Telecopy to J. T. Barr (pages)

Air Products and Chemicals INC.

ESCAMBIA PLANT

INTEROFFICE MEMORANDUM

To: Mr. E. A. Ray

Date: 12 March 1974

Copies: J. T. Barr
T. L. Carey
R. Fleming
J. D. Kramer
A. K. McMillan
E. A. Primeau
G. B. H. Speed
R. R. Spiegelhalter
M. Sterman

From: W. C. Wilde

Re: Personal Monitoring for VCM Exposure at Pace Plant

Three portable sampling systems have been received and are now being used for personal monitoring of VCM levels at the Pace Plant. After an initial period of debugging, it was found that the battery life was only 3 to 4 hours before a 16 to 20 hour recharge was needed. This is the same battery life experienced at Calvert City with identical equipment. To increase the utilization of these instruments a purchase order has been placed for 6 more batteries and 3 more chargers.

It was expected that the operators exposed to the highest VCM levels would be the utility, recovery and solutions operators. The utility operators clean reactors, blind and unblind them, and do most of the washing out; therefore, we expected them to experience higher exposure levels than other operators. The initial round of samples showed:

Utility Operator	27 ppm VCM
Solutions Operator	8 ppm VCM
Recovery Operator	6 ppm VCM

This data confirmed our expectations, and it was decided that the initial testing program should concentrate on the utility operators.

The next two samples taken on the utility operators showed 14 ppm and 180 ppm. The 180 ppm reading was taken during a three-hour reactor cleaning period. As a result of this unexpected high reading, the following steps were taken:

1) The man's supervisor was questioned and he said that normal entry procedure was followed.

2) It was impossible to contact the employee directly, he walked off the job without giving notice. His final paycheck is being withheld until he is questioned about possible unusual conditions.

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3) Based on this one high (180 ppm) analysis, our entry procedures were modified to require the shift supervisor to check each reactor prior to entry with the Century portable analyzer. We have been reluctant to require this since the Century has not yet received UL approval for use in hazardous areas.

The monitoring of utility operators has continued and the results have ranged from 5 to 88 ppm. The average for all utility operators to date (including the 180 ppm) is 51 ppm.

Our program is to continue to monitor the exposure levels of the reactor cleaners to the exclusion of the other operators. We expect to have a good set of base data for the cleaners within one week. At that time our monitoring program will be extended to include the other operators.

W C Wilde
W. C. Wilde

WCW:bp

Enclosure

Telecopy TO: MR. J. T. BARR

Personal Monitoring for VCM Exposure

Operator's Job Title	Operator's Name	Date	Sampling Time Start	Sampling Time Stop	Shift Taking Sample	T.W.A. VCM level
Solutions	J. Summerlin	3/6/74	10:30 AM	1:30 PM	7-3/"D"	8 ppm
Recovery	A. Collins	3/6/74	4:00 PM	7:00 PM	3-11/"A"	6 ppm
Utility	F. Henderson	3/6/74	4:00 PM	7:00 PM	3-11/"A"	27 ppm
Utility *	F. Henderson	3/7/74	4:30 PM	7:00 PM	3-11/"A"	14 ppm
Utility *	Martin (carrol)	3/8/74	12:00 MN	3:00 AM	11-7/"B"	180 ppm
Utility	Henderson	3/8/74	8:00 PM	11:00 PM	3-11/"A"	17 ppm
Utility *	Berry	3/9/74	10:30 AM	1:30 PM	7-3/"C"	14 ppm
Utility *	Henderson	3/9/74	3:30 PM	6:30 PM	3-11/"A"	69 ppm
Utility *	Henderson	3/10/74	1:30 AM	4:30 AM	11-7/"B"	88 ppm
Utility *	Berry	3/10/74	10:45 AM	1:30 PM	7-3/"C"	74 ppm
Utility *	Henderson	3/10/74	4:30 PM	7:30 PM	3-11/"A"	5 ppm
Utility *	Watson	3/11/74	2:00 AM	5:40 AM	11-7/"B"	23 ppm

* Operator was in reactor cleaning during sampling period

AP00050380

CALVERT CITY PVC EXPANSION
PROCESS HAZARDS ANALYSIS
(PART I)

Date: 12-16 September 1977

Committee: A. J. Santay
W. Silowka
G.B.H. Speed
T. N. Sreenivasan
J. J. Stango

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Executive Summary

Part I of the Calvert City PVC Expansion Hazards Analysis was done on 12-16 September 1977. Major hazards and corresponding recommendations are summarized in the following:

HAZARD	RECOMMENDATION
• Overpressurize gas holder, possibly rupture	• Install control valve at scrubber which closes on high gas holder level.
	• Install pressure relief inside gas holder membrane area.
• Runaway reaction	• Install agitator shaft zero-speed alarm.
	• Provide strict maintenance of "short stop" system.
• Flammable mixture inside reactor	• Provide adequate N_2 purge.
	• Install flow alarm on N_2 supply line.
• Operator exposed to "short stop" chemical while filling tank.	• Install check valve on drum fill line.
• VCM pipeline rupture from hydraulic hammer	• Ensure that all JV ball valves are slow-closing.
• Overfill VCM charge tank	• Install JV valve on VCM feed line after metering station.
	• Install high level alarm in control room for level transmitter on charge tank.

The status of all recommendations appears in Appendix III of this report.

INTRODUCTION

The scope of the Calvert City PVC Expansion includes increasing the plant's capacity to 210 mm lb/year. New polymerization, stripping, drying, and product storage facilities will be provided, as well as incorporating portions of the existing plant.

The process hazards analysis of the Calvert City PVC Expansion project was divided into two parts. This report covers the items included in Part I of the review, done on 12-16 September 1977. Specifically, the reactor and stripper areas, raw material storage, and some of the monomer recovery area were examined.

The objectives of this review were to:

- identify major hazards in the PVC Process
- generate recommendations to minimize the hazards
- ensure that the recommendations were implemented into the design as soon as possible.

Chemicals' Group Project Management is responsible to answer to all recommendations of this hazards review.

Team members for the PVC Expansion Hazards Analysis - Part I were:

A. J. Santay - Corporate Safety
W. Silowka - Chemicals' Group Engineering
- Process Design
G. B. H. Speed - Calvert City Manufacturing
J. N. Sreenivasan - Plastics R & D
J. J. Stango - Chemicals' Group Engineering
- Mechanical Design

METHODOLOGY

Fault Tree analysis was used for this hazards review of the PVC Expansion. In some cases, the "What if" method was tried but abandoned because of the complexity of the systems and difficulty in documentation.

For Part I, nine systems were defined, a system performing a single unit operation. They include the:

- reactor
- blowdown tank
- continuous stripper
- monomer charge tank
- raw material storage, including DMF
- freon condenser
- recovered monomer receiver
- methyl chloride splitter
- gas holder

Vessel rupture, external fire, and internal fire were the undesired events examined in these systems.

The development of a fault tree for any system begins with the undesired event at the top of the page. The analysis proceeds using specific logic symbols (Appendix I) until all basic causes are defined. The biggest advantage of this method is that it allows the team to identify those causes and all possible relationships. Since most major industrial accidents are the result of two or more simultaneous failures, these interactions are important in analyzing a system.

A reactivity grid of the raw materials used in the PVC process was developed. This matrix provides a graphical means of determining what effect the mixing of any two materials might have.

With vinyl chloride monomer a known carcinogen and under strict regulation, the potential for employee exposure was also investigated. The purpose of this discussion was to highlight the health hazards associated with the process.

ANALYSIS

The fault trees generated for the various systems in Part I are shown in Appendix II. Most of the systems were analyzed for vessel rupture or explosion, stressing the need for adequate relief protection. External fires in the process, monomer recovery, and storage areas were developed, as well as a fault tree for a runaway PVC reaction. A major portion of these main undesired events also appear within other fault trees as subevents.

The reactivity grid for the PVC Process is shown in Figure 1. Fifteen major and supplementary raw materials were included in this analysis. Most of the combinations will result in rapid temperature and pressure increases, as shown on the key to the grid.

Operator exposure to vinyl chloride monomer was briefly examined. Basically, a "closed-system" approach was used in the design of the PVC plant. Those areas specific to the plant which will minimize exposure were highlighted. A summary of this discussion appears in the Conclusions and Recommendations section of this report.

FIGURE 1

PVC PROCESS: REACTIVITY GRID

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. WATER						b						a	b	b	
2. METHOCEL K-90 (METHL CELLULOSE)															
3. METHOCEL K-35 (METHL CELLULOSE)															
4. MBCP															
5. ULTRAWET-60L															
6. ESPEROX 33M	b						e	c	d	f		g			
7. VAZO 64						e		h							
8. VINYL CHLORIDE						c	h						c	c	
9. VINYL ACETATE						d							d	d	
10. SODIUM BICARBONATE						f						i	f	f	
11. VERSENE															
12. PHOSPHORIC ACID	a					g				i			g	g	
13. LUPERSOL 223	b							c	d	f		g			
14. LUPERSOL 228	b							c	d	f		g			
15. DREW 475 (ANTIFOAM)															

KEY TO REACTIVITY GRID

a = may react to produce heat

b = in closed systems, can generate temperature and pressure increases through auto-acceleration decomposition (>90°F)

c = in confined non-diluted state will lead to temperature and pressure build-up

d = in confined non-diluted state will lead to heat generation

e = in confined non-diluted state will lead to heat generation

f = will lead to rapid base hydrolysis, possible pressure build-up, and temperature rise

g = will lead to rapid acid hydrolysis, possible pressure build-up, and temperature increase

h = in confined non-diluted state will lead to heat release and pressure build-up

i = in closed containers, can generate temperature and pressure increase through heat of neutralization

Conclusions and Recommendations

Major hazards were identified with this analysis, and recommendations to minimize them have been generated.

HAZARD	RECOMMENDATION
• Overpressurize gas holder, possible rupture	1. Install a control valve at scrubber (DA-8301) before maintenance bypass. Reactor vent and blowdown lines will be tied in upstream of valve; all other vents are to be located downstream. Valve will close on high level in gas holder.
	2. Install pressure relief on gas holder (within membrane area).
• Methyl chloride splitter ruptures	3. Install relief valve on MeCl splitter reboiler (EA-8317).
	4. Install high-temperature, high-pressure, and high-level alarms on MeCl splitter. Evaluate a feed interlock with pressure alarm.
	5. Check that relief vent size on splitter is adequate to handle vapor from thermal polymerization of vinyl acetate.
• Freon condenser plugs from water freezing	6. Install a differential pressure loop on freon condenser (EA-8308). Have DP alarm to activate bypass loop.
	7. Install level alarm.
• Gas blows back through condensers	8. Provide liquid seal legs or sufficient slope to allow liquid seal on both primary and both secondary condensers.
• Exchanger shell ruptures	9. Install relief valves on shell side of all exchangers.
• Vessel or safety equipment failure	10. Establish procedure for periodic inspection of vessel integrity.

HAZARD	RECOMMENDATION
	11. Ensure that design provides means of relieving any pressure buildup between rupture disc and relief valve.
	12. Evaluate rupture disc design to ensure that liquid cannot be extruded past it.
• Runaway reaction	13. Consider the installation of an agitator shaft zero-speed alarm switch or equivalent.
	14. Have plant establish strict procedures for maintaining a fully operable "short stop" system.
• Flammable mixture inside reactor	15. Provide adequate nitrogen purge on reactor when emptying DMF, rather than relying on N_2 from DMF tank displacement. Same recommendation applies for emptying of displacement water.
	16. Install flow alarm on N_2 supply line to reactor.
• Runaway reaction initiated by impurities	17. Install on-line analyzer for recovered monomer.
• Wrong charge pot filled with initiator	18. Install signal lights on charge pots. Lights should be computer-controlled.
• VCM leaks in condensers, baffles, etc.	19. Install VCM monitoring points in cooling tower and chilled water systems.
• Wrong initiator used	20. Provide means to identify different types of initiator.
• Operator exposed to "short stop" while filling tank	21. Install check valve on drum fill line of "short stop" tank.
• "Short stop" feed system blocked	22. JV-0425 and JV-0428 on "short stop" system should be "fail close", not "fail open".
• Leaks in "short stop" system	23. "Short stop" tank level gauge should be armored and equipped with ball check valves.

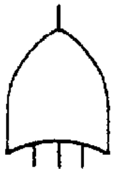
HAZARD	RECOMMENDATION
• Process upsets	24. Provide an indication and analysis of stream that is sent to the incinerator.
• Overpressurize blowdown tank	25. Evaluate failure mode of control valve between blowdown tank and gas holder system.
• VCM pipeline rupture from hydraulic hammer	26. All JV ball valves on VCM line runs (i.e., from BF Goodrich, between existing storage and new monomer charge tank) should be slow-closing.
• Overfill VCM Charge tank	27. Relocate JV-0324 from BFG side of metering station to line VCS-601-3" CM, which services existing storage bullets. Install a manual valve in its place for maintenance access to PSV-0330.
	28. Install a JV valve on line to new charge tank after metering station. This valve should be tied in with JV-0324 for emergency shut-off of VCM feed from BFG.
	29. Install high level alarm in control room for level transmitter on charge tank. High level switch should close LCV-0322.
• Thermal expansion in VCM piping	30. Use rupture disc with PSV-0330, vent to atmosphere.
	31. Review VCM piping to install thermal expansion reliefs wherever there is a possibility of a line segment being closed off (either manually or automatically).
• Excessive vibration in VCM pumps from bearing failure	32. Establish preventative maintenance program for all VCM pumps.
• Miscellaneous VCM leaks	33. All level gauges on storage tanks should be armored and have ball check valves.
• Thermal expansion in DMF, VAM, and TCE piping	34. Review thermal relief requirements for DMF, VAM, and TCE piping.
• Raw material supply pumps fail	35. Evaluate need for pressure relief valves on raw material supply pumps.

HAZARD	RECOMMENDATION
• VCM leaks into DMF storage	36. Add VCM monitor to DMF storage tanks.

Certain features of the new PVC plant will aid in reducing operator exposure to vinyl chloride monomer. These are:

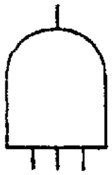
- Computer control of reaction system.
- Double mechanical seals on rotating equipment.
- Closed reaction through recovery system, gas holder, and incinerator.
- Reactor Building open on all sides for better wind dispersion.
- Reactors will be opened less often and water displacement will be used to reduce any emissions that occur if the reactor is opened.
- Fugitive emissions system evacuates VCM from equipment for maintenance purposes.
- Breathing air system.
- Reducing emissions by adding a continuous stripper. This de-regulates the drying/centrifuge system.
- Water streams will be stripped to less than 10 PPM VCM; therefore, there will be very little emissions of VCM from process used water.
- Laboratory Sampling Procedures are modified to reduce exposure. Number of sample points are reduced.
- Final product will have a lower VCM content than present final product.

APPENDIX I



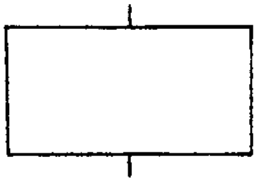
"OR" GATE

The output of this gate results if at least one of the inputs is in the failed state.



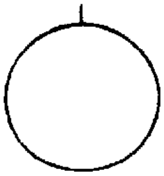
"AND" GATE

The output of this gate results only if all inputs are simultaneously in the failed state.



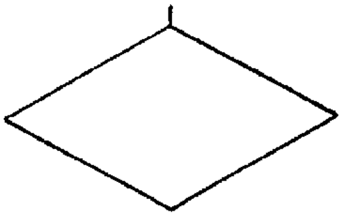
SUBEVENT

Describes the output of a gate.



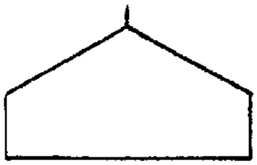
PRIMARY CAUSE

Represents either a system component primary failure, or an independent basic fault.



SECONDARY CAUSE

Represents a basic fault which cannot be or is not developed further because of a lack of information or its low probability of occurrence.

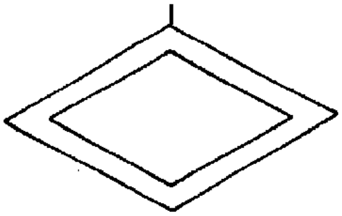


NORMAL OPERATION

Represents an event of element which occurs because of design or normal conditions.

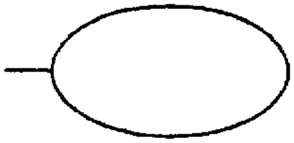
TRANSFER

Transfer one part of a tree to another location on the same tree or to a separate page for more elaborate development.



AUXILIARY SECONDARY CAUSE

Describes an event which is beyond the scope of the review.

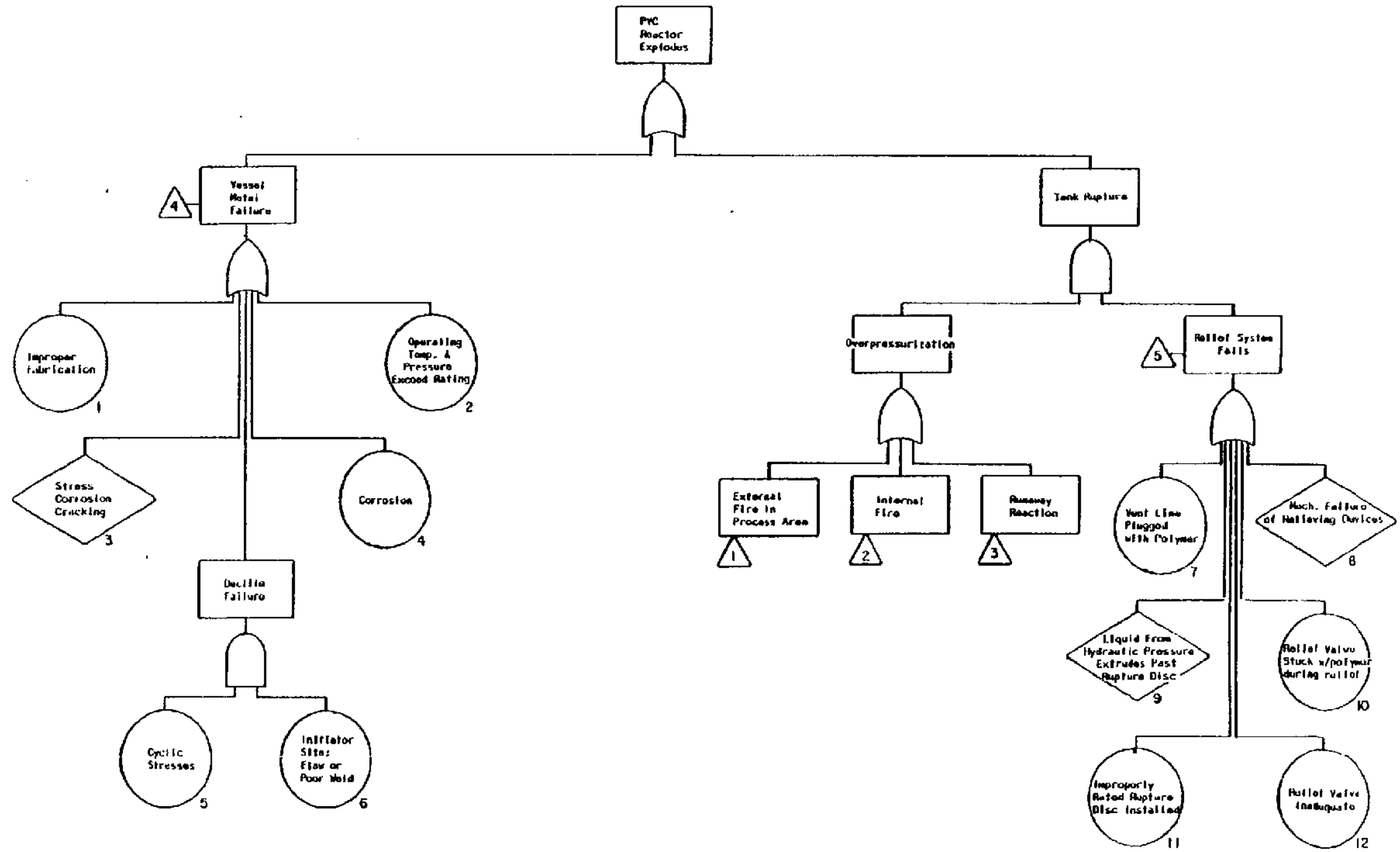


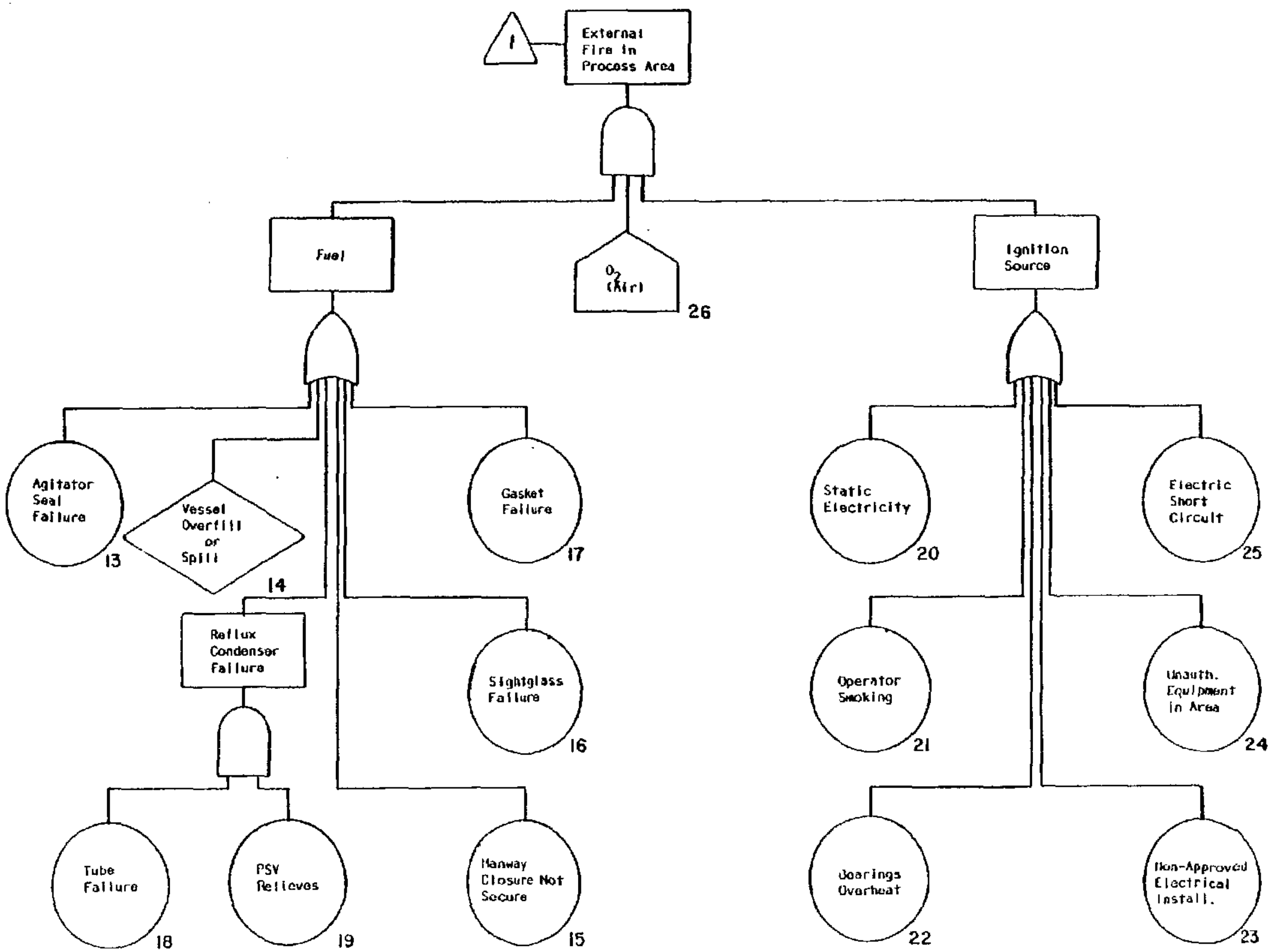
RESTRICTION OR CONDITION

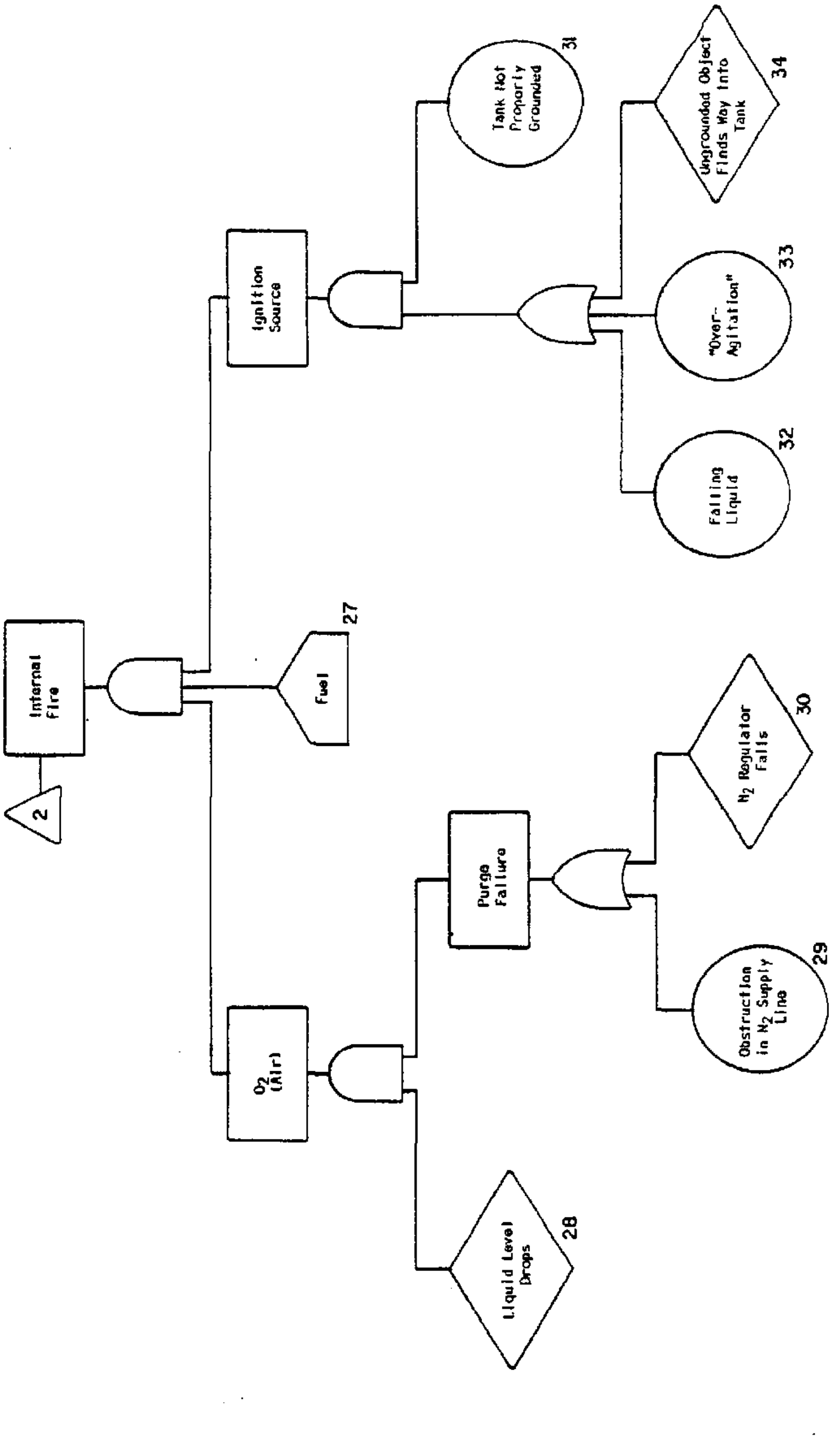
Stipulates those circumstances under which the output would result from the inputs.

APPENDIX II

Fault Tree of PVC Reactor




1
External Fire in Process Area
Fuel
O_2 (Air)
26
Ignition Source
Agitator Seal Failure
13
Vessel Overfill or Spill
14
Reflux Condenser Failure
Gasket Failure
17
Sightglass Failure
16
Tube Failure
18
PSV Relieves
19
Manway Closure Not Secure
15
Static Electricity
20
Electric Short Circuit
25
Operator Smoking
21
Unauth. Equipment in Area
24
Bearings Overheat
22
Non-Approved Electrical Install.
23


Internal Fire
2
Ignition Source
Tank Not Properly Grounded
31
Ungrounded Object Finds Way Into Tank
34
"Over-Agitation"
33
Falling Liquid
32
Fuel
27
O_2 (Air)
Purge Failure
N_2 Regulator Fails
30
Obstruction in N_2 Supply Line
29
Liquid Level Drops
28

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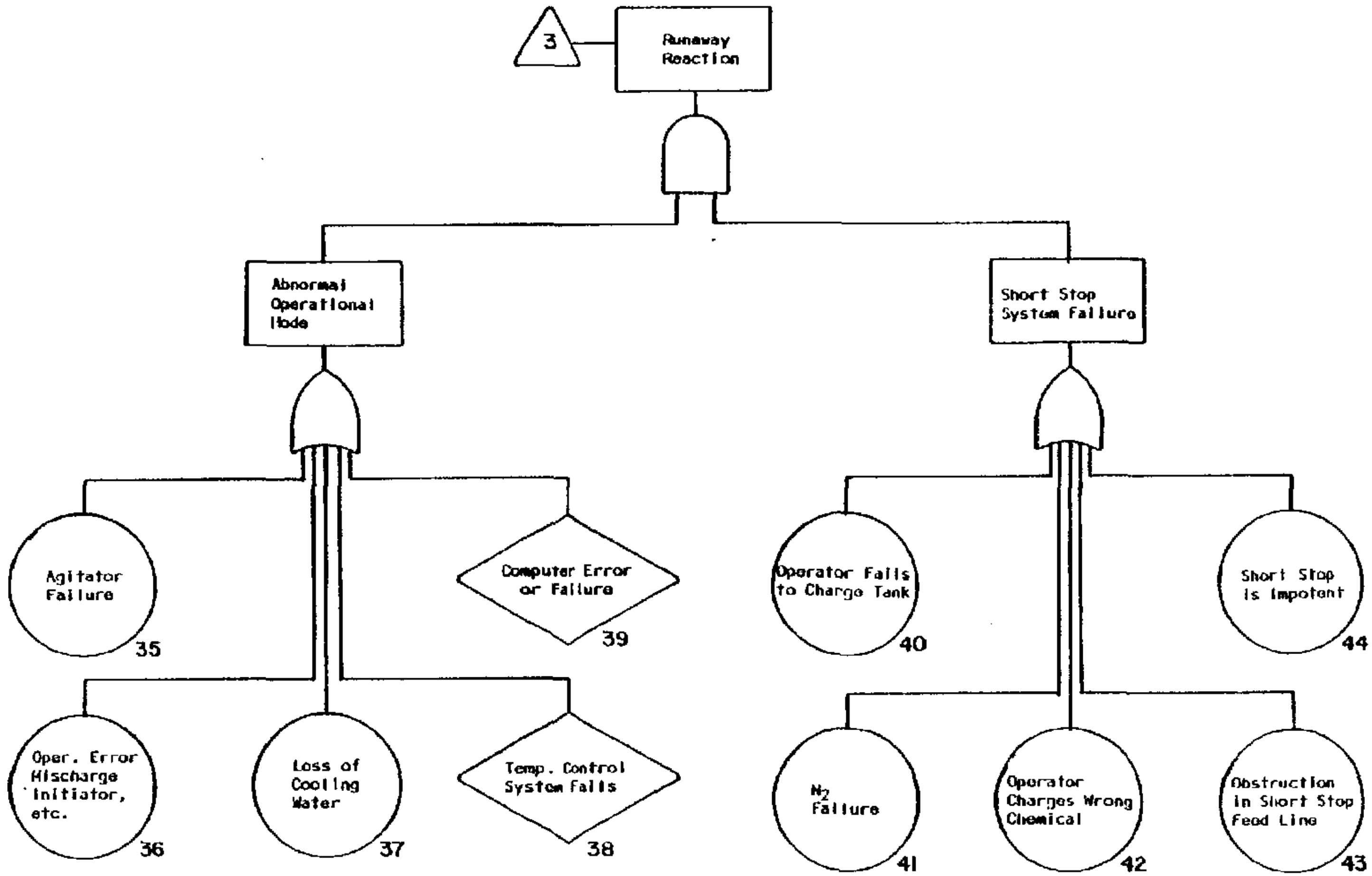
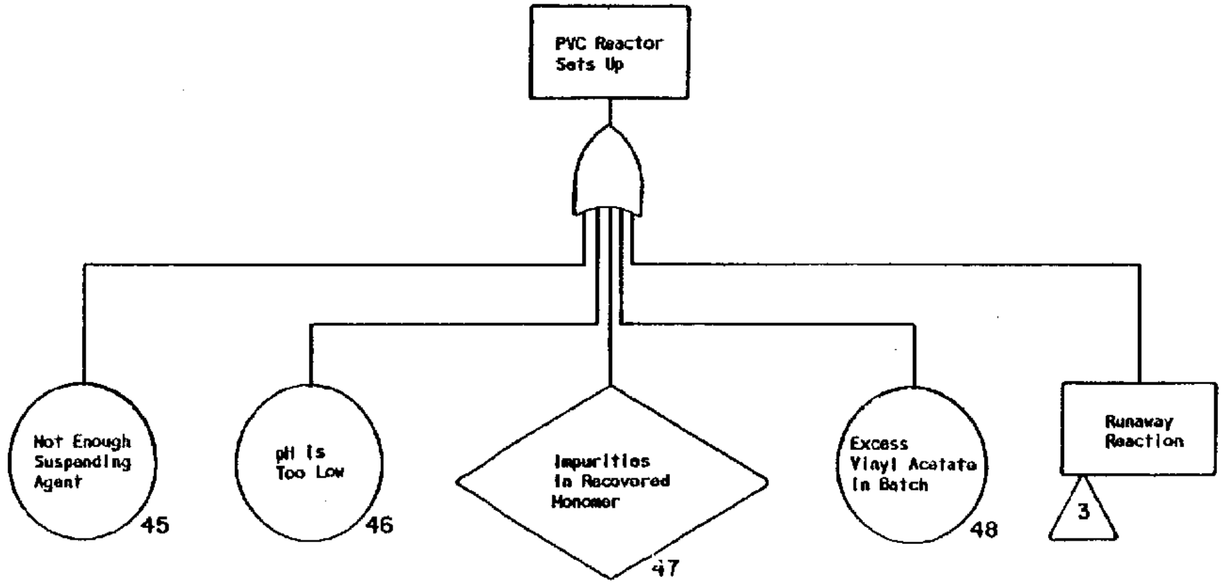

3
Runaway Reaction
Abnormal Operational Mode
Short Stop System Failure
Agitator Failure
35
Computer Error or Failure
39
Oper. Error Mischarge Initiator, etc.
36
Loss of Cooling Water
37
Temp. Control System Fails
38
Operator Fails to Charge Tank
40
Short Stop is Impotent
44
N_2 Failure
41
Operator Charges Wrong Chemical
42
Obstruction in Short Stop Feed Line
43

Fault Tree of PVC Reactor Set-Up



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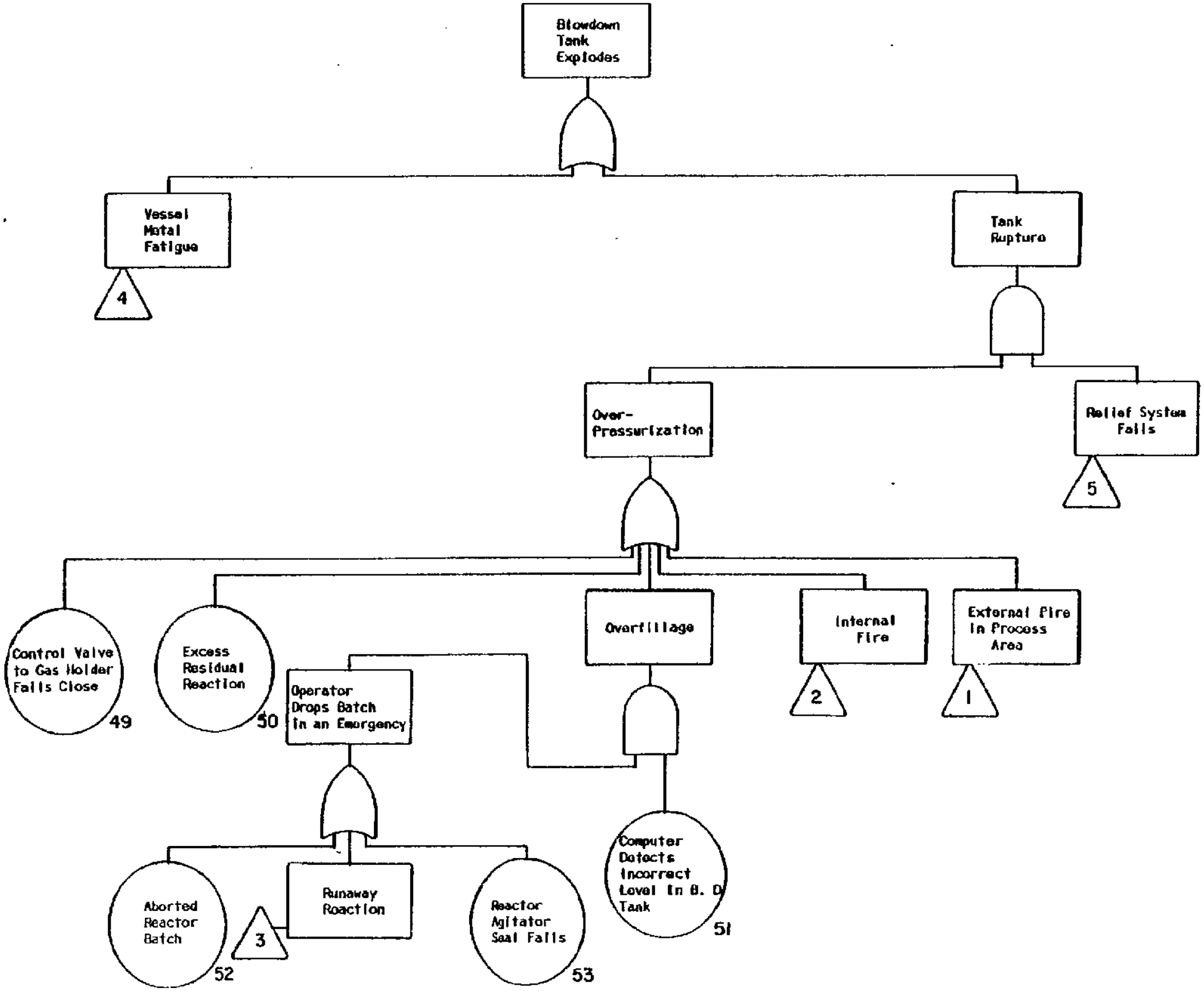
Fault Tree of Blowdown Tank



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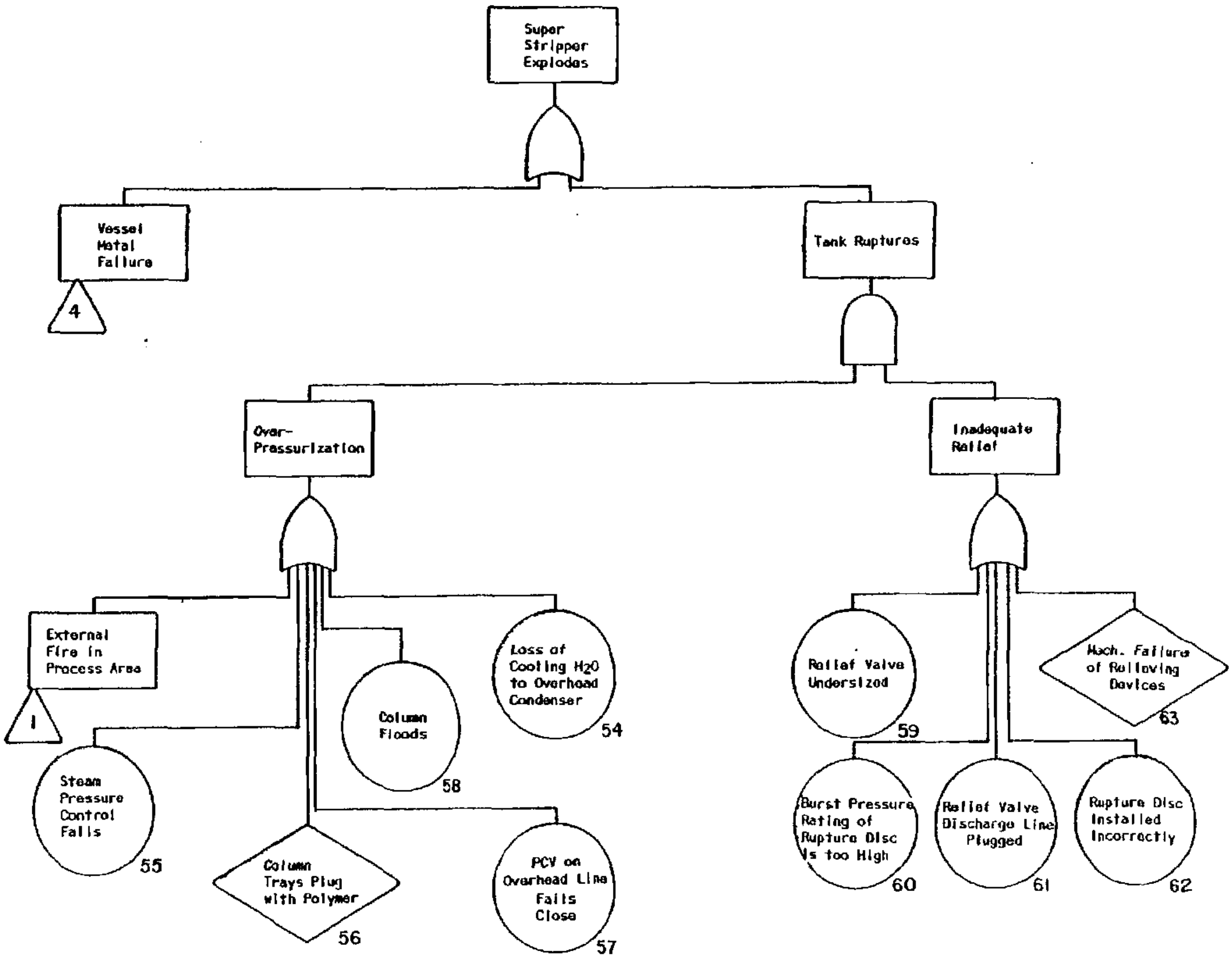
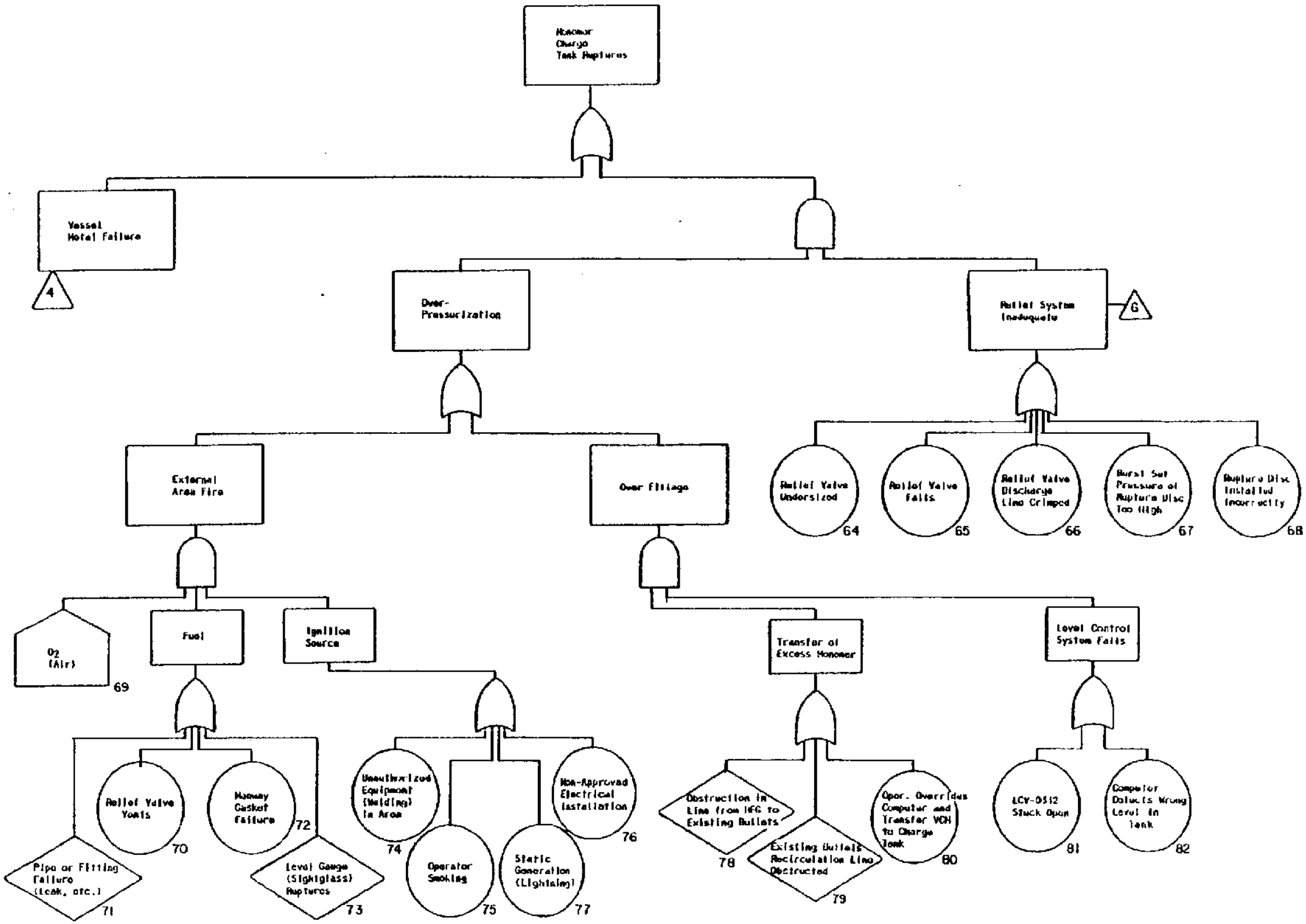
Fault Tree of Continuous Stripper



Fault Tree of Monomer Charge Tank



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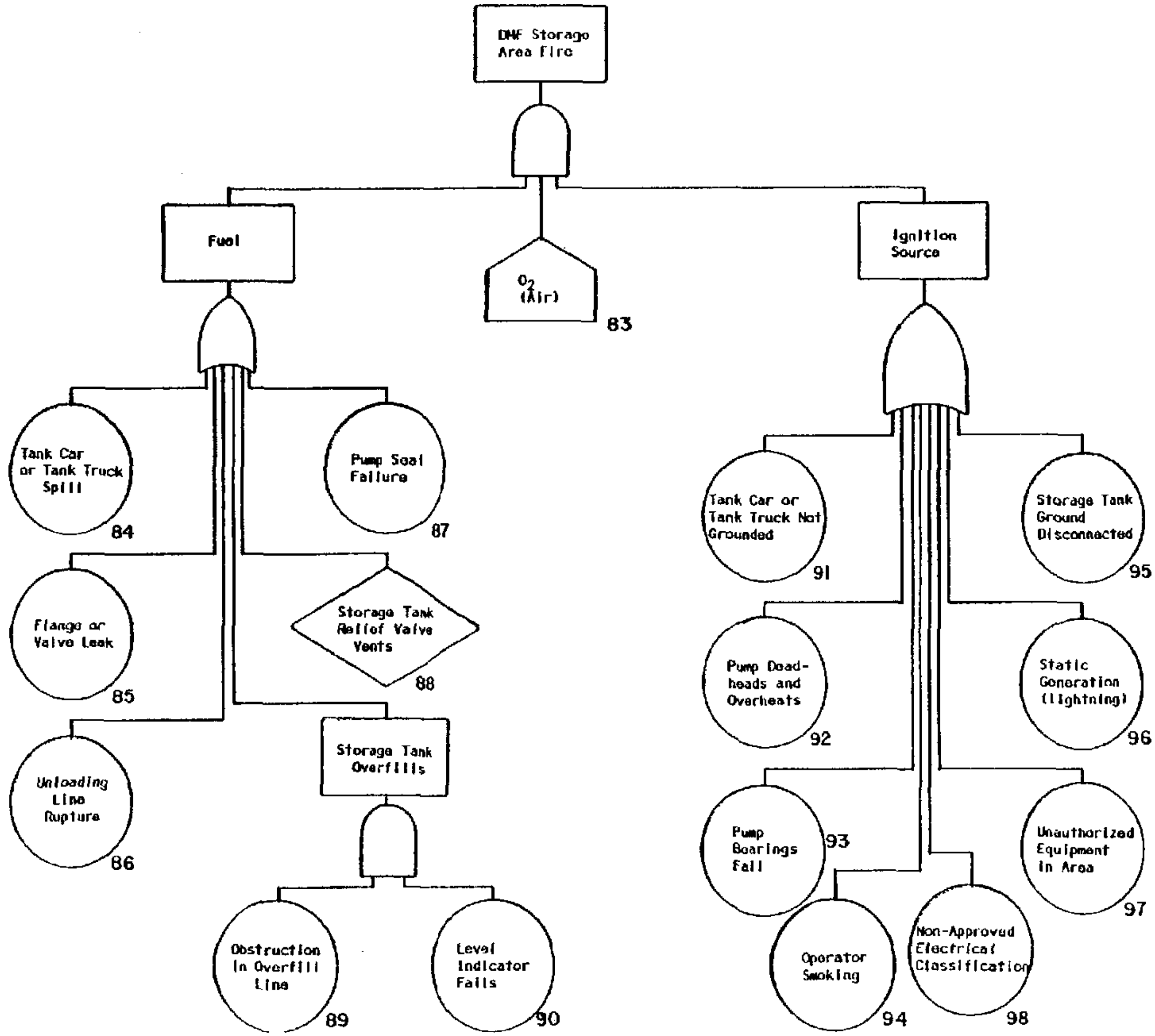
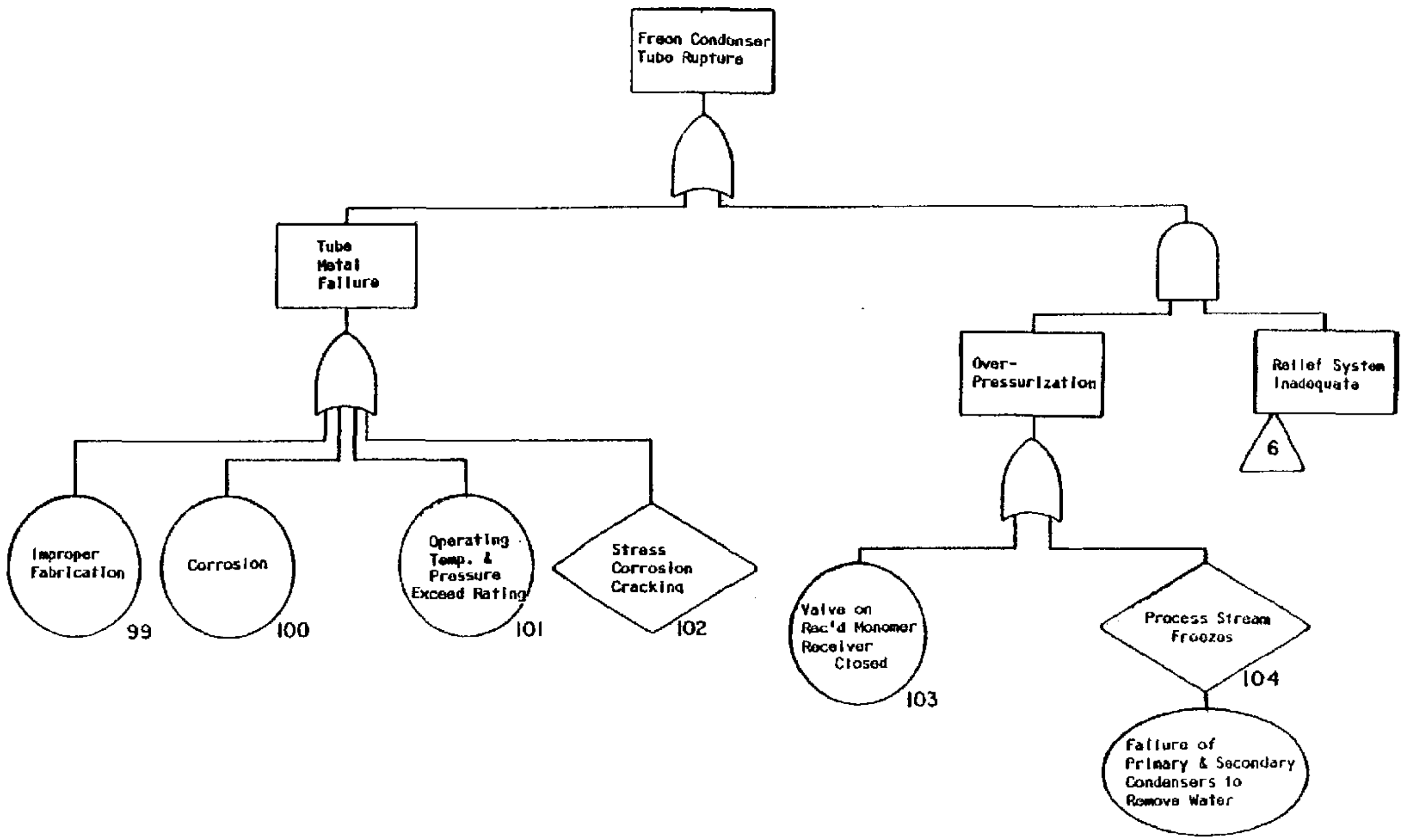
Fault Tree of DMF Storage



Fault Tree of Freon Condenser



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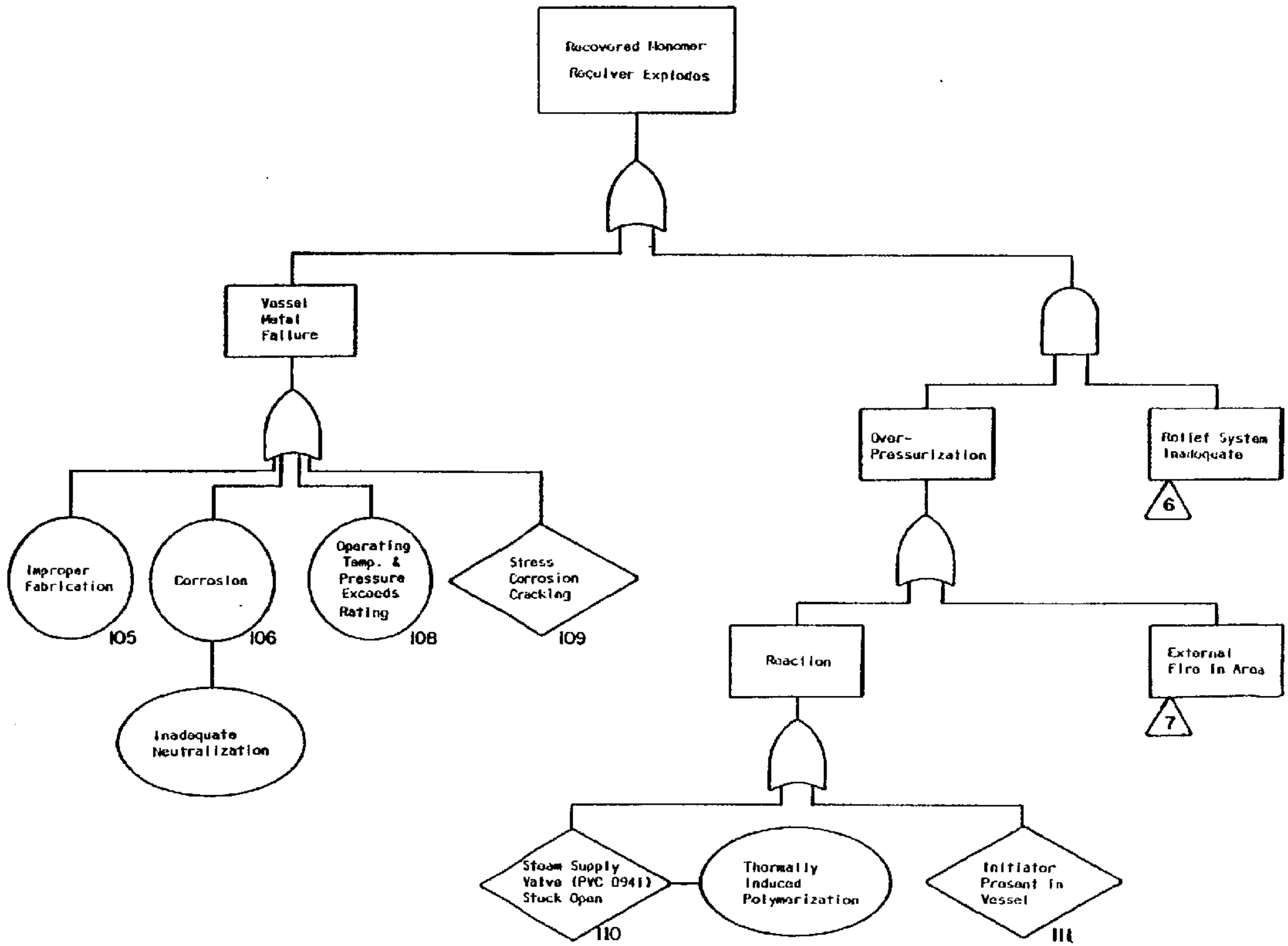
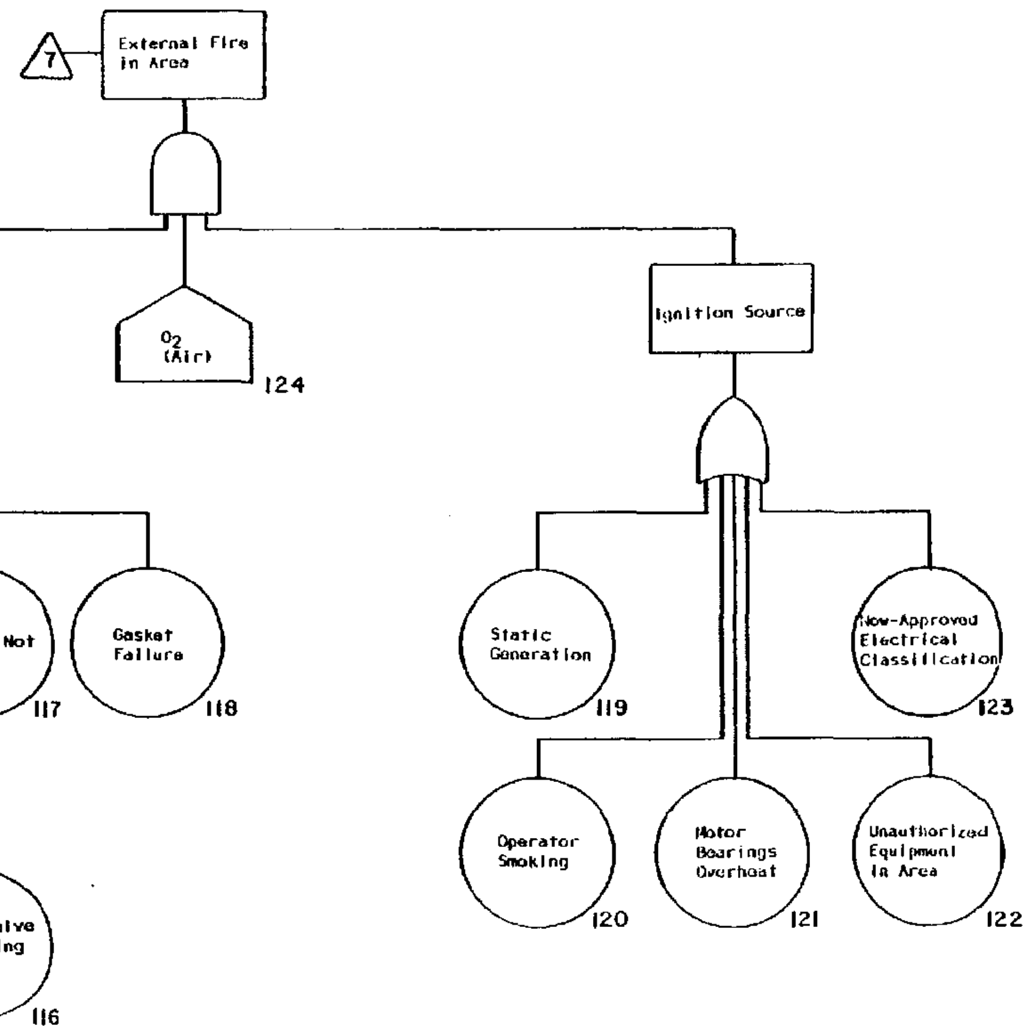
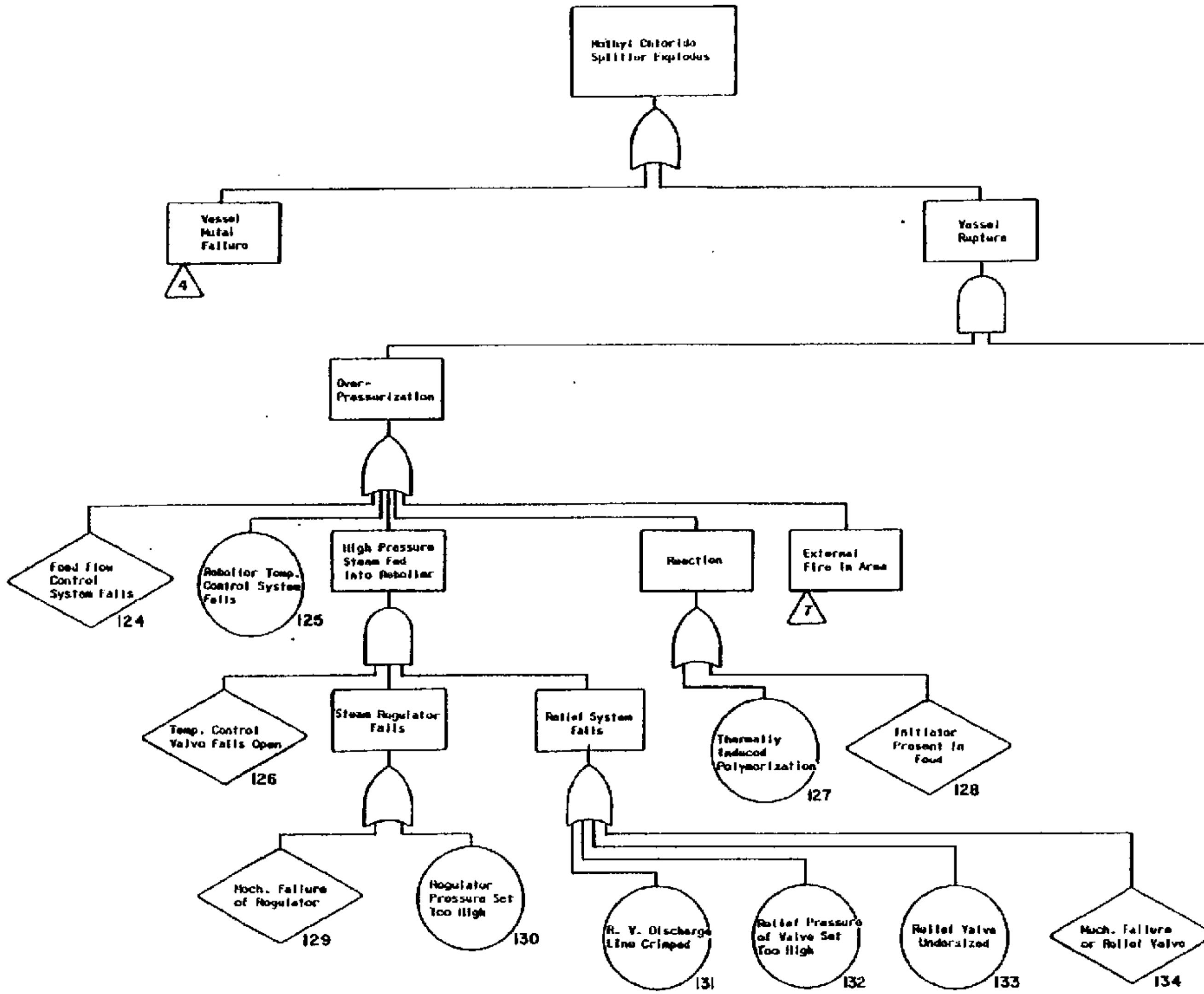
Fault Tree of Recovered Monomer Receiver




7
External Fire in Area
Fuel
O_2 (Air)
124
Ignition Source
Agitator Seal Failure
112
Relief Valve Vents
113
Manway Closure Not Secure
117
Gasket Failure
118
Pump Seal Failure
114
Overfill or Spill
115
Pipe, Valve or Fitting Leak
116
Static Generation
119
Non-Approved Electrical Classification
123
Operator Smoking
120
Motor Bearings Overheat
121
Unauthorized Equipment in Area
122

Fault Tree of Methyl Chloride Splitter



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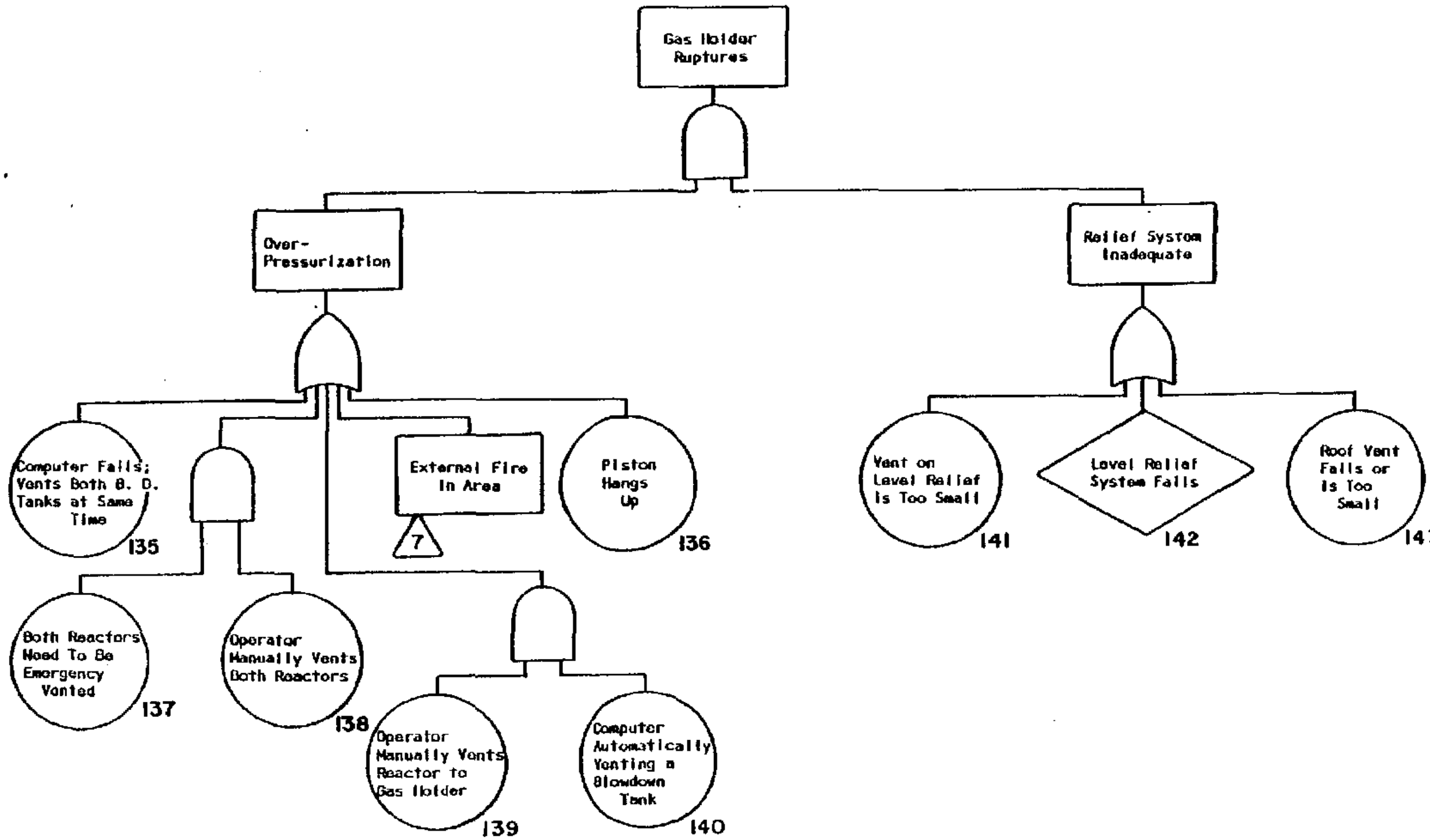
Fault Tree of Gas Holder



AP00050410

APPENDIX III

Air Products

INTEROFFICE MEMORANDUM

Date 17 January 1978

Subject Disposition of Hazards Review Recommendations for Calvert PVC Plant

To DISTRIBUTION

From W. Silowka — Chemicals Group Engineering (Location, Organization, or Department)

Distribution:

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V. L. Hoeksema	G. B. H. Speed
J. D. Kramer	J. J. Stango
R. C. Lietzau	C. M. Tronolone

The following thirty-six recommendations were developed during a hazards review of the expanded PVC plant at Calvert City. For each recommendation, I have indicated the status and disposition of each in the current plant design, and a brief explanation of the item when needed.

1. INSTALL A CONTROL VALVE AT SCRUBBER (DA-8301) BEFORE MAINTENANCE BYPASS. REACTOR VENT AND BLOWDOWN LINES WILL BE TIED IN UPSTREAM OF VALVE; ALL OTHER VENTS ARE TO BE LOCATED DOWNSTREAM. VALVE WILL CLOSE ON HIGH LEVEL IN GAS HOLDER.

   Flow control valves have been added to the lines between blowdown tanks and gas holder. Valves will close on high level in the gas holder.

2. INSTALL PRESSURE RELIEF ON GAS HOLDER (WITHIN MEMBRANE AREA).

   This suggestion cannot be implemented. Catalytic has been unable to obtain a pressure relief valve system which can operate at 0.4 psig, which is the operating pressure of the gas holder. Of course the gas holder is protected by a mechanical relief which opens on high level.

3. INSTALL RELIEF VALVE ON MECL SPLITTER REBOILER (EA-8317).

   A PSV has been added to the reboiler. The splitter is now protected on top and bottom by relief systems - in the event that the column packing should plug from polymerization products.

4. INSTALL HIGH-TEMPERATURE, HIGH PRESSURE, AND HIGH-LEVEL ALARMS ON MECL SPLITTER. EVALUATE A FEED INTERLOCK WITH PRESSURE ALARM.

   Low level alarm and indication and high temperature alarm on the reboiler, and DP unit on column to slow pressure build-up have been added to the MeCl splitter system.

5. CHECK THAT RELIEF VENT SIZE ON SPLITTER IS ADEQUATE TO HANDLE VAPOR FROM THERMAL POLYMERIZATION OF VINYL ACETATE.

   Catalytic is currently checking the basis for relief in the entire monomer recovery area.

6. INSTALL A DIFFERENTIAL PRESSURE LOOP ON FREON CONDENSER (EA-8308) TO DETECT PLUGGING FROM WATER FREEZE-UP. HAVE DP ALARM TO ACTIVATE BYPASS LOOP.

   A DP loop (DPT-1083) will be installed, but enough time exists for an operator to manually activate the bypass loop on the exchanger.

7. INSTALL LEVEL ALARM ON FREON CONDENSER TO DETECT A POSSIBLE PLUG IN LIQUID BOTTOMS LINE.

   A high-level switch and alarm (LSH-1082 & LAH-1082) have been added to the freon unit.

8. PROVIDE LIQUID SEAL LEGS OR SUFFICIENT SLOPE TO ALLOW LIQUID SEAL ON BOTH PRIMARY AND BOTH SECONDARY CONDENSERS TO PREVENT GAS BLOW-THROUGH.

   Complete.

9. INSTALL RELIEF VALVES ON SHELL SIDE OF ALL EXCHANGERS.

   Completed, where necessary (the thermal relief system had not been completed at the time of the hazards review).

10. ESTABLISH PROCEDURE FOR PERIODIC INSPECTION OF VESSEL INTEGRITY.

    To be established by Plant Management.

11. ENSURE THAT DESIGN PROVIDES MEANS OF RELIEVING ANY PRESSURE BUILD-UP BETWEEN RUPTURE DISC AND RELIEF VALVE.

    Standard procedure will be to install tell-tales with a PI.

12. EVALUATE RUPTURE DISC DESIGN TO ENSURE THAT LIQUID CANNOT BE EXTRUDED PAST IT.

    At the time of the hazards review, the rupture disc selected for the reactors could be hydraulically overpressured by DMF liquid during the reactor cleaning sequence. Since that time, BS&B has come back to APCI with a design which avoids this problem.

13. CONSIDER THE INSTALLATION OF AN AGITATOR SHAFT ZERO-SPEED ALARM SWITCH OR EQUIVALENT.

    A zero speed indicator (ST 1141) has been added to each reactor agitator shaft.

14. HAVE PLANT ESTABLISH STRICT PROCEDURES FOR MAINTAINING A FULLY OPERABLE SHORT STOP SYSTEM.

To be completed by Plant Management.

15. PROVIDE ADEQUATE NITROGEN PURGE ON REACTOR WHEN EMPTYING DMF, RATHER THAN RELYING ON N_2 FROM DMF TANK DISPLACEMENT. SAME RECOMMENDATION APPLIES FOR EMPTYING OF DISPLACEMENT WATER.

DMF and air can develop explosive mixtures in the reactor. As such, nitrogen blanketing will be employed during the cleaning cycle on a reactor. By JV-1107, an operator can add positively N_2 from the header to the DMF tank and reactor, and ensure through low flow alarm that nitrogen is indeed available and being used.

16. INSTALL FLOW ALARM ON N_2 SUPPLY LINE TO THE REACTOR.

Complete (see 15)

17. INSTALL ON-LINE ANALYZER FOR RECOVERED MONOMER. LAB TESTS HAVE BEEN DISCONTINUED AT THE PLANT.

A chromatograph has been added to sample the monomer pumped to and the recycle line around, the RVCM tank. The analysis will be used by the computer to determine, for a given recipe, the amount of RVCM which can be charged to the reactor.

18. INSTALL SIGNAL LIGHTS ON CHARGE POTS TO INDICATE WHICH CHARGE POT IS TO BE CHARGED WITH INITIATOR. LIGHTS SHOULD BE COMPUTER-CONTROLLED.

The computer will indicate with a green "running" light which charge pot the operator should fill with initiator. This technique should avoid double-charging or mischarging of a reactor batch.

19. INSTALL VCM MONITORING POINTS IN COOLING TOWER AND CHILLED WATER SYSTEMS TO DETECT LEAKING CONDENSERS, CRACKED BAFFLES, ETC.

Area monitor has been added to the cooling tower cells and to the chilled water return tank.

20. PROVIDE MEANS TO IDENTIFY DIFFERENT TYPES OF INITIATOR TO ENSURE THAT CORRECT INITIATOR IS ALWAYS USED.

By Plant Management. Must distinguish between binary initiators (to be used for homopolymer production only) and azo-type initiator (for copolymer production only). Both types come in same sort of container. Only the label gives away the bottle contents. APCI will investigate color-coding of caps, etc.

21. INSTALL CHECK VALVE ON DRUM FILL LINE OF SHORT STOP TANK TO PREVENT N_2 BLOWBACK DURING AN EMERGENCY WHILE OPERATOR IS FILLING TANK.

The short-stop tank is always pressurized with N_2 (for emergency purposes). During refilling of the tank, a check valve will keep N_2 from blowing-back to the short-stop drum.

22. JV-0425 AND JV-0428 ON SHORT STOP SYSTEM SHOULD BE "FAIL CLOSE", NOT "FAIL OPEN", TO ISOLATE PUMP UNDER EMERGENCY CONDITIONS.

This recommendation has not been enacted. Closing these JV's only closes off a pump, which is normally used to add short stop on a routine basis. The JV's will fail-open to allow short stop to blow through the pump network as well as through the pump bypass line.

23. SHORT STOP TANK LEVEL GAUGE SHOULD BE ARMORED AND EQUIPPED WITH BALL CHECK VALVES.

Done.

24. PROVIDE AN INDICATION AND ANALYSIS OF STREAM THAT IS SENT TO THE INCINERATOR.

This recommendation was found to be unnecessary and expensive. Normally the flows to the incinerator will range from very rich in VCM to very high in inert gas. Losses of monomer are easily determined by pressure and temperature in the condensation train.

25. EVALUATE FAILURE MODE OF CONTROL VALVE BETWEEN BLOWDOWN TANK AND GAS HOLDER SYSTEM.

These valves will fail close to prevent an overpressure in the gas holder/ recovery sections.

26. ALL JV BALL VALVES ON VCM LINE RUNS (I.E., FROM BF GOODRICH, BETWEEN EXISTING STORAGE AND NEW MONOMER CHARGE TANK) SHOULD BE SLOW-CLOSING TO PREVENT HYDRAULIC HAMMER WHICH COULD RUPTURE LINES.

Agreed.

27. RELOCATE JV-0324 FROM BFG SIDE OF METERING STATION TO LINE VCS-601-3" CM, WHICH SERVICES EXISTING STORAGE BULLETS. INSTALL A MANUAL VALVE IN ITS PLACE FOR MAINTENANCE ACCESS TO PSV-0330.

JV-0324 was left on the BFG side to give remote/positive shut-off of VCM from BFG in event of PVC plant emergency. Also a new JV was added to the VCM line from the metering station to the existing storage bullets to remotely allow VCM to the bullets in event that main charge tank cannot take VCM directly from the BFG line.

28. INSTALL A JV VALVE ON LINE TO NEW CHARGE TANK AFTER METERING STATION. THIS VALVE SHOULD BE TIED IN WITH JV-0324 FOR EMERGENCY SHUT-OFF OF VCM FEED FROM BFG LINE.

    Agreed. See above.

29. INSTALL HIGH LEVEL ALARM IN CONTROL ROOM FOR LEVEL TRANSMITTER ON CHARGE TANK. HIGH LEVEL SWITCH SHOULD CLOSE LCV-0322.

    Agreed.

30. USE RUPTURE DISC WITH PSV-0330, VENT TO ATMOSPHERE.

    Rather than vent to atmosphere, we chose to put relief back to the low-pressure side of the charge tank.

31. REVIEW VCM PIPING TO INSTALL THERMAL EXPANSION RELIEFS WHEREVER THERE IS A POSSIBILITY OF A LINE SEGMENT BEING CLOSED OFF (EITHER MANUALLY OR AUTOMATICALLY).

    Completed. P&ID's were incomplete at time of hazards review.

32. ESTABLISH PREVENTIVE MAINTENANCE PROGRAM FOR ALL VCM PUMPS, PARTICULARLY FOR VIBRATION ANALYSIS (BEARING FAILURE).

    By Plant Management.

33. ALL LEVEL GAUGES ON STORAGE TANKS SHOULD BE ARMORED AND HAVE BALL CHECK VALVES. Agreed.

34. REVIEW THERMAL RELIEF REQUIREMENTS FOR DMF, VAM, AND TCE PIPING.

    Catalytic is currently investigating the need for thermal relief for the above services.

35. EVALUATE NEED FOR PRESSURE RELIEF VALVES ON RAW MATERIAL SUPPLY PUMPS.

    Instead of PSV's, flow control loops were added to VAC, VCM, RVCM, and DM H_2O. In addition, a PIC circuit was added to VCM and DM H_2O lines with set points at 275# and 290# respectively. These lines relieve to each storage tank.

36. ADD VCM MONITOR TO DMF STORAGE TANKS TO DETECT VCM LEAKING THROUGH VALVE FROM REACTOR.

    Agreed.

W. Silowka/pj
W. Silowka

WS:paj

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