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The Reliability Study and Loss Prevention Review
of the Distillation and Storage Areas of the
VCM-I Unit (P-757)

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- 4. B. J. [signature] / R. E. Sanders
- 5. B. M. White
- 6. Author
- 7. C. R. West - G.O.
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ABSTRACT

A Level III Reliability Study and Loss Prevention Review were made on the distillation and storage areas of the VCM-1 unit. This study and review completes the examination of the VCM-1 unit.

Using cause-consequence sheet analysis the reliability study did not reveal any undefined potential hazards in terms of fire, explosion, and toxic gas releases.

A Loss Prevention Review of the unit was completed and revealed several situations that could contribute to hazards. The Loss Prevention Jobs list was also reviewed to update the status of the individual items.

Several recommendations were made based on the Loss Prevention Review including such items as installing temperature alarms, additional SRV protection, installation and replacement of fireproofing, and repair of cable trays. These items are detailed in the conclusions and recommendations section of this report.

An Operations Review Subcommittee meeting will be held soon after this report is issued to determine a course of action for the items from the Loss Prevention Review.

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INTRODUCTION

A Level III Reliability Study and Loss Prevention Review of the distillation and storage areas of the VCM-I unit were made. These studies complete the examination of the VCM-I unit. These studies are a part of the project (P-757) to make Level III Reliability Studies of all the units in Plant B thereby ensuring that there are no unacceptable risks.

DISCUSSION

The Reliability Study started with preparation of cause-consequence sheets covering all of the equipment in the VCM-I distillation and storage areas. The equipment starts downstream of the secondary quench condenser and continues through the distillation train and on to the product storage vessels.

The cause-consequence sheets are a way of systematically examining all of the equipment in terms of process changes (causes) and the results (consequences) of the changes. The Hazard and Operability Study III Guide diagram, developed by ICI, was used to provide a checklist of causes such as high flow, high pressure, low temperature, etc. used to predict consequences.

The cause-consequence sheet analysis did not reveal any previously undefined potential hazards in terms of fire, explosion, and toxic gas releases. Several situations were recognized that would cause operational upsets or result in product quality problems.

In conjunction with the Reliability Study, a Loss Prevention Review was conducted to identify the qualitative conditions that can contribute to hazards. The review was conducted with Carey Brazitis, VCM-I Area Foreman; Jim Wood; Don Rigler; and Wayne Fast. The Loss Prevention Manual was used as a guide for assuring satisfactory equipment design, personnel safety, and general plant layout.

A Loss Prevention Job (LPJ) list review was also made to update the status of the listed jobs and delete completed jobs.

An Operations Review Subcommittee meeting will be scheduled after this report is issued in order to determine the best course of action for implementing the listed items. The resulting questions and answers from the Loss Prevention Review are listed below.

1. Will a reaction result in solids formation which could cause a hazard or a production loss?

The intrusion of water into the distillation system can cause a rapid formation of ferric chloride. The ferric chloride will collect on the top trays of the stripper and the product still resulting in an increased pressure drop and reduced flow. This situation can happen over a period of a few hours but is not viewed as a hazard.

2. What problems can be caused by freezing of the process material?

The possibility of freezing EDC in the -40°F lean oil cooler or the absorber vent condenser was recognized. An item to install a low temperature alarm

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on the lean oil cooler outlet is on the Loss Prevention Job (LPJ 257) list. Freezing of the EDC would result in a loss of lean oil flow to the absorber and contamination of the HCl vent with organics.

3. Are the columns in the VCM-1 unit adequately protected by safety relief devices?

The SRV's on the columns are sized for a fire exposure rating but are inadequate in the event of maximum steam boilup. A project (LPJ 206) to install larger SRV's is on hold at this time. This project will be altered if the new quench heat recovery project is installed. The installation of the larger SRV's to handle the maximum boilup case could create another potential hazard in the possible release of large volumes of organic vapors during slight overpressure conditions.

4. Is additional fire protection needed in the form of water sprays, fireproof coatings, flammable vapor detectors, etc.?

Flammable vapor detectors are strategically located throughout the unit. The pressure vessels are all surrounded by deluge system nozzles. The Albiclad fireproof coatings on structural steel members of the furnace and process areas need to be replaced with Chartek or the new PPG coating. The Albiclad has sloughed off and the portion remaining no longer has the ability to intumesce and is useless as fire protection.

The support structures of the dryers, dryer filters, and neutralizers as well as the main columns and beams in the process unit need new fireproofing.

5. Are critical bearing temperatures monitored?

The bearings on the Elliott air compressors are not monitored for temperature although high oil temperature is alarmed and low oil pressure provides a shutdown. The motor bearing and motor winding temperatures on the York drive motors are alarmed.

6. Can high speed centrifugal units coast to a stop in the event of a power failure without damage to the equipment from lack of lubrication?

The Elliott air compressors and York freon compressors are equipped with auxiliary oil pumps. These auxiliary oil pumps on the York freon compressors are connected to emergency power.

7. Is the rotating equipment critical enough that vibration monitoring alarms and/or shutdown systems should be employed?

The York freon compressors have vibration monitors that read out in the control room and also have warning lights.

8. On positive displacement compressors is protection provided against overpressure by restricted or blocked discharge?

The freon recovery compressor does not have an SRV on the discharge but has a high discharge pressure shutdown. The compressor should be fitted with a safety relief valve.

9. Do all desiccant dryers have backup filters to prevent carryover of desiccant?

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The lower intercooler dryer filters have been removed and the upper intercooler and quench liquor dryers have only one filter each left from an original dual system. The dryers are used infrequently but the lower intercooler dryer should be equipped with at least one filter.

10. If a filter is not equipped with a safety relief device, will an unacceptable condition result if the filter overpressures?

A filter would be subjected to overpressure in the event of a fire with the filter blocked in liquid full. These small vessels have generally been excluded from SRV protection throughout the Complex due to their small size.

11. Do all control loops meet failsafe criteria?

A list of the failure position of all of the control valves in the VCM-1 plant is needed to make this determination but a list does not exist.

12. Are all instrument cable trays and electrical control conduit properly protected from mechanical damage and exposure to fire?

The cable trays are protected from mechanical damage although some portions are severely corroded and in need of replacement. The cable trays are routed to minimize exposure to fire but no fireproofing is applied. Plant practice does not include fireproofing cable trays.

13. Is all critical instrumentation on emergency power?

The level indicating controllers on the refrigeration system, the vaporizer shutdown system, the Arcas vinyl chloride analyzer, and control room panelboard are on emergency power. The vapor detector systems should be on emergency power so that they would operate by something other than the heat activated device (HAD) system.

14. Do all storage tanks containing flammables have dikes or drain to an impounding basin?

The heavies still bottoms tank is located off of the process pad area. Any spillage from this tank would flow into the storm sewer and not the process sewer. The vinyl sphere areas near VCM and at the docks, along with the day tanks are in diked areas.

15. Is all fire fighting equipment strategically located?

All fixed water spray systems are adequately engineered and maintained. There are, however, no explosion proof bunkers around the deluge valves nor are they recommended at this time. The marking of the hand held fire extinguisher locations could be improved.

16. Is there a common venting system which could lead to cross contamination of all vessels?

The venting of the day tanks is to a common system and sometimes results in HCl contamination of tanks. This presents a product quality problem and not a hazard.

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17. Is the general area lighting sufficient for both normal and emergency operating conditions?

The emergency lighting in the control room in the event of a total power failure is poor. Additional battery powered lanterns are needed.

18. Are piping systems adequately protected against excessive pressure build-up, including hydraulic expansion from exposure to the sun?

Most transfer lines are protected by thermal SRV's but it is possible to block in some lines. The normal procedure is to leave the lines open on one end or the other to equalize the pressure buildup.

19. Are adequate control measures provided to prevent clouds of flammable vapors from reaching known ignition sources?

The buildings located to the west of the VCM-1 plant are of concern in the event of a large spill. The old construction warehouse is now occupied by the carpenters while some of the other construction buildings are no longer inhabited. Recently a VCM-1 unit evacuation alarm was installed in the maintenance building west of the unit but other perimeter buildings do not have any warning devices.

Hydroshields and deluge systems are installed to prevent vapor clouds in the process area from reaching the furnaces.

20. Are all areas containing flammables properly drained for carrying spilled flammable liquids and water used for fire fighting away from buildings, tanks, and process equipment?

The main process pad drain would not handle the flow of two 1½ inch fire hoses during tank washing on the recent outage. The sewer flow capability needs to be evaluated. The 6" drain from the process pad is designed to handle a 225 gpm flow.

21. Are screens provided in the lines upstream of deluge valves?

Yes, screens are provided on deluge systems to sprinklers but not to the hydroshields. Due to the large orifice size on hydroshields, screens are not needed.

22. Are adequate safeguards provided to prevent explosions in the incinerator and 36" process area vent headers?

The incinerator vent header has an oxygen analyzer which samples at a point after all the VCM-1 plant vents are collected. The analyzer reads from 0 - 10% and is alarmed. Nitrogen purges are added to both the incinerator vent header and the 36" process area vent header to limit air intrusion.

23. Do all sight glasses have excess flow valves?

The sight glasses do not have ball checks in many cases so the sight glass valves should be closed except during readings. Inaccessibility of the valves is one reason for the difficulty in complying.

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The following items from the LPJ list were discussed and a new status decided.

LPJ 199 Lean Oil Cooler Subject to Design Pressure

Industrial Engineering needs to provide input on how to correct the problem of operating the lean oil cooler at its design pressure.

LPJ 206 Additional SRV for VCM Columns

This project covers the installation of larger SRV's to protect the columns against maximum boilup instead of only fire exposure. Steam shutoffs were considered as an alternative but SRV sizing standards do not take credit for shutoffs. These larger SRV's will also introduce a greater hazard of vapor cloud explosion due to the large quantities of organic vapors released. The installation of the quench heat recovery system will impact on this project and force a redesign of the SRV's. This needs Loss Prevention attention before the project goes any further.

LPJ 173 Fireproof Structural Steel per ORC

The replacement and installation of fireproofing is pending a management decision on whether Chartek, the new PPG material, or cementitious coatings should be applied. This decision is pending the outcome of testing of the materials.

LPJ 259 Replace Seal Flush Filter with High Rating

A new work order will be written and Loss Prevention will be consulted before this filter purchase is made.

LPJ 166 Install Test Taps on Maxon Valves to Determine Leaks

Jim Wood will write the ORC to determine if this project should be pursued.

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RESULTS

Since there were no previously undefined potential hazards recognized during the cause-consequence sheet development, no fault tree analysis was done on this study.

Plans for implementing the recommendations of the Loss Prevention Review will be made at the Operations Review Subcommittee meeting to be held after this report is issued.

The Loss Prevention Jobs list items will be acted on as outlined in this report.

CONCLUSIONS AND RECOMMENDATIONS

In order to reduce the potential for hazard within the VCM-1 distillation and storage areas the following items from the Loss Prevention Review should be implemented. Each item is referenced to a question number.

1. Install a low temperature alarm on the lean oil cooler outlet. (Q 2)

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2. Evaluate the installation of the larger SRV's on the distillation columns in light of the quench liquor heat recovery project. Resolve the question of SRV sizing for maximum steam boilup in view of the larger SRV release. (Q 3)
3. Apply fireproofing to the supports of several vessels and to structural steel with deteriorated fireproofing. (Q 4)
4. Install an SRV on the discharge of the freon recovery compressor. (Q 8)
5. Install a filter downstream of the lower intercooler dryer. (Q 9)
6. Make a list of the failure mode of all control valves. (Q 11)
7. Repair corroded cable trays. (Q 12)
8. Connect vapor detector systems to emergency power. (Q 13)
9. Improve marking of hand held fire extinguishers. (Q 15)
10. Install additional battery powered lanterns in the control room. (Q 17)
11. Study the drain capacity of the process pad in light of fire fighting water requirements. (Q 20)
12. Equip sightglass shutoff valves so that they can be shut off except during readings on the routine operator rounds. (Q 23)

The following items from the LPJ list require action.

- | | |
|---------|--|
| LPJ 199 | Request Industrial Engineering assistance in determining method to have lean oil cooler operate at a pressure lower than design. |
| LPJ 206 | Study the installation of additional overpressure protection of the VCM-1 unit columns. |
| LPJ 173 | Determine the best material to use in replacing and applying fireproofing where needed in the VCM-1 unit. |
| LPJ 259 | Design the new seal flush filter to withstand the operating pressure of the furnace feed line. |
| LPJ 166 | Determine if test taps are needed for the Maxon valves. |

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Author: S. Wayne French

Date: 11/30/83

Approved: Roy E Sanders

Date: 12/16/83

Approved: Charles R. West

Date: 12/19/83

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APPENDIX

TABLE I

LIST OF
VCM-I DISTILLATION AND STORAGE AREAS EQUIPMENT
STUDIED IN THE
RELIABILITY/LOSS PREVENTION REVIEW

Absorber Stripper

Absorber column
Lower intercooler
Lower intercooler surge tank
Lower intercooler dryer
Lower intercooler dryer filters (2)
Lower intercooler pumps (2)
Upper intercooler
Upper intercooler surge tank
Upper intercooler dryer
Upper intercooler dryer filters (2)
Upper intercooler pumps (2)
90° lean oil cooler
+34° lean oil cooler
-40° lean oil cooler
Lean oil pumps (2)
Absorber vent condenser
HCl stripper
Stripper reboiler
Stripper feed pumps (2)
Quench liquor dryer
Quench liquor dryer filters (2)

Vinyl Product Still

Product still
Product still reboilers (2)
Product still condensers (2)
Product still vent condenser
Product still feed tank
Product still reflux tank
Product still feed pumps (2)
Product still reflux pumps (2)

Heavies Still & EDC Recycle System

EDC recycle cooler
EDC reaction tank
Heavies still feed tank
Heavies still
Heavies still reboiler
Heavies still condenser
Heavies still reflux tank
Heavies still feed Pumps (2)
Heavies still reflux pumps (2)
Waste recovery tank

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Heavies Still & EDC Recycle System (Cont'd.)

Heavies still bottoms pumps (2)
Heavies still stack seal
Heavies still feed filter
Heavies still bottoms filter

Neutralization

Neutralizers (3)
Acid product phase separator (Humidifier)
Product phase separator (Dehumidifier)
Water addition tank
Product cooler
Product filters (2)
Neutralizer drain tank

HCl Distribution

Entrainment separator
HCl knockout pot
No. 1 HCl heater
No. 2 HCl heater
No. 1 HCl line
No. 2 HCl line
VC HCl scrubber

Product Storage

VCM Daytanks (8)
Product transfer pumps (2)
Product transfer filter
CertainTeed transfer pump
Daytank rework pump
Storage spheres No. 1, No. 2 & No. 3
Tank car loading pumps (2)
Tank car loading filter
Dock storage transfer line
Ship and barge loading pumps (2)
Ship and barge loading filter
Vent compressor
Vent compressor K.O. pot
Day tank rework neutralizer

York Refrigeration System

York refrigeration compressors (2)
Compressor motors (2)
Gear speed increasers (2)
Compressor oil system pumps (2)
Freon recovery compressor

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Freon Liquid System

Freon condensers (2)
High pressure float chamber
Freon surge receiver
Fourth stage controls
Freon pump-out unit
Freon storage tank
Purge units

Auxiliary Equipment

VC cooling towers Nos. 2 & 3
Cooling tower fans (4)
Cooling tower water pumps (4)
Condensate collection tank
Condensate Pump
Steam desuperheater
Steam desuperheater condensate pump
Coke K.O. drum
Seal flush filter - F.E. supply
Seal flush filter - prod. still feed supply
Dopp kettle seal flush filters (2)
Rework pump
Instrument air blower
Elliott air compressors (2)
Regeneration air blower on instrument air dryers
Chlorine vaporizer
Aftol addition pump
Chlorine surge tank
Aftol still aid tank

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