the chain tightened, two fingers were caught between the hook and the boss on the squeezer knob.
- b. An operator hooked the lifting yoke suspended from an overhead crane to the three lifting lugs available on a cell. He attempted to balance the load and got his hand caught between the cell frame and the lifting device.
- c. Inner cell casting form was lifted with a hoist and it failed to collapse completely. The form was lowered back into the cell but one end caught on the cell. One man hit the form with a hammer and the other man continued lowering the hoist hook allowing the form to slip from the cell and catch the first man's hand.
- d. Two cells on the forks of a lift truck were being positioned on blocks. The cells were bouncing and caught the man's thumb between the block and the cells.
- e. The edge of a cathode was being lifted when the cathode slipped and sliced the end of the man's finger.
- f. A cab crane with cathode attached was moving along the transfer aisle and the cathode hit a post. The cathode bounced off the post and swung back hitting the right foot of the crane operator.
- g. An operator was lining up a skid timber suspended from the O/H crane. He backed against the timber to push it into place and the crane lowered the timber. The man's hands were under the timber and were mashed against the drip cap.
- h. A bridge crane with pendant controls moved by itself as a result of a spring falling out of a control switch shorting the controls. It hit a bridge, dislodged a gas log and broke a set of stairs. It was stopped with the main disconnect switch.
- i. An M-81 cell was being loaded onto a truck for shipment. One lifting lug was not properly seated on the lifting knob as the cell was rotated to the vertical position. The lug slipped off the knob applying torque which caused the plate on the handling beam end to fail. The cell was destroyed.
- j. An operator in an overhead crane picked up a cell to turn it over. As he moved into the final position before setting down the cell, the crane continued travelling forward. The travel lever would not control so the operator opened the main power switch in the cab. Three cells were knocked over, but damage was minor.

DO 072781
CONFIDENTIAL

- k. A cab crane was lifting a dummy from a skidway near the wall of the cell building. The crane rail broke at the butt welded joint near the wall. The dummy was not actually lifted so the load was released and the crane moved off the bad section of rail.
- l. A pendant controlled electric hoist was supporting a cathode in a drawing vat. The operator was attempting to free a stuck pocket and dropped the control box into the vat. The switch shorted allowing the crane to move down the rail about six feet before activating the emergency switch.
- m. An operator was backing cab crane from bridge to monorails when the rear wheels began to drop off bridge rail. The bridge was not matched with the monorail.
- n. The front wheels of a cab crane were run off a bridge because of misalignment.
- o. The cab of an overhead crane with load came loose from the back truck placing enough strain on the front truck to cause the cab and hoist to break away from both trucks and fall to the floor. The fall was cushioned by a cull cell so injury to the operator was minor.
- p. While dismantling a series, the crane was tied to a cell and the slack was taken out of the chains. The cable broke when the strain was put on the crane.
- q. A man was using the electrical controls to load drums onto a truck when the yoke and chain wheel used for traverse movement came off the shaft and fell to the floor.
- r. Cell Service operators were using an overhead crane to remove a cell from the end of a series during an end repair. The putty sealing the joint between the cell being lifted and the next one to it was not broken away resulting in an extra load on the crane. At this point the crane cable snapped near the crane hook.
- s. An overhead crane was being used to remove a cathode from the acid bath area. When attempting to move south, the starting torque of the driver motor broke the motor free from the gearbox. The motor fell 20 feet striking the lip of the acid bath tub and bounded 8 feet through the adjacent transite building wall. No personnel were injured.
- t. A yoke was being raised with a 5 ton crane with a guideman holding the guide rope. When the control voltage was removed, the hoist motor continued to raise the yoke. The crane operator and guideman were preoccupied with the problem. Another employee walked under the yoke as the hoist cable broke and the yoke fell and hit him on the right side of his head and right shoulder.

DO 072782
CONFIDENTIAL

- u. In the Cell Manufacturing Building, a crane was to be used to move a cell body. When passing a narrow passage, the employee was between a stationary cell body and the one being hooked to the crane which swung a bit and pressed him against the stationary cell. A serious abdominal injury was sustained.
- v. Cable breakage on two 3-ton hoists allowed a cathode and cathode draw pan to fall into the cathode draw tank which was 90% full of a cell effluent asbestos slurry. One person was splashed with a small amount of slurry.
- w. While lifting the outer form from a cell body, it fell off the lifting device about 2 feet above the floor. No one was injured.
- x. An employee was hooking crane in the Cell Repair area. The cell to be lifted had only 3 (normally 4) lifting lugs available on which to hook the lifting yoke. He attempted to help balance the load and, as a result, got his hand caught between the cell frame and the lifting device.
- y. Bridge crane with pendant controls was being used to put cells on a series. Crane began moving by itself, hit bridge placed across gap between series, dislodged gas log and knocked over and broke plastic stairs at west end of building. A spring out of one of the control switches had fallen out shorting the controls so small toggles disconnect switch would not function. Crane was stopped using main disconnect switch.
- z. A crane operator was changing an anode cell from the horizontal to the vertical position; the cable broke allowing the cell to fall over on the cover and break it. There was minor damage to the cell --the cable had been installed about 2 1/2 months before the incident; investigation revealed that the end of the cable was dry and corroded.
- aa. The crane operator had picked up cell to turn it over. As he moved crane into final position before setting cell down, the crane continued to travel in the forward --he tried to stop the crane by jiggling the travel lever to "unstick" it; the crane continued travelling until operator opened the main power switch in the cab. Three cells were knocked over with minor damage resulting; there were no injuries.
- bb. Cab crane was attempting to lift dummy from skidway on Series 27. Crane was located near west wall of Cell Building. Crane rail broke at butt welded joint near wall. Dummy was not actually lifted from skid timbers. Crane released load and moved off bad section of rail.

3. Cathode Drawing, Drying, and Cleaning

- a. Employee was in sump making repairs to cathode washer. The liquid level was deep enough to enter top of boots and both legs and feet were chemically burned.

DO 072783
CONFIDENTIAL

- b. An operator pulling diaphragms had his apron torn and removed it and continued work without an apron. Some caustic-asbestos mixture splashed on his thigh and he showered for 15 minutes and changed his clothes. He put the used, wet protection suit on and continued work. Two hours later when pain became more serious, he reported to the Medical Department for treatment.
- c. Electrician was working on hydraulic system adjusting limit switches on cathode washer and his hand got caught in the moving equipment.
- d. A raised cathode swung and hit an employee's foot, cutting his boot. Later he noticed stinging feeling and had an acid burn on right instep.
- e. A workman standing on a fixed ladder on the drying oven rack was guiding the third row of cathodes suspended from the crane. When turning the cathode it moved away from him and he reached out to bring it back and his right foot left the ladder. His left foot swiveled off the ladder causing him to fall five feet. He landed on his left heel causing the bone to break in fragments.
- f. An employee and co-worker had placed a cathode, held by a jig, into a carriage at the cathode washer. While he was rotating the unit to the vertical position, the locking mechanism on the jig apparently disengaged. This released the upper attachment to the cathode, allowing it to fall forward. This also let an "I" beam, which is part of the jib, move against the jig frame. His finger was caught between the "I" beam and the frame.
- g. Employee was attempting to unplug a line containing asbestos and cell effluent (8% caustic). The line unplugged suddenly and the air pressure forced the slurry out of the line with enough force to dislodge his chemical goggles. He received serious eye injuries and complete loss of vision to the right eye.
- h. An employee was removing cathode from cathode lifter and moved back into the Cell Building to set air wrench down, bending over to do so. As he straightened up, the handle on the cathode lifter struck him on the right cheek as it was being moved back into the building.
- i. An employee was removing cathodes from drying oven after having dried the diaphragms. Boards placed between the cathode and the floor had stuck to the asbestos --employee knocked two boards loose with his hand but a third one could not be loosened, so he attempted to kick it loose. The cathode lifter was apparently not engaged properly; the cathode became disengaged from the lift and fell to the floor, scraping employee's leg and falling on his left foot.
- j. A cathode depositing pan with two cathodes assembled to it was picked up by the crane for rotation. This was done in order that the cathode with a diaphragm deposited on it could be inserted in a cell. When the pan was rotated, the cathode fell to the floor.

- k. Operating pendant control on electric hoist supporting cathode in drawing vat. Holding control in one hand --tried to free stack pocket with other hand using broom handle. Moved onto platform and held control line across one corner of tank. Control slipped out of hand and fell into tank. Switch shorted. Crane moved down rail 6 feet before activating emergency switch.

4. Series Erection and Dismantlement

- a. A series was dismantled until only three cells remained standing. One of the cells was attached to the lifting device. A man stepped backwards and fell. He only received some scratches.
- b. A set of four cells had been squeezed and the steam boat jacks installed. The hydraulic squeezer still had the squeezing chain under tension. The top left latch box on the squeezer broke, throwing pieces of the latch box around the ara.
- c. An employee placed an iron clamp on a series timber, then turned to get a bolt. In this moment the clamp tipped over and fell on his left foot.
- d. Employee had just completed the assembly of covers on new series. He left the cell area and entered the laboratory, removed his chemical goggles, and using a paper towel from a dispenser, wiped his forehead to remove perspiration. He felt a sensation in his eye which he thought was an eyelash. He washed his eye in an eye-bath and was then taken to Industrial Medicine for treatment. A scratch was detected on the surface of the eye. Two days later, an unknown foreign body was removed from his eye.
- e. Employee was assisting in the erection of a new series. A squeezer mechanism weighing several thousand pounds is moved periodically down the cell support rails by an overhead travelling crane. The squeezer is lifted by two chains hanging down from the crane. Each chain has a slip-type chain hook at the lower end which engages a knob on each side of the squeezer. The employee had engaged the hook with the knob and signalled the crane operator to raise the load. In order to keep the hook in place, he held the hook at the bottom. As the chain tightened, two fingers of his right hand were caught between the hook and the boss on the squeezer knob, resulting in severe contusions to the fingers.
- f. A patch job on a series had been completed. Employee standing on top of cell cover walked to end of cover, stepped on backup --it slipped off cover and fell to top of cell, hitting employee on the leg as it fell. He received a scraped leg and some broken blood vessels in his foot.
- g. Cell maintenance men were moving concrete trench covers out of cell building using a drumbuggy. Wheel of buggy ran into concrete pedestal. Injured man and co-worker attempted to shift buggy to side by lifting bottom of slab. They lifted slab off buggy (off prongs). When they set it down on end of prongs, it began sliding

downward. Man's fingers were caught between the cover and the floor.

- h. Metallurgical failure of lugs on cell squeezer in use -- fractured when pressure was built up in the cylinder and the cylinder came off cell squeezer. No injuries resulted.
- i. Series 10 was being dismantled. All cells had been removed and the cathode terminal had been lifted and was near the transfer aisle. The dummy fell backward off the skid timbers and knocked a 6" nozzle off a heavy elbow on one of the cooling towers. There was no injury and no gas release resulted.
- j. Cell repair was being made on a 124-cell series (64th cell). Consequently, it was necessary to use a connecting chain link to lengthen squeeze chain. First squeeze had been made; tie-off jack had been attached when the connecting link broke. It was located between the tie-off assembly and the squeezer. Following this failure, one of the knobs to which the tie-off assembly was fastened broke. No injuries resulted.
- k. The cell maintenance crew was erecting series. They had made squeeze, tied off and tightened up with jacks and removed pin from hydraulic cylinder, when knob on cell broke. Chain grazed cell maintenance employee after knob broke off.
- l. The cell maintenance crew at Chlorine No. 1 was dismantling a series, employee "felt a shock" and attempted to move away --in moving, he slid off the series, landing on skidway. He sustained a cut on his right temple.
- m. Cell repair crew was erecting cells when some cell lifting knobs were popped off. All incidents occurred on the same series. The first incident occurred when the evening crew had just tied off the series after squeezing; when the squeezer was relaxed, two of the knobs broke. The second incident occurred when the squeezer again was taken off after the cells had been tied off; two knobs broke and when they fell, it broke off another knob. The squeezer was backed off to again attempt the final squeeze and tied off after squeezing; several minutes later, one more knob failed.

5. Cell and Cover Manufacture

- a. An employee had a partition leaning against a cover behind him. He leaned back against the partition, the partition slipped causing him to lose his balance and he fell with the partition landing on him and breaking his right foot.
- b. Employee climbed to the top of a sand hopper car to check on sand level. While in the process of raising the lid, he lost his balance and fell 15 feet landing on his right wrist. His wrist coupling was shattered from the impact.

- c. Employee had been pouring the boarder on an M-82. When he completed the task, he set his mix bucket down and walked to the water fountain for a drink. He removed his chemical goggles and wiped the sweat, which had run down into his eyes, with the back of his hand. His eye started to burn more. He walked into the restroom and began to wash his eyes at the hand wash. He then became aware that he had possibly wiped Derakane® in his eye from his hand. Another employee helped him to the eye wash station.
- d. Setting up M-63 frame mold, employees were closing mold. To do this, one man has to be on each end of mold to guide intersection of the mold between corners driven by hydraulic cylinders. Another employee pulled the control and was guiding the intersection when a lining pin began coming out with the intersection. He pushed the lining pin back in with his left hand and while doing this he installed a styrofoam block in place with his right hand. His ring finger slipped behind the pin mount and intersection pinned his finger. He then pushed controls to open and released his finger.
- e. Employee walked under the M-82 milling machine while cleaning up. The cutting blades caught his shirt and ripped it off. He was very lucky and did not get a scratch. The machine was still on having finished cutting the anode and the table moving to the rest position. He said he forgot about it being on and had ear plugs in and did not hear it running.
- f. A man driving a pick-up truck holding one end of a 20-foot section of 2-inch angle iron allowed it to shift and strike another man on the right waist above the hip.
- g. While mixing 5 gallons of Derakane® resin, too much methyl ethyl ketone was added and the solution burst into flames and burning Derakane® was thrown on the right arm and face of the employee. First degree burns to the right arm and face were the result.
- h. Employee took the block keeping the magazine from falling while the saw is being worked on and hung it in the proper place. Then he started the saw to check the repair work. While the saw was running, he went to replace the bolts that hold the block in place while repairs are being made and his fingers slipped off the bolt and his first finger of his left hand was caught in the gears of the saw.
- i. Employee mashed his finger while opening the tail gate of trash truck. The lever had tension on it and when he opened it the force caught his finger in a pinch point. He was loading trash from change room lockers when the incident occurred.
- j. While loading plates into grinder, plates slipped out of employee's hand and struck him on the finger. He did not know his finger was hurt bad, he didn't say anything about it. His finger started hurting after he got home and he went to the doctor.

DO 072787
CONFIDENTIAL

- k. While trying to drive the bearing off the roller shaft, a piece of the bearing flew out and lodged in employee's left forearm above the wrist approximately 1 1/2 inch.
- l. Employee was driving the electric truck and started to turn and stopped resulting in the truck rocking up and on his left foot.
- m. Employee was getting 23 1/2" plates from storage area. The pallet was located on top of a stack of pallets three high. The fork truck was at a very fast idle which was caused by the footfeed sticking and not going all the way up. The man hit his brakes which caused the center three rows (approximately 45 boards) to slide back and fall through the rack on top of the fork truck striking the man on the shoulder.
- n. Employee was under an M-63 cell, trying to replace some missing plates. He had three plates wedged in and was trying to put the fourth one in place when one of the three that he had already put in fell out and hit him on his upper lip. When the plate hit him it cut his lip.
- o. While grinding flat surface on M-82 cell a piece of abrasive disc broke off grinder and struck employee on right thigh causing a skin abrasion about two inches long.
- p. Employee was grinding the copper side of an M-63 frame when his grinder must have hit a rough spot and kicked back, striking into his upper right leg. It cut through a plastic apron and his trousers, and cut a 2 inch gash in his upper right leg.
- q. At cell manufacturing, an employee was bending copper connectors by feeding copper plates into a bending machine --a 1400 pounds box of copper became unbalanced and fell off the pallet, hitting employee on right foot. He was wearing hard-toes shoes.
- r. At cell manufacturing, a new employee was working with another employee picking up an 80-lb graphite board with a vacuum lift. The board started swinging and the new employee was given a signal to lower the load but released the vacuum lift in error, allowing the graphite board to fall on the other man's right foot.
- s. Employee was preparing to install plates in a new chlorine cell. A pallet of plates was located near the cell. He looked for a band cutter to cut the bands out but could not locate any in the area. He then proceeded to cut the band using a pair of wire cutters and channel locks. When the band was cut, the upper end sprang up and punctured his left arm at bend of the left elbow. The deep puncture required stitches for closure. Pallet was not contained in protective shield designated for this use.
- t. Employee was driving pin of throat hole positioner on an M-81 cell form (this particular throat hole is on an angle.) The pin must be driven into positioner to allow removal of form later. He was using a squeeze pin and ball peen hammer. He had placed the squeeze pin

on the end of the positioner pin and was striking the squeeze pin with the hammer. The hammer glanced off the squeeze pin, struck his left little finger and apparently pinned it against part of the bracing on the form. He sustained a compound fracture of the little finger.

- u. Employee and a fellow employee had removed inner form from cell in collapsed position. They set form on cell and changed lift points to allow form to spread. When they raised form only one side spread due to interference by an end piece. They proceeded to lower form back into cell to collapse form and reposition end piece. When lowering into cell, one end of form caught on cell. Employee obtained a hammer and hit form to knock it off cell. Fellow employee had continued to lower hoist hook without employee's knowledge. Form slipped off cell and caught his hand between edge of form and concrete.
- v. M-81 cells were being loaded on truck for shipment. As the last cell was being loaded, one of the lifting lugs was not properly seated on the lifting knob --as the cell was being rotated to the vertical position, the lug slipped off the knob and became disengaged. This suddenly applied torque caused the plate on the handling beam end to fail. The cell was destroyed beyond repair. There were no injuries.
- w. New valve had just been installed on bypass line from D-13 to separator. Employee first opened valve through trap and drainer but determined the flow was not sufficient so he closed it in and opened the bypass valve. He had just begun to operate the valve when it broke. Steam, condensate and tung oil hit him in the face, knocking off his hard hat.

6. Miscellaneous

- a. Two cell maintenance employees were attempting to close a rest room window when rain started falling. The injured employee checked to see that the window latch was free on his side of the window and then notified his co-worker who was on the opposite side of a partition, that his latch was holding the window open. The window closed suddenly when the other latch was opened and amputated the end of his middle finger as the heavy window fell on his left hand.
- b. Pipe slipped and dropped on chisel causing it to flip up striking employee's right cheek bone which was fractured.
- c. Employee was wiping graphite cuttings from drill press jib with her hand. She was wearing rubber gloves over canvas gloves. Her right glove was caught by the rotating drill bit, twisting her right hand and wrist, and forcing her around the drill press against the wall. Partial dislocation right elbow, strain and contusion right hand and shoulder.

DO 072789
CONFIDENTIAL

- d. Employee operating floor sweeper in a building. An A-frame was located over some stored backscreens in building. Employee backed into area alongside the A-frame. The area was narrow and sweeper came in contact with frame. The A-frame collapsed and came to rest on headache rack of sweeper. Cross member on legs is normally secured by a pin held by a cotter pin and a safety cable extends from leg to leg. After incident pin was found beside frame and cable was broken.
- e. An employee was checking a waste bin located under the backboard cleaning machine to see if it was full. A pivot arm (one of two used for lifting the bin with a fork truck) fell on the employee's foot. The weight of this unit is approximately 40 lbs. The epoxy safety cap on the employee's boots prevented the injury from being any more serious than a bruised foot.
- f. The employee was sawing graphite plates with an electric power saw. He attempted to brush a piece of scrap material out of the way with his left hand. The saw blade caught the piece of scrap and drew it and the employee's left index finger and thumb through the blade. He sustained amputation of left index finger at middle joint and severe laceration and tendon damage to left thumb.

G. CAUSTIC OPERATIONS

1. Evaporation

- a. A train of evaporators was shut down. The steam control valve was closed but the gate valve to the desuperheater was not closed and caused the pressure to rise on the first effect heat exchanger. The condensate level control valve was opened to relieve the pressure. The steam pressure entered the first effect evaporator. In approximately 3-4 minutes the 1st effect evaporator ruptured as its safety relief valve did not function at the set pressure.
- b. A refractometer was removed from the bypass line on a 50% caustic forwarding pump for an evaporator. To stop air leakage a stopper was taped in the outlet hole. Later the evaporator was shut down to plug heat exchanger tubes. As the lines were being washed out the pressure blew the rubber stopper out and caustic hit a man in the face and ran behind his goggles and got into his eyes.
- c. When removing an evaporator circulating pump, a maintenance supervisor was sprayed with hot caustic solution when plug broke loose in discharge line. Employee had 2nd degree burns over 40% of his body.
- d. The drain line on caustic evaporator was back flushed with condensate. The condensate hose was disconnected without first closing the valve on the wash out nozzle. Hot 20% caustic sprayed through the open valve striking him on the hips, arms, and face. First degree burns were sustained on left hip, left arm and face.

- e. Employee stepped in area where trench grating had been removed and opening was not barricaded. Another employee going for a hose so he could help wash employee stepped into same trench. First employee sustained caustic and thermal burns to right foot and ankle. The other employee involved did not sustain an injury.
- f. The first effect heat exchanger on "A" train HE-21A ruptured on the steam side. The initial failure broke tubes and 95,000# of caustic was lost to the ditch. The shell side design pressure was 185 psig. The steam pressure at the time of failure was 172 psig. Materials Engineering experts feel that the failure resulted from stress corrosion cracking and fatigue.
- g. The operator went down to shut down and wash out one of the first effect forwarding pumps on "B" train. The suction valve would not close because of salt under the gate. The river water valve was opened on the suction of the pump. Water went back into the suction line. An expansion joint on the suction line stretched from 19 1/2 inches to 22 inches. The suction line was bent in a 90° ell plus one vanstone flange was cracked. The expansion joint did not have stay belts. Apparently the mixing of water with 50% caustic at 320°F caused a temporary surge in pressure. The steam generated could be as high as 60 psig. The pressure rating of the expansion joint was 41 psig.
- h. The level controller on an evaporator failed allowing the vessel to fill up and spill over into the second effect heater causing the rupture disc to fail and vent a caustic spray to the atmosphere. Steam to the evaporator was shut off immediately but the caustic spray continued for 5 or 10 more minutes and covered a large part of the evaporator and tank farm area. The only injury involved was a minor eye injury. While showering at an eye wash station, a contactor pipe welder received some irritation to the eyes when he removed his goggles.
- i. An incident occurred when hot caustic and salt spilled out of the first effect evaporator, as the lower manhead was removed. Apparently salt had bridged over behind the internal cone causing some liquor to stay in the evaporator when it supposedly was empty after a 1 1/2 hour boilout and dump. Fortunately no one received a caustic burn.
- j. An operator was switching cyclones on first effect evaporator. The job instructions were carefully followed and the washout lines were closed. A 3" cleanout valve on the top of the cyclone, which is normally blinded, had been left open and the blind flange off. When the feed valve was opened into the cyclone, caustic was vented from the valve.
- k. An employee was attempting to catch a sample on T-30 (40% NaOH). The sample point on the discharge of P-30S was plugged. He shut the pump down, closed the discharge and suction valve, opened the valves on the sample line and put water on the suction of the pump. The water dislodged the plug and pushed caustic out into the drain pan.

When the caustic hit the drain pan, it splashed out onto his right leg and upper lip causing a burn.

1. An employee was attempting to lower condensate level in the second effect heat exchanger. A dump valve was opened at the condensate pump, apparently causing the pump to cavitate and the vacuum was lost in the plant, resulting in splashing at the cyclone. Caustic dripped on employee as he went to shut down the caustic. Burns were minor.
 - m. The discharge line from P-321 cracked at five locations. 50% caustic sprayed the area. The pump was shut down from the switch room. At the time of the incident, the evaporators were being water treated and 3-way control valve downstream of this pump was closed. The recycle line was plugged and consequently pump was dead-headed. The line failure probably occurred from a "water-hammer" effect; either from a low level at the pump suction that allowed air to enter pump or from a "flash" condition that resulted from contacting dilute caustic with the hot caustic in the "dead-headed" pump.
 - n. An operator got his finger caught between wrench handle and spool piece he was tightening. He cut the end of his finger (8 stitches) and broke the bone in the end of his finger.
 - o. A gasket blew out on a heat exchanger containing caustic and ammonia. This blew NaOH/NH₃ some 15 or 20 feet in the air. Operator blocked in leak and there was no damage or injury.
 - p. A 3/4" pipe nipple broke off a caustic feed line causing a spill of 2000 to 5000 pounds of caustic on the pad.
 - q. A 3" corrugated nickel expansion joint in a purified NaOH line ruptured. This allowed a leak of 145 gpm into a seawater flume of 9000 gpm. The line had been in 73% NaOH service but when the line was taken out of service, the expansion joints were taken out except this one had been overlooked since it was covered with insulation.
 - r. An operator was preparing to wash a caustic feed line and was blocking necessary valves in. When he opened valve to wash, he sprayed caustic on both legs. Injuries required surgery. Accident was caused by improper blocking procedure.
2. Salt Removal and Filtration
- a. The operator had completed flushing a cyclone with hot condensate but omitted to close the valve at the cyclone end of the hose. He disconnected the Kam-lock connection which had pressured up from the cyclone and received burns over 30% of his body when sprayed with 135°C caustic.
 - b. When the operator was in the process of putting a caustic pump on the line the coupling broke and knocked the bolted guard off the base. The operator received a bruise.

DO 072792
CONFIDENTIAL

- c. A caustic filter was washed with hot condensate. When a quick opening valve was closed on the end of the steam hose it ruptured causing hot condensate to spray on the operator's right leg.
- d. A hole in body of caustic polishing filter was welded 2" below rubber body gasket. The filter was filled with hot caustic to check for leaks. The vent line was plugged and the partly burnt gasket blew out and hot condensate struck the operator's legs.
- e. An employee was attempting to open a 6" Keystone valve using a 2" pipe 4 feet long and a hammer. The pipe slipped catching his finger between the pipe and hand rail. The valve was located approximately two feet outside the handrail and he was in a very awkward position.
- f. Employee was taking a sample from a bleeder on the filtrate line from the Enzinger Filter, when the coupling failed and cold 50% caustic splashed on him causing minor burns to tongue and lips.
- g. A Sharples centrifuge's 60 hp motor was changed out on evening shift. Electrician rewired motor and operator put machine in service. Operator told electrician machine was o.k. Later centrifuge would not take a load or unload correctly. Instrument technician was called out to check loading valve. The feed distributor was in the up position. The instrument technician attempted to pull the arm down when the distributor hung up and was torn off the machine, busting the mounting housing and linkages. The machine was left down until the next morning when the machine was disassembled to check inside. The distributor was removed and at this time rotation was checked and the machine was found to be rotating in the wrong direction, thus causing the distributor to hang up. No one was injured.
- h. The Sparkler filters discharged to ditch. Precautions had been taken to minimize the effect of spray. Material apparently sprayed high enough to get on employee's head. He didn't think he had anything in eye. Came in to shower and change clothes. Thought he had something in eye. Started irrigation procedure. First degree burn to hip, foreign bodies in both eyes, chemical burns to both eyes.

3. Iron Cells

- a. The operator was following the procedure for acidizing an iron removal cell and had started acid recirculating when material was sprayed all over everything. Draining caustic from the iron removal cell before adding acid was not included in the procedure.
- b. Caustic was in the process of acidizing the two new iron removal trains. Procedure calls for removal of caustic from cells and immediately filling with water to prevent the iron plated out from flashing. The iron is pyrophoric. The west train had been trained and flushed, but the operator had failed to start the refilling when

DO 072793
CONFIDENTIAL

he was called to another area. The iron flashed in the first cell (southern most) resulting in damaged hood and ducting. There was a shift change shortly before the fire broke out.

4. Low Salt Plant

- a. Employees removed the water drain line from the scrubber on the tail-end of ammonia recovery system in caustic purification. The 8" by 8' long pipe was lying on the ground with flat side of trough down. Employee lost his balance and fell over the pipe and sustained a fracture in his right leg above the ankle.
- b. A 2" inlet nozzle to T-201A separated adjacent to the weld. A 50% caustic-ammonia mixture sprayed approximately 100 feet into the air. A brisk NW wind carried it toward other plants, but there were no injuries resulting. The tank operates at 240 psig and 276°F. There was no indication of operational upset.
- c. Employees attempted to depressure a 2" process line containing 60% ammonia, 5% caustic and 4% salt. The line had approximately 260 psig pressure on it at the time and had been blocked in. A hose was hooked up to the bleed valve and stuck into a trash can full of water. Bleed valve was opened and ammonia began to bubble into trash can. Valve was opened wide open and continued to bubble. Employee started to close valve at this time. Ammonia suddenly blew out of the hose, both employees got a strong whiff of ammonia. Bleed valve apparently had a plug in it.
- d. The purified caustic plant was in the process of a total shutdown. The ammonia was being worked out of the system and into a storage vessel by way of the absorption system. Also the ammonia was cleared by pumping water through the system. When the pressure of the system dropped to zero, bleeders were opened to drain the system. The absorber and cooling tower were the last items to be shut down. The shift foreman had an inquiry from Industrial Security if ammonia was being released. Upon investigating, the shift foreman ran into a strong ammonia odor at the northwest part of the caustic purified plant. He called 333 and blew the emergency horn. It took about 10 minutes to block the system in. There are two possible sources for the release. 1) Due to limited storage, one of the extraction columns (D-7) was left full of caustic and ammonia. The column was blocked in. The other two columns (d-5 and D-8) were full of water. The water was pumped from P-200 TE and into the columns via the ammonia feed lines. Since D-7 was not involved, a vapor lock and/or aqua ammonia might have exited in its ammonia feed line. When the bleeder was opened to drain the system, the ammonia worked its way into the atmosphere.
- e. Employee left the control room to make a process adjustment. While walking on the walkway between process equipment, he was sprayed with 63% hot (320°F) caustic. The caustic also contained ammonia. He was knocked to his knees by the shock and summoned help. Another operator came to his aid and assisted him to an eye bath about 20

DO 072794
CONFIDENTIAL

feet away where he irrigated his eyes. He sustained a chemical burn to his left eye.

5. Loading and Unloading

- a. An operator was not available when a rejected load of 50% caustic was returned. The truck driver who was not to unload the truck, started unloading it. When the operator arrived, he began checking the situation, the truck went empty blowing the unloading hose out of the storage tank. Caustic sprayed on the operator and surrounding area.
- b. Truck driver and helper were sprayed with cell effluent when removing loading line before closing valve on caustic storage tank.
- c. While loading 50% caustic, an employee got some on his left wrist from the loading spout. He used a service water hose to wash off the caustic and received burns to the left hand and wrist because the water was hot in the service water line.
- d. 50% caustic splashed in a man's eyes as he was gauging a storage tank. A 6" x 6" monel plate attached to a monel tape was lowered into the tank too rapidly and caustic splashed behind his chemical goggles. The eye wash fountain 10 feet away had been drained of water because of freezing conditions.
- e. Employee was loading a 50% purified tank car. Shut off flow to tank car with a chain operator on a valve about 8' above his head --flow did not stop. Pulled harder on chain; spokes broke on hand wheel allowing wheel and chain operator to fall. Total weight of wheel and operator was 22 pounds. Wheel and operator hit employee on head. Broke his hard hat; laceration on head 1 1/2" long requiring 3 stitches to close. Inspection of the operator shows that the bolts were striking the yoke. This probably started the spokes breaking. Chain operator may have been improperly installed to add stress to the hand wheel.
- f. 50% caustic spilled out on the road from the rear hatch of tank trailer as the truck was approaching the gate. The caustic operator had loaded the trailer through the forward hatch and closed and secured the hatch. The driver secured the rear hatch and the truck proceeded to the customer.
- g. Preparing to transfer 50% NaOH from T-8 to T-7. The valving into T-9 was closed. The pump at T-8 was started up and the line jumped and a rumbling noise was noticed. The expansion joint at T-9 ruptured and caustic sprayed the area. It was later discovered that the pump heat at T-9 was broken. There is a recirculation line to T-9 tank at the pump. A metal guard over the joint was thrown 60 feet. Failure apparently resulted from line movement due to start-up shock.
- h. Filling 16,000 gallon tank car; car was chocked both ways. Car was nearly full, car settled down on springs, rolled against chock.

Chock slipped and allowed car to roll about 8 feet. Employee was on top of car when it started to roll. Employee climbed off car and blocked the loading valve. Approximately 100 gallons of 50% caustic were lost.

- i. Employee attempted to insert a pressured line further into the loading port of a tank truck. It was his intent to take up slack in the safety chain, which was already snapped, so that there would be no possibility of the pipe coming out of the opening. He lost control of the pipe, however, and the end came out of the port. Caustic splashed against the manway and deflected up into his face. Line pressure was approximately 100 psi. The operator was wearing monogoggles and hard hat with monogoggles strap over the back of the hat and the monogoggles over his eyes. The injury resulted in loss of sight in his left eye, and minor burns to inside of mouth.
- j. A foreman was directing the unloading of 50% caustic from a tank trailer. Normal truck unloading procedures had been modified to overcome freezing problems attributed to low temperatures and blizzard conditions. A gear pump had been connected between the tank trailer and the top unloading pump with chemical process hose to provide additional suction head to the unloading pump. After unloading the truck, the operator shut off the gear pump, disconnected the hose from the truck and proceeded to shut off the unloading pump. The foreman noticed the plugcock valve between the loading and unloading pump was open. In the process of closing the valve, the chemical hose blew off the shank coupling connected to the valve and sprayed the foreman's thighs and legs with steam and caustic.
- k. A tank car of caustic couldn't be unloaded out the bottom unloading nozzle because of a salt plug. An employee was using an air lance in the dip pipe to try to dislodge the salt. Air pressure caused the caustic to blow out of the dip pipe and his chemical goggles were knocked off and caustic got in his eye. He ran by an eyebath to the laboratory and started splashing water into his eye from the sink. He was forcibly carried to the eyebath. He sustained burns to his eye.

6. Miscellaneous

- a. The power shift foreman had the "heatup" valve around the 18" electric operated valve at Power opened to equalize the pressure before opening the valve. When the pressure differential across the valve got down to 30 psig he had the valve opened. The water in the line caused "water hammer" in the 36" portion of the line. It jumped up off the supports and broke some of the support shoes. Gaskets were blown out of the line, and the yokes on the two automatic valves to "B" train were broken because of whiplash.
- b. An automatic control valve stuck closed on the discharge of T-61 pumps causing T-61 to overflow into the basement. The operator thought the heat exchanger needed washing. He by-passed the heat exchanger and tried to wash it. He found level control valve closed. Other operators diverted the flow to a different tank.

Operator got control valve open and pumped tank drum. Tank overflowed for approximately 15 minutes. East sump pump would not pump. All material had to run to west sump pump which reclaims the caustic. Operator went into basement to turn on a hose on the east end. His idea was to wash caustic from east to west. He stepped into a small hole and got caustic into his shoe. He sustained a caustic burn to his left foot.

- c. An employee went to hand a 6' ladder on the rack. Two ladders were on the adjacent rack. Ladder that fell was a 14' ladder. Ladder fell off the rack and struck him on his hard hat and knocked him down. Hard hat took the blow and was cracked open.
- d. Closing 8" gate valve using an aluminum valve wrench and a 1 1/2" cheater pipe. The wrench broke at the end of the cheater and was pulled into employee's chest, bruising him slightly.
- e. Operator and shift foreman went out to switch a cell effluent valve. This was an 8" alloy 20 valve about 8 feet above the ground. The operator secured a 6' ladder to open the valve. The shift foreman was holding the ladder. As pressure was applied to the hand wheel the bonnet gasket began to leak. Both men ran but before they could get out of the area, the bonnet bolt failed and the entire bonnet blew off. Both men were sprayed with cell effluent (8 1/2% caustic). One man sustained a burn to his right eye. Investigation revealed that all the bolts in the bonnet had failed. The metallurgy and corrosion group have analyzed the bolts and found them to be 304 stainless steel. The cause of failure concluded to be chloride stress cracking.
- f. At Caustic, a maintenance job was started on the seawater header at the barometric condenser of the refrigeration unit. Red Danger Tags were installed by the Operation Department and the pipefitter crew leader for the Maintenance Department. The job was understood to be nearly finished and the seawater line ready to be put back into service. The operator removed the Operating Department Tag and the Maintenance Department Tag simultaneously. The operator, having talked with the fitters who were working near the tagged valve, believed that it was all right to remove both tags. This was a violation of the Red Tag Rule which states that tags MAY NOT be removed across organizational lines. He had moved the tag signed and placed by the pipefitter crew leader who was not at the scene at the time the tags were removed. Fortunately, there was no hazard or injury connected with this particular incident. The investigation pointed up the fact that this particular operator was on an extended absence from the plant because of illness at the time of the intensive training on the amended Red Tag Rule.
- g. The 8" cell effluent trench liquor line was washed. Repairs were completed. The river water line used to wash and pressure the line was left open. When they started taking cell effluent, a valve was left open by mistake. This allowed a portion of the loop line to be pressured by mistake. Cell effluent backed into the river system through the open river water line. Two contractors were washing

their trucks down with a hose that came off the same river water line. They were splattered with cell effluent.

- h. The screws had rusted off the bell housing on an electric motor allowing the housing to drop down on the fan blades. This created a noise the employee was attempting to locate. He raised the bell housing which the motor was operating and caught two fingers of his gloved right hand between the fan and housing. Amputation of right middle and ring fingers above the first joint was the result.
- i. An operator was using an air motor to open a 36" gate valve. His right sleeve was caught on a wire holding the socket on the air motor shaft. The rotating shaft twisted the sleeve and in effect applied a tourniquet to his arm. He jammed a wrench into the valve wheel gear teeth to stop the shaft from turning. The defective control valve could not be turned off without a wrench, so the operator was unable to free his arm until help arrived. He suffered a constricting type contusion and abrasion to his right arm.
- j. Employee was attempting to free a gear-operated valve which would not close completely due to plugging. Material involved was caustic - 40% at 240°F. Equipment immediately associated with the valve was shut down due to plugging, but not blocked in. Pressure was present from associated equipment. In an effort to free the gear valve, the employee loosened the bolts from the valve bonnet instead of the bolts securing the gear operator. When he attempted to move the gear operator, he was immediately sprayed with hot caustic. Employee sustained second degree burns on arm, trunk of body, and one leg.

H. CAUSTIC FINISHING

1. Evaporation

- a. An employee standing about 10 feet from the level control tank for the 73% caustic evaporator heard an unusual rumbling, looked up and saw caustic and steam spraying out the top. He received burns to his right shoulder and a bruised ankle.
- b. An employee was working on the flaker. He shut down the flaker and was washing it up. He was preparing to wash the pan on #1 drum. He walked over to the hot water hose and turned it on. There was a hole about five feet from the end. Hot water shot down on his feet. He sustained thermal burns to his big toe, left foot and his little toe, right foot.
- c. The operator received a slightly sprained ankle and a small caustic burn on his arm when hot caustic solution sprayed out between flanges in the dust collection system. He jumped and fell in an effort to get out of the path of the caustic spray.
- d. An employee was on top of bead tower and was changing from glasses to chemical goggles, when something was blown into his eye. He ran

DO 072798
CONFIDENTIAL

to eyewash station situated on top of flaker structure. Eye wash did not function. He took elevator to bottom of structure and washed his eyes in another eye wash. Minor chemical burn to left eye resulted. Investigation showed that water had been turned off safety shower system for freeze protection during previous period of freezing weather. The water had not been turned back on when the weather had warmed.

- e. Two centrifuges were working in caustic area. When one of the centrifuges tripped out, the other centrifuge could not be started since maintenance was being done on it. This caused 200°F - 50% caustic to be sprayed on an operator in the area.
- f. Pump recycle line to T-1 tanks blew caustic out of inlet flange on top of tank. Caustic was sprayed onto operator below. On investigation, 7 of 8 bolts holding flange were hand tight.
- g. A minor explosion occurred in a 50% storage tank at the Caustic Plant. A cutting torch was making a hole in the top of tank for overflow. On the inside of the carbon steel tank was heavy scale deposits of caustic. At the elevated temperature (>140°C) provided by the torch, carbon steel and caustic reacted to give off hydrogen that exploded.

2. Loading and Storage

- a. Caustic cars were being loaded with 73% caustic through a flexible Teflon lined rubber hose. High temperature of the caustic resulted in the liner "balling up" and plugging the line. 73% caustic blew out of the top flange and sprayed half the loading rack. The operator was standing behind the control panel which protected him.
- b. The employee had finished loading 73% caustic and was clearing lines. The line had been blown and steam was on the line. Some caustic was coming out two of the nozzles but not the third. He closed the automatic valves to force something out the third nozzle. When the two valves closed, caustic and steam blew out the third nozzle onto the man.
- c. A 73% NaOH loading line was plugged, the loader put 150# steam into the line at the pump discharge. Then did not free the plug so he applied steam to the outside of the line. The loading arm was chained down. When the plug thawed there was sufficient pressure and velocity at the end of the loading arm to cause the arm to swing 180° and strike the loader on the head, knocking him unconscious.
- d. One employee was observing his fellow worker fill drums at the loading station. This operation consists of positioning an empty drum resting on a roller conveyer under a loading spout. A shield is placed over the drum top to catch any molten caustic dripping from the spout while the positioning step takes place. The shield is then removed, the spout lowered into the drum opening and the flow started. The employee failed to remove the shield and started the flow with the spout above the drum. The resulting spill splashed several feet and struck the other employee on the elbow.

DO 072799
CONFIDENTIAL

- e. When capping 100# flake drums, employee had problems with the pneumatic operated automatic capping machine. He attempted to push a drum through the capper. His hand was on the side of the drum with the little finger toward the top. As he pushed the drum through, the machine went through its cycle and caught his finger, breaking it in two places. The finger was caught between the capper and the lip of the drum.
- f. Drum of molten caustic hung up on cross-over of hot slat conveyer. Second drum in line jammed against the first drum, and the third drum fell from the conveyer --top first. The top seam burst, spraying molten caustic over a large area. No injury resulted.
- g. The drum stop on one of the gravity cooling rows failed to hold the hot caustic drums. This allowed the hot drums to enter the outgoing cold slat conveyer. These hot drums caused a jam with the flake drums already on the cold slat. Man was attempting to straighten out this jam when he slipped and brushed against a hot drum causing a minor burn to his right forearm.
- h. Employee was inserting lid into just filled molten caustic drum when caustic popped onto his forearm, neck and forehead. Water in the cap caused the molten caustic to pop.
- i. An employee had just completed filling a drum with molten caustic. He withdrew spout and moved drip pan under it. He left the loading station and when he returned, he positioned an empty drum, lowered loading spout and pushed pump button. He then noticed that he had failed to remove the dip cover from the spout and stopped the pump. The caustic in the line came on out, hit the drip pan and splashed protective shield; some came through small slot in shield, burning him on left hand.
- j. Employee was loading molten caustic into drums. He raised loading spout, put drip pan under spout, moved full drum off scales, moved empty drums onto scales, moved drip pan and lowered spout. Spout sat down on lip of drip pan. Employee turned restartup to start DC driven pump. He turned to his left to remove lids from empty drums. The spout had apparently hung on the edge of the drip pan, when caustic started to flow, it splattered out on his right thigh.
- k. An employee had been filling drums with molten caustic on the north pump stand when he noticed a drum jam up where the short slat conveyer intersects the hot slat conveyer. He proceeded beside the conveyer. he then tried to unjam the drums using a two-by-four. While pushing on one of the drums, he poked a hole in it about 10 inches from the bottom. After a period of time, probably more than an hour, he returned to the drum and decided to wash it out with water. He strung out a hose from the pump stand into the drum (about 15 feet) and then returned to the pump stand to turn on the water. Employee says that he filled the drum with water and then allowed the water to drain out of the drum. He then returned to the jam up and again started pushing the drums with a two-by-four. At this time, hot caustic erupted from the drum, splashing employee on the back of the shoulders and the hip.

- l. Limit switch on short slat to hot slat did not operate. Drums jammed on hot slat. Operators were attempting to move drums with 2 x 4 and drum fell, splattering employee on arms and chest. Two drums had emptied themselves, one was collapsed by the others and one had bottom torn out of it by the short slat conveyer.
- m. A drum of molten caustic had failed to move all the way off the hot slat conveyer onto the cooling rolls; this automatically shuts the hot slat down. Employee activated the drum deflector in order to move this drum and apparently failed to notice that the next drum in line on the hot slat conveyer had moved far enough to partially obstruct the path of the drum deflector ram. This drum was torn by the ram, opening up a hole approximately 2" wide by 5" high and approximately 3" from the bottom of the drum. Molten caustic ran out splashing below the shield on the deflector, striking him on both hands and stomach.
- n. The ram on No. 1 deflector stuck in the out position. The employee cut the air off the entire system. He went to the shielded side of the deflector, raised the shield and examined the tripping mechanism. He tripped the manual switch by pulling the chain and bled down the cylinder on the side that pushed out. He walked to the other side of the deflector, reached across and pulled out on the trip bar. The bar retracted and pinned his right arm against the housing. He pushed on the trip bar and the ram moved forward enough to release his arm.
- o. An employee was placing a lid on a solid caustic drum when he was suddenly splashed with hot molten caustic. He fell backwards and turned a river water hose on himself immediately. It is suspected that the loading spout was not in the center of the drum, but was placed on top of and several inches from the center of the drum. A safety switch is in the starting circuit for the pump, which only allows the pump to start when the spout is in the down position. Examination of this switch immediately following the accident showed that it was working properly and the spout had to be in the down position.
- p. 78% caustic tank was being emptied. Approximately 3'3" of caustic remained in the tank when hot water was introduced through 2" line at the tank top for dilution. When there was 4' to 5' of water in the tank the temperature of caustic was approximately 120°C. At this same time it was decided to agitate the tank so dilution would be assured. A piece of pipe attached to a hose was lowered into the tank and when the air was started, a reaction was immediately heard by the operator. He closed the air valve. Apparently the heat of dilution caused an instantaneous release of steam which caused the pressure. The flat bottom of the tank was dished, elevating the sides of the tank about 15".
- q. A hopper trailer had returned and was spotted below the hopper to be loaded again. The trailer had a nitrogen pad put on it. The operator pulled a 6" camlock cap off the trailer. Nitrogen pressure in the trailer blew the cap into his face. He sustained a broken nose and small laceration on upper lip.

- r. An employee was attempting to open a 4" second-hand chain wheel valve when the valve handle and chain assembly came off. The valve was located about 12 feet overhead and the handle and chain assembly fell and struck him on the hardhat and stomach. The incident occurred on the tank car loading rack which is narrow and cluttered. This happened while in the process of loading a 73% tank car.
- s. One of the rollers on a roller conveyor, that handles drums of molten caustic, was not turning freely and it was necessary to use the next roller conveyor. The operator was attempting to move the drum deflector and had raised the head about one inch above normal when the deflector was accidentally activated. The deflector head punctured a drum, spraying molten caustic on the operator. Severe thermal and chemical burns to right arm and hand.
- t. The employee had been filling drums with molten caustic when the scales became fouled with solidified caustic from a leaking valve on the fill line. After the valve had been replaced, he filled about two drums and attempted to wash the caustic off the scales from the operating platform with a water hose. This was unsuccessful so the operator decided to go behind the protective screen to be able to wash the conveyor more effectively. To do so he stopped the pump emergency STOP button, placed an empty drum under the fill line, opened the fill valve in order to drain the line. He then stepped onto the conveyor beside the drum, squatted down and proceeded to wash the conveyor. The pump was not stopped as he supposed, the drum filled and molten caustic overflowed the drum and splashed onto the man. He sustained burns on four fingers of left hand and forehead.
- u. Due to a shortage of steel pallets, which are normally used, drums of hot caustic were loaded onto wooden pallets and stacked four pallets high in the warehouse. The wood ignited and spread through the stack, involving approximately 550 drums. In anticipation of the use of wood pallets for this service, tests were run to determine heat resistance of the wood pallets. Test conditions did not duplicate actual conditions accurately enough to allow prediction of the results. "It is generally agreed that 150°F is the highest temperature to which wood can be continually exposed without the risk of ignition."
- v. A 73% caustic rail car had been returned from a delivery with 8" to 10" of caustic in the bottom. The caustic at this pressure and normal ambient temperature is frozen solid. The normal procedure is to heat the rail car by using steam in the car's steam coils. Also, some people have been known to dilute the caustic with water as a weaker caustic solution has a higher freezing point. This creates an exothermic reaction so this practice is forbidden. The top of the rail car had been left open so rainwater was allowed to enter the car. This heated up the solution and the addition of steam caused the pressure buildup to where the solution vented through the top of the car and on to working personnel.

- w. A tank truck came in and asked to be loaded with 50% caustic. When the dome of the truck was opened, the operator noticed a funny smell. Operator asked driver if last truck load was caustic. The driver said yes. On test with litmus paper, the truck was found to be acidic.
- x. An operator in Caustic received NH_3 gas inhalation when he started to add 50% caustic to a car that had been rejected after another plant had put about 70 gallons of an ammonia based chemical in the car.
- y. Operators were sprayed with 50% caustic when they were using condensate to unplug a 50% line. The condensate backed up into a tank containing 50% hot caustic. The heat of mixing, caused an eruption of NaOH from the tank.
- z. A major NH_3 spill occurred when an operator tried to pump NH_3 out of a truck that had some mechanical problems. The problems were that the pump seal leaked and that the trailer may not have been inspected. When unloading began, a major spill occurred. The truck driver tried to close valve by pulling emergency handle, but the cable broke and the valve did not close. Spill alarm was turned in but no injuries.

3. Miscellaneous

- a. An employee was going down the stairway into the basement to catch a sample. The 4th step from the bottom of the stairway had come loose and dropped down. He did not see the missing step. He fell and skinned his knee; no explanation for when the step came loose. Steps were held in place with 3/8" bolts. Heads of the bolts had corroded away.
- b. A man was loading 55 gallon drums full of brick onto a flatbed truck. The yoke and chain wheel used for transverse movement came off their shaft, falling to the floor. The man was using the electrical controls at the time. No injury resulted.
- c. An employee was closing a chain operated valve on steam line so that line could be worked on. Valve yoke broke and valve handle, yoke and chain assembly fell. The valve operated easily and there was not any excess strain on the chain. There was no one injured.
- d. Pipefitters had one overhead crane attached to the rundown line when an operator, who was moving pot pumps prior to the fitters using the crane, attempted to use the crane while it was attached to the line.
- e. Operator found a 54 inch fan wheel on walkway near floor level in the cooling room. The fan wheel had fallen from an overhead roof fan due to the fan shaft failure. No one was in the area when the incident occurred. The fan wheel was damaged beyond repair.
- f. An employee and a fellow worker were trying to push the diverter valve at the bottom of the molten caustic seal pot during an emergency shutdown. The diverter box is moved about 12 inches to

change the direction of caustic flow. This equipment is provided with an air-operated cylinder to mechanically move the box. At the time of the accident, the air cylinder was inoperative and disconnected. He inserted a crowbar in a slot in the diverter, to pry the unit. The bar slipped and his finger was severely pinched between the bar and an adjacent pipe. His right ring finger was fractured.

- g. At Caustic finishing, an employee was washing up the north pump stand. The area was wet. His right foot slipped into the conveyor and he fell in up to his knee.

I. MAINTENANCE

1. Falls

- a. An employee stumbled and unintentionally pushed wooden shelf causing it to fall on another employee's right hip. A painful bruise was suffered.
- b. An inspector received minor lacerations when he fell about 20 feet inside a 36" diameter pipe on the side of a caustic evaporator. The chain ladder was "bunched up" around the top elbow and fell a short distance and the injured lost his grip and fell.

2. Materials Handling

- a. A 3,000 pound circulating pump bearing housing was being moved by rolling on section of 2" pipe. As housing tripped off a 2" pipe, employee could not hold shaft and an employee's fingers were caught between the shaft and hard toe of his boot. Lacerations and fracture of fingers of right hand.
- b. Cherry picker was used to move cables. It was parked with right rear outrigger only partially extended. Boom was extended so far out that when load was moved to the right the cherry picker tilted and came to rest against a high line pole.
- c. Employee was using a condor lift to sandblast a crane. He was going to move condor lift to sandblast another section of the crane and as he operated controls, the lift went up smashing his finger between condor lift control box and I-beam of the crane.
- d. While maintenance work was being performed from a ladder on a small bridge crane, an operator started to move the cell with a large bridge crane. When the maintenance man stood up, another employee yelled. The maintenance man ducked; a large crane brushed back of his head and shoulders. Clearance between large and small crane was approximately 6" to 8". The man could have been decapitated.
- e. As a walkway was being removed from its support columns, the support columns tilted over. Investigation showed that the rebar from original foundation had been cut and new base was not attached to old base.

3. Electrical

- a. A switch was found that was broken inside and thus not breaking the circuit when the starter was in the "off" position. An electrician checking the switch gear got a light shock. He found 480 volts across the starter even though the switch was in the "Open" position.
- b. A millwright pushed a red station button, which is mounted on a pump switch gear cabinet door and when attempting to pull down the main disconnect breaker arm, an explosion occurred. The explosion warped the switch gear doors and burned a starting gear. He received a shock.
- c. A motor was installed for a pump on Friday by an electrician. He did not have time to connect the leads. On Monday, he started to hook up the leads and discovered that power had been put on the control cable. He was not injured by the electric current.
- d. Caustic had a power failure on a bus. An employee came out to check for the problem and after reading the electrical one-line diagram, shut down safety switch that was labeled Bus 22. This switch actually shut down No. 24 bus, shutting down approximately 18 pumps. After investigating, all 6 safety switches to the six busses in Switchroom #1 were mislabelled.
- e. Unit 9A tripped off the line. Injured was checking out two alarms on unit 9 at the rectifiers. He saw that the oil pump was not operating, and he checked to see if there was power on the motor starter. There was, so he went to the motor and moved the 440 volt insulated lead at the motor connection, causing it to flash and burning his left palm.
- f. The plant had been shut down due to an instrument malfunction. While the plant was down, it was decided to repair a pump. The operator went to the switch room, burned the handle on the disconnect, and attached a Red Tag. The machinists also attached Red Tags and then repaired the pump. After completing the repair job, the machinists removed their tags. Three days later, the shift foreman noticed a Red Tag still on the disconnect of a pump that he knew was operating and reported the incident. Subsequent investigation revealed that a different operator on another shift had placed the pump in operation by operating the flip switch at the pump. Later, it was found that the engaging mechanism on the shaft of the disconnect was not properly adjusted, and thus allowed the handle to turn without opening the disconnect.
- g. It was reported that the 10 ton crane was dead; the fuses were blown. This system consists of 4 crane rails, all having separately fused power supply. The blown 15-amp fuses were replaced with 30 amp fuses and the crane used for about 30 minutes. The brakes were dragging badly and it was taken out of service. The crane was checked and a burned out brake coil was discovered. No replacement was available, so the coil was taken to a vendor shop and rewound on a rush basis. The brake shoes were replaced and the rebuilt coil

DO 072805
CONFIDENTIAL

installed. The crane was checked over completely and put back in service. Shortly thereafter, the end bell was blown off the motor, travelling through the air for approximately 30 feet and striking the north wall of the building. The unit is totally enclosed for outside service.

- h. A journeyman electrician was killed when the sprayer that the electrician was cleaning switches with made contact across a switch, creating a short circuit. This resulted in a high energy electrical flash which caused the man to receive severe electrical burns that eventually caused the man to pass away. The apparatus had been prohibited from service but it was used anyway.

4. Burning and Welding

- a. A welder was using a torch to thaw some frozen stem lines under the hydrogen room roof. The wooden roof caught fire several hours later.
- b. A welding machine was grounded to one structure while welding on another, and the structure on which the welder was not grounded except through a flexible conduit to the other structure and the conduit developed a hot spot.
- c. While cutting bolts off a walkway to replace a section, the acetylene bottle on the ground caught fire.
- d. A river water line was to be hot-tapped to provide cooling on the E-308's. After tap was complete, it was found that the job was done on a cell effluent line instead of a river water line. The error was made in initial identification of the line --not in their transmittal of information later on.
- e. Employee was pulling a valve stem from inside an ammonia tank. The tank had been cleared according to Safety Standard. It was necessary to sever a hollow valve stem which was built into the tank. Torch was used to cut into stem. When cutting began, ammonia ran out of stem, filling tank with ammonia fumes. Employee got out of vessel with no injury.

5. Miscellaneous

- a. New belts were being installed on a caustic pump. The sheave had to be rolled to guide the belts on the sheave. An employee grabbed the belts between the two sheaves to roll them. As he pulled on the belts, the pump started thermosyphoning and pulled his glove and end of his ring finger between the belt and the sheave.
- b. A heat exchanger water box had been removed and taken to the shop for cleaning. The employee removed his chemical goggles and was wearing safety glasses. As he uncovered the gasket from the water box, a piece of caustic flaked off and struck him in the eye. He did not continue to wash his eye until personnel from first aid arrived.

DO 072806
CONFIDENTIAL

- c. Employee was attempting to screw a 2 foot piece of 1/2" pipe into a 90° fitting which was above his head. His hand slipped from the pipe and it pinwheeled over striking him above the left eye. Laceration above left eye.
- d. Safety valve on C-23 pad compressor was changed out. An operator located a leak from bottom plug of safety valve on C-23. Pipefitter tightened plug --plug blew out and was thrown approximately 15 feet across room. Hit pipefitter; no injury.
- e. A steam-traced eyebath-shower station was found with hot water when checked prior to doing a job.
- f. Newly installed hydrogen blower belts caught fire due to friction.
- g. An employee was attempting to tighten packing on positive displacement, high speed water pump. The spanner wrench was caught between the packing follower and shoulder of piston rod. This forced the wrench against the pump housing, mashing the employee's middle finger at the end joint.
- h. An operator suffered from heat exhaustion when the operator got overheated while working in the chlorine loading area.
- i. An operator pulled on the chain of a chain wheel valve opener. When he did, a 24" wrench handle fell out of piperack onto operator's forehead. The injury required stitches.
- j. An operator jumped about 6' out of a piperack after finishing a pipe marking job. When he landed, he felt a pain in the abdomen. On examination, he had a minor fracture of the pelvis.
- k. Two jobs were being performed inside a vessel. Neither people know that other was working inside vessel. Both jobs had independent safety observers. One of the jobs switched safety observers and when they did, the new safety observer saw the other safety observer and consequently left the job. When other job was finished with their safety observer, that left the first job inside vessel with no safety observer.
- l. A gasket blew out of a salt slurry line knocking monogoggles off. The slurry had .5% caustic and was used at 150°F. The operator received chemical burns to both eyes.
- m. An operator fell 5 or 6 feet when he attempted to prop up against a handrail in an attempt to get more leverage in closing a valve. The handrail was wooden and was nailed to the outside of the corner post.
- n. A piece of equipment that was Red Tagged was mistakenly started. The leads to the equipment were connected causing the fuses to fail instantly. If the leads hadn't been taped, single phase grounding could have occurred.

J. HYDROGEN COLLECTION

1. Motors and Compressors

- a. A motor failure on a compressor failed due to the rotor dropping on the stator and windings. The motor was reworked and repaired. When the motor was put back into service, the magnetic slot wedges were not put back into place. This was due to a lack of knowledge about the design of the motor.
- b. A hydrogen-air explosion occurred when a compressor lost positive pressure causing air to be pulled into the hydrogen collection header. This resulted in an explosion.
- c. Two low power explosions took place in the hydrogen processing unit during startup. A power failure caused the chlorine cells to shut down but the compressor kept drawing in air. The air pulled in mixed with hydrogen and this mixture went to the carbon beds and de-ox catalytic unit.