Contract No:

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Calculation Cover Sheet

Project	Calculation No.	Project Number
F-Canyon BIO	S-CLC-F-00140	NA
Title Fault Tree Analysis of Red Oil Reactions in the F-Canyon Evaporators (U)	Functional Classification NS Discipline Risk Analysis Group	Sheet 1 of 129
Preliminary [X Committed]		Confirmed
Computer Program No. CAFTA+		Version 2.2c

Pupose and Objective

As requested by NMPD Safety Documentation, this Calc-Note determines the frequencies of runaway red oil reactions involving more than 3,000 lbs of TBP, in F-Canyon evaporators 8.5E, 7.6E, 7.7E, , and 9.3E. The dominant sequences leading to an explosion and top event frequency for each evaporator are determined by fault tree analysis.

Summary of Conclusion

Runaway red oil reactions involving more than 3,000 lbs of TBP in the evaporators are calculated to be incredible (<10E-6/yr). Incredibility is achieved by a combination of old and new controls involving: temperature, solvent inventory, and ensuring that aqueous is present during evaporation. The results of the analysis (i.e. incredibility) are contingent upon resolution of the open items listed in this calc-note.

Revision

Rev. No.	Revision Description
Rev. A	Initial Issue
Rev. B	Replaced pages 1-129

Sign Off

Rev. No.	Originator (Print) Sign/Date	Verification / Checking Method	Verifier /Checker (Print) Sign/Date	Manager (Print) Sign/Date
Rev. B	L. W. Christiansen C. R. Lux		W. C. PERKINS	D. A. Sharp
Rev. B.	[redacted] 3/10/95	CHECKING	[redacted]	

Classification [redacted]

ENGINEERING DOC. CONTROL – SRS
00064759

TABLE OF CONTENTS

OPEN ITEMS

Facility Commitments

The following is a list of commitments made by the facility (Ref. 18) that must be implemented in order for runaway red oil reactions to be incredible. These commitments must be implemented in order for the status of this calculation to be changed to "confirmed."

Equipment-Related

1 Low solvent hold tank (906, 14.7) level interlock and high level alarm will be installed or modified to ensure that solvent losses do not exceed 10,000 lbs of 30% TBP.

Operational Basis

2 Solvent wash waste will not be fed to the batch or continuous evaporators (the batch evaporator will be fed only the continuous evaporator bottoms). Solvent wash waste will be processed via caustic evaporation.

Procedural

The procedural open items listed below are referred to by number in the tabulation of human error events presented in Appendix C. Appendix C specifies which procedural open items require modification of existing procedures, and which require new procedures to be written.

3 Operator shall verify (via flow measurement) that steam is shut off (closing the steam block valve manually if needed) whenever temperature or level interlocks demand the steam valve to close.

4 The solvent hold tanks (14.7, 906) inventory will be administratively controlled to prevent losses in excess of 10,000 lbs of organic.

5 During start-up, evaporators will not be operated until levels in solvent hold tanks have stabilized (steady state).

6 Any actuation of the solvent hold tank's (906, 14.7) low level interlock, or discovery of large solvent losses, will require the evaporators to be shut down until accountability of the solvent inventory is performed.

7 Solvent hold tank operator (906, 14.7) will ensure that the solvent feed pump (to banks) is shut off if the low level interlock is demanded.

8 Operations will commit to emptying out the 8.7 and 8.3 feed tanks once every six months, such that three consecutive tank cleanings would have to be missed to build up 3,000 lbs of TBP (Ref. 19).

9 OMITTED

10 Administrative controls will be implemented to limit transfers from 17.5 to 8.7 (and from 7.3 to 8.3) to once per 72 hours to ensure that two full sump receipt tanks are not fed to the continuous evaporator feed tank in an evaporator cycle (Ref. 10).

11 Operators must verify that sp g in the batch evaporator is greater than 1.1 (matches that of the feed tank at the beginning of the batch) to ensure that an aqueous layer is present.

ASSUMPTIONS

Technical Bases

The following list contains details of system operation and characteristics used in the development of the fault tree. These items have formal documentation.

12 Tanks, cell ventilation, and the F-Canyon structure can withstand runaway red oil reactions involving less than 3,000 lbs of TBP with minimal consequences (Ref. 1).

13 Experimental results indicate that a 1 ft aqueous layer will prevent red oil reaction for up to 9 feet of organic (Ref. 11).

14 There exist level and temperature interlocks for the continuous evaporators (Ref. 10).

15 There exist temperature interlocks for the batch evaporator (Ref. 10).

16 Each batch evaporator will process no more than 100 batches/yr (Ref. 10).

17 Because small amounts of the TBP in the evaporator will degrade within 72 hours, TBP can not accumulate in the evaporators unless a process upset has occurred (Ref. 10).

18 The probability of having 10,000 lbs of solvent in the sump receipt tanks (7.3 & 17.5) is 2.0E-3 (Ref. 3).

19 Process upsets occur at a frequency of 1/10 years (Ref. 10).

20 Operator actions are considered independent when they involve different tanks since the operations usually involve different operators and are not performed simultaneously. A review of human error dependencies and common causes was performed (Ref. 9), and the facility has agreed to operational and procedural changes that eliminate most of the dependencies between operators found during the initial human factors review (i.e. acidic evaporation of solvent wash waste streams will not be performed). A tabulation of the human error events for the continuous and batch evaporators is presented in Appendix C. This table specifies which operator actions are contingent upon open items. The tables are

somewhat different than those listed in Reference 9 because of the previously mentioned facility commitments and because of logic changes to the trees subsequent to the initial review.

21 Temperature of concentrate in the de-entrainment column will increase and trigger the temperature interlock if there is a failure to supply feed to the evaporator. The temperature will increase due to an increase in the boiling point and sp g of the concentrate (Ref. 2).

22 There is sufficient time for the operator to shut off the steam block valve if a high solution temperature is detected (Ref. 10)

23 Cold streams are assumed to be sent to the evaporator feed tanks 25% of the time (Ref. 10).

Experience-Related and General

The following assumptions are used in the fault tree and are assumed to be true, but do not have a formally documented technical basis:

24 Uncontrolled reactions do not generate sufficient heat to raise the evaporator contents over 120° C and to cause a red oil reaction. Most uncontrolled reactions lead to eructation of evaporator contents, and cause high delta-p's that lead to the steam being shut off. Since it is assumed that uncontrolled reactions can not lead to red oil reactions, these scenarios are not modeled.

25 Direct transfer errors to the evaporator feed tanks are not considered because direct solvent paths are assumed blocked off.

26 Continuous evaporator will not run more than a total of 4 days/month.

27 OMITTED

28 All TBP is assumed to "survive" the continuous evaporator and will be fed to the batch evaporator.

29 No credit is given to the batch evaporator temperature interlock whenever a very large amount of solvent ($\geq$ 30,000 lbs) is fed because there may not be sufficient aqueous to prevent a runaway reaction even if the steam is shut down.

30 Process upsets can be detected and corrected in 12 hours.

31 Calibrations for instrumentation are performed every 6 months.

Continuous Evaporator 9.3E (when different from 8.5E)

32 Can receive excess TBP from 1A bank with credit for low level detection in 14.7 to catch a large loss of solvent ($\geq$ 10,000 lbs). For losses involving $\geq$ 30,000 lbs, credit was given for detection via the low level alarm, since the full capacity of the tank is slightly less than 30,000 lbs and at least one full tank would have to be sent (Ref. 12).

33 Can receive excess TBP from 7.3 sump receipt tank. Transfers were assumed to be sent from 7.3 5% of the time, per cognizant engineer's estimate.

INTRODUCTION

A very small potential exists in the SRS separations operations for an uncontrolled reaction between tri-n-butyl phosphate (TBP) and nitric acid that could result in unacceptable damage to separations facilities and a significant release of radioactive materials.

The recent red oil (TBP and nitric acid) accident in Tomsk, Russia, resulted in considerable damage and radioactive release. Explosions have also occurred at SRS during the early years of operations. While the SRS separations facilities have operated without incident for many years, it is prudent to revisit the SRS defense in depth approach to preventing such an accident and to upgrade preventive procedures and hardware if appropriate.

A previous analysis (Ref. 16) was performed showing that the frequency of a runaway red oil reaction in the F-Canyon feed tanks, mixer-settlers and sump receipt tanks was incredible. This analysis presents the frequency of runaway red oil reactions in the F-Canyon evaporators.

Originally, due to the lack of experimental data , it was assumed in early evaporator fault trees that a red oil reaction could occur whenever TBP was exposed to temperatures exceeding 120° C or at temperatures above 80° C under certain conditions. Since evaporation of the solution is a very good mechanism for removing any excess heat from an uncontrolled reaction at temperatures below 120° C, the original fault trees modeled runaway reactions occurring during a) cool down b) heating prior to boiling and c) during excessive heating.

Experimental results demonstrate that this reaction would not occur if an aqueous layer (Ref. 1) is present unless the temperature exceeds 120° C. Since the vessels at SRS are open systems a second set of fault trees were developed to determine the frequency of a red oil reaction due to overheating or due to evaporation of the aqueous layer. The presence of aqueous in the evaporator tanks allow credit to be taken for temperature interlocks. The temperature of the solution is limited by the boiling point of the aqueous solution, and the sp g of the solution increases as the aqueous is evaporated (Ref. 2).

INPUT

Basic data used to quantify the fault trees came from the following sources: WSRC-TR-93-262, "Savannah River Site Generic Data Base Development", WSRC-TR-83-581, "Savannah River Site Human Error Data Base Development for Nonreactor Nuclear Facilities", Low Activity Waste (LAW) Study Guide (221-F Canyon), High Activity Waste (HAW) Study Guide (221-F Canyon), and estimates by F-Canyon and SRTC engineers/scientists (references 2,3,4,5). Complete sources for the basic events in the fault trees are listed in their corresponding "Basic Event and Type Code" reports, which are included in this Calc-Note. The basic event file also includes assumptions involving restoration and mission times used to calculate unavailabilities and unreliabilities of equipment.

ANALYTICAL METHODS AND COMPUTATIONS

Fault tree analysis was used to generate a logic model that generates "minimal" combinations (cutsets) of events that yield a runaway red oil reaction involving in excess of 3,000 lbs of TBP. The fault trees' logic structure was developed based on extensive discussions of a) canyon operations with F-Canyon engineers (D. Chostner, R. Eubanks (Ref. 10), S. Marek, and T. G. Campbell), and b) experimental results by SRTC (Ref. 1,11).

In order for a runaway red oil reaction of sufficient magnitude to compromise the F-Canyon containment to occur, it must involve at least 3,000 pounds of TBP. In addition, the organic must be heated to 120° C or above in the absence of an aqueous layer of at least one foot.

The fault trees model failures of the three main controls that prevent runaway red oil reaction: solvent inventory control, temperature control, and ensuring the presence of aqueous in the evaporator.

The analysis is conservative because the fault tree calculates the frequency of runaway reaction for 3,000 lbs (in the first two cases below), and for 10,000 lbs (in the last case). Reactions involving more than 3,000 pounds will happen with less frequency than those involving exactly 3,000 lbs because a large process upset is less likely than a small one, so the calculated frequency will conservatively bound the "actual" frequency.

The analysis does not take credit for items not committed to by the facility in the F-Canyon Basis for Interim Operation (BIO) (Ref. 18). If a non-safety class item performs a mitigative or preventative action, then no credit was taken for it in the analysis. However if the failure of an item (for example a pressure switch) could instigate a failure scenario, then its failure was accounted for in the fault trees.

Continuous Evaporators

- Excess TBP (≥ 3,000 lbs) is fed to the continuous evaporator and failure to regulate steam pressure to maintain a safe temperature. Credit is given to automatic shut down of steam by temperature interlocks. If the interlocks do not work, but the loss of control is detected by the temperature sensors or alarms, then credit is given to an operator for closing a steam block valve.

- Excess TBP (≥ 3,000 lbs) is fed to the continuous evaporator and failure to maintain an aqueous layer, and failure to shut down steam. Credit is given to automatic shut down of steam by level and temperature interlocks if the heating tubes begin to uncover. If the interlocks do not work, but failure is detected by the temperature or level sensors or alarms, then credit is given to an operator for closing a steam block valve. It is postulated that as long as the steam is shut off before all the aqueous is evaporated a runaway reaction is prevented. It should be noted that operators could be misled by the correct instrumentation signals (high level) to increase the steam flow and therefore remove the aqueous present.

- Excess TBP (≥ 10,000 lbs) is fed to the continuous evaporator and normal operation. 10,000 lbs of TBP represents enough organic so that any aqueous present will be displaced, so that no credit can be taken for cooling by an aqueous layer. Credit is given to automatic shut down of steam by the temperature interlock. It should be noted that, due to the large amount of TBP and small amount of aqueous in this scenario, a rapid response is necessary.

Batch Evaporators

- Excess TBP (≥ 3,000 lbs) is fed to the batch evaporator and failure to regulate steam pressure to maintain a safe temperature. Credit is given to automatic shut down of steam by the temperature interlocks. If the interlocks do not work, but the loss of control is detected (by the temperature sensors or alarms), then credit is given to an operator for closing a steam block valve.

- Excess TBP (≥ 3,000 lbs) is fed to the batch evaporator and failure to maintain an aqueous layer by overcooking the feed. Credit is given to automatic shut down of steam by the temperature interlock (due to an increase in boiling point).

- Excess TBP (≥ 10,000) is fed to the batch evaporator from the continuous evaporator bottoms tank during normal operation. Credit is given to verification that the sp g in the batch evaporator matches that of the evaporator feed tank at the beginning of the batch.

The following table shows the sources of TBP for each evaporator and mechanisms for detecting its presence.

Evaporator	**Source of TBP**	**Detection**
Continuous		
8.5E	Solvent Extraction Bank 2A Solvent Extraction Bank 2B (cold streams operations) Sump Receipt Tank 17.5 *	Organic high level alarm in tank 906 Organic low level alarm in tank 906
9.3E	Solvent Extraction Bank 1A Sump Receipt Tank 7.3 Tank 12.6, 1C Bank (cold streams operations)	Organic high level alarm in tank 14.7 Organic low level alarm in tank 14.7

*B-Line (via tank 9.7), this event was judged incredible because: a) no further processing of B-Line material is planned b) would have to transfer organic up to B-Line unnoticed then back down to canyon again

Evaporator	**Source of TBP**	**Detection**
Batch		
7.6E	8.5 Bottoms Tank (see above 8.5E)	Verification of matching sp g between 7.6E and 7.8 prior to evaporation
7.7E	8.5 Bottoms Tank (see above 8.5E)	Verification of matching sp g between 7.7E and 7.8 prior to evaporation

The fault trees underwent extensive revisions and the open items represent the list of requirements needed to prevent an unacceptable runaway red oil reaction frequency. The list below shows some of the additional controls that were considered:

- High and low sp g alarms for the evaporators
- Monitoring of feed flow rate into continuous evaporators
- Improved sampling & additional sampling requirements
- Improved decanting procedures
- High organic level alarms on decanters

Reference 17 presents a scoping calculation detailing the frequency of uncontrolled red oil reactions in F-Canyon if these additional features/controls are implemented. These controls cause a reduction in frequency of approximately two orders of magnitude less than those presented in the Results section.

RESULTS

The frequency of evaporator explosion due to red oil reaction is listed in the following table for each of the evaporators analyzed. The final sets of fault trees and resulting cutsets are included in Appendices D, E and F.

Evaporator	**Operation**	**Frequency (/yr)**
Continuous		
8.5E	Continuous Mode	2E-7
9.3E	Continuous Mode	2E-7
Batch		
7.6E	Batch (8.5E Bottoms Only)	4E-7
7.7E	Batch (8.5E Bottoms Only)	4E-7

CONCLUSION

The frequency of red oil explosion in each F-Canyon evaporator is determined to be incredible by fault tree analysis. These results are contingent upon the facility implementation of the identified open items. Runaway red oil reactions are unlikely to occur in the evaporators because very large amounts of TBP are needed to cause significant uncontrolled reactions in a well-vented system. Experimental analysis and consequence studies demonstrate that only reactions involving more than 3,000 lbs of TBP could result in unacceptable releases to the environment and public. These red oil reactions are prevented by maintaining administrative controls of solvent inventory, ensuring that the evaporator's temperature remains below 120° C, and ensuring that one foot of aqueous is maintained in the evaporator to provide adequate heat removal.

REFERENCES

1. M. L. Cowen, "Uncontrolled TBP-Nitric Acid BIO Risk Analysis (F-Canyon BIO Reference Paper, Uncontrolled TBP-Nitric Acid Reactions)", EPD-SSS-950007. Westinghouse Savannah River Co. February 3, 1995.

2. Inter-Office Memorandum from T. G. Campbell, "Boiling Points of Various Evaporator Solutions", Westinghouse Savannah River Co. August 26, 1994.

3. Inter-Office Memorandum from T. G. Campbell, "Probability for Accumulation of TBP in Canyon Sumps", Westinghouse Savannah River Co. June 3, 1994.

4. Inter-Office Memorandum from S. H.Marek, "8.5 Evaporator Information", Westinghouse Savannah River Co. August 4, 1994.

5. Inter-Office Memorandum from Tracy Rudisill (with attachments), "RE: Mixing Studies" , Westinghouse Savannah River Co. August 30, 1994.

6. C. H. Blanton and S. A. Eide. "Savannah River Site Generic Data Base Development" „WSRC-TR-93-262. Westinghouse Savannah River Co. June 30, 1993

7. H.C. Benhardt et al. "Savannah River Site Human Error Data Base Development for Nonreactor Nuclear Facilities", WSRC-TR-93-581. Westinghouse Savannah River Co. February 28, 1994.

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11. J. R. Smith and W. S. Cavin, "Isothermal Heat Measurements of TBP-Nitric Acid Solutions", WSRC-TR-94-0540. Westinghouse Savannah River Co. December 16, 1994.

12. V. M. Martinez, "F-Canyon Vessels Capacities (U)", NMP-EFA-94-0054. Westinghouse Savannah River Co. February 17, 1994.

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15. H. A. Ford, "Common Cause Parameters Using the Multiple Greek Letter Method-Work Performed by Los Alamos National Laboratory for WSRC (U)", WSRC-TR-92-470. Westinghouse Savannah River Co. June 21, 1993.

16. C. R. Lux, L. W. Christiansen, K. M. Marshall, T. L. Slaven, "Frequency Determination for Runaway TBP/Nitric Acid Reactions in Support of the F-Canyon BIO (U)." S-CLC-F-00100. Westinghouse Savannah River Co. June 21, 1994.

17. E. V. Browne, L. W. Christiansen, C. R. Lux, "Scoping Study of Red Oil Reactions in F-Canyon Evaporators (U)." S-CLC-F-00146. Westinghouse Savannah River Co. January, 1995.

18. F-Canyon Basis for Interim Operation (U). WSRC-RP-93-1215.

19. Inter-Office Memorandum from R. A. L. Eubanks, "Solvent Additions (U)", Westinghouse Savannah River Co. March 8, 1995.

ATTACHMENTS AND APPENDICES

APPENDIX A - MEMORANDA

INTER-OFFICE MEMORANDUM
Savannah River Site

26-Aug-1994 02:53pm EST

To: See Below

From: Thomas G. Campbell
(CAMPBELL-TG-O5094 AT A1 AT SASRS2)
Dept: NMPD Safety Documentation
Tel : 2-3319

Boiling Points of Various Evaporator Solutions

I have found some good information on vapor-liquid equilibrium and boiling points in DPSOP 250, "200 Areas Process Guidebook". Using this information, I have made some calculations to prove our assumption that the temperature interlock will be reached before all of the aqueous in an evaporator could be boiled away. In these calculations I assumed the temperature interlock was set at 118 C, although I'm sure we could set the interlock lower without adversely impacting operations.

Under normal operating conditions, a continuous evaporator runs with a boiling sp g of 1.25, and makes overheads with about 6% nitric acid. For this condition, the vapor-liquid equilibrium chart in DPSOP 250 gives a sodium nitrate concentration of 25% (about 3.7M) and 20% nitric acid (about 4.0M), with a boiling point of 112 C, which is consistent with our experience. Concentrating this solution to a boiling point of 118 C gives a final sodium nitrate concentration of 33% and nitric acid concentration of 23%. The sp g would be about 1.33 (boiling). The volume reduction to reach this point is only about 30%.

If you assume that the evaporator bottoms have no solids (very unusual), only nitric acid, then to make 6% nitric acid overheads would require the bottoms to be about 32% nitric acid, with a boiling point of about 106 C. To reach a boiling point of 118 C, the evaporator bottoms must be concentrated to about 56% nitric acid. My calculations indicate a volume reduction in this case of about 75%, which is probably somewhat larger than actual because of the conservative assumptions I made about the amount of nitric acid lost to the overheads.

In my opinion, expected operating conditions are closer to the first example, with the second example being more of a worse case. In both of the examples, however, the temperature interlock of 118 C would be reached and the evaporator shut down well before all of the aqueous is gone. As I mentioned earlier, the interlock probably can be lowered to at least 115 C, thus providing even more margin.

Although the above calculations were primarily done with the continous waste evaporators (9.3E and 8.5E) in mind, the same conclusions can be expected with the batch evaporators, especially when they are being used for acid stripping concentrated bottoms. As for 17.7E, you can concentrate uranyl nitrate to a boiling point of 118 C also, but the U concentration (wt%) would have to be increased from about 30% (1.5 sp g) to about 75% (sp g of over 2.2). I find it hard to believe that the evaporator would continue to operate under these conditions. The temperature interlock on 17.7E could be lowered substantially, however, probably to about 110 C.

INTER-OFFICE MEMORANDUM
Savannah River Site

03-Jun-1994 04:30pm EDT

To: See Below

From: Thomas G. Campbell
(CAMPBELL-TG-05094 AT A1 AT SASRS2)
Dept: NPSR
Tel: 2-3319

Probability for Accumulation of TBP in Canyon Sumps

Process solvent is expected to be received in canyon sump receipt tanks from time to time due to overflows and leaks from canyon tanks and piping. Procedures require that accumulated solvent be removed from receipt tanks before amounts (about 3000 pounds of TBP) are reached that could be a concern from a "red oil" reaction standpoint. The only way an amount can be received that is large enough to be of concern is from a single sump transfer. Experience indicates that the frequency of receiving such a large mass of organic material unexpectedly into a canyon vessel is very low. Myself, Ronnye Eubanks, and Dave Chostner conservatively estimate that a receipt of solvent, containing more than 3000 pounds of TBP, can be expected in the sump receipt tanks less than once every five years. This value is considered conservative because loss of such a large volume would be detected during operations. Actions other than transfer to sump receipt would be expected in these situations. Also, in our collective experience in the canyons (more than 40 years) we can recall of no occasion when such a large volume of organic material was received into a sump receipt tank from a leak, spill, or transfer error. Please incorporate this value (once in 5 years for receipt of large volumes of solvent in sump receipt) into the sump receipt tank fault trees for "red oil".

Distribution:

To: Lance W. Christiansen
(CHRISTIANSEN-LW-L0489 @A1@SLSRP1)

CC: ONELIO M. EBRA-LIMA (EBRALIMA-OM-T5452 @A1@SLSRP1)
CC: Ray Lux (LUX-CR-T7244 @A1@SLSRP1)
CC: William E. Harris (HARRIS-WE-05596 AT A1 AT SASRS2)
CC: David F. Chostner
(CHOSTNER-DF-03090 AT A1 AT SASRS2)
CC: Ronnye A. L. Eubanks
(EUBANKS-RA-06258 AT A1 AT SASRS2)
CC: Sandra H. Marek (MAREK-SH-07923 AT A1 AT SASRS2)

INTER-OFFICE MEMORANDUM
Savannah River Site

30-Aug-1994 02:25pm EST

To: ONELIO M. EBRA-LIMA
(EBRALIMA-OM-T5452 AT A1 AT SLSRP1)

CC: Thomas G. Campbell (CAMPBELL-TG-05094 @A1@SASR52)

From: Tracy 5. Rudisill
(RUDISILL-TS-T6876 AT A1 AT SLSRP1
Dept: CPT/CHEMICAL & HYDROGEN TECH
Tel : 52539

RE: Mixing Studies

Neguib estimates the experimental work will be complete by the end of September. He anticipates data analysis and documentation will require approximately 2 months. Therefore, we should have correlation(s) for the canyon tanks by the end of November.

INTER-OFFICE MEMORANDUM
Savannah River Site

22-Jul-1994 08:15am EST

To: See Below

From: Neguib M. Hassan (HASSAN-NM-L2267 AT Al AT SASR52)
Dept: CPT/CHEMICAL & HYDROGEN TECH
Tel : x5-5765

RE: Good News About Mixing Tests

This may be a worse case, but in the next few runs we will reduce the liquid level in small increments and establish a mixing pattern. We know thus far that just below the second impeller (approximately 12 inches of liquid in our tank or about 5.3 feet scaled canyon tank-8' x 11') no organic is detectable in the current sampling procedure.

Distribution:

To: Thomas G. Campbell
(CAMPBELL-TG-05094 AT Al AT SASR52)

CC: DON F. PADDLEFORD
(PADDLEFORD-DF-H0010 AT Al AT SLSRPl)
CC: Tracy 5. Rudisill
(RUDISILL-TS-T6876 AT Al AT SLSRPl)
CC: Lee Hyder (HYDER-ML-T3258 AT Al AT SLSRPl)
CC: James R. Schornhorst
(SCHORNHORST-JR-Y4538 AT Al AT SLSRPl)
CC: William E. Harris (HARRIS-WE-05596 @AlQSASRS2)
CC: Ray Lux (LUX-CR-T7244 AT Al AT SLSRPl)
CC: ONELIO M. EBRA-LIMA
(EBRALIMA-OM-T5452 AT Al AT SLSRPl)
CC: Thomas G. Campbell (CAMPBELL-TG-05094 @Al@SASRS2)
CC: David F. Chostner (CHOSTNER-DF-03090 @Al@SASRS2)
CC: Charlene B. Cochran (COCHRAN-CB-06921 @Al@SASRS2)
CC: CLINT R. WOLFE (WOLFE-CR-H0021 AT Al AT SLSRPl)
CC: Jim Knight (KNIGHT-JR-T3559 AT Al AT SLSRPl)
CC: Frank R. Graham (GRAHAM-FR-T6413 AT Al AT SLSRPl)
CC: Neguib M. Hassan (HASSAN-NM-L2267 @Al@SASRS2)
CC: Major C. Thompson (THOMPSON-MC-T3324 @Al@SASRS2)

INTER-OFFICE MEMORANDU~
Savannah River Site

22-Jul-1994 08:23am EST

To:**See Below**

From: Tracy 5. Rudisill
(RUDISILL-TS-T6876 AT Al AT SLSRPl
Dept: CPT/CHEMICAL & HYDROGEN TECH
Tel : 52539

RE: Good News About Mixing Tests

When the tank is full, two agitator blades are used to mix the tank. This doubles the mixing power and is apparently enough to form a dispersion which reaches the dip tube at the bottom of the tank. In Neguib's previous work, the liquid level was just below the bottom of the top agitator.

There will also be a very low liquid level where the mixing quality would permit the detection of large amounts of organic. At this point, a single agitator would provide enough power to disperse the organic phase. Intermediate levels seem to be the problem.

Distribution:

To: Charlene B. Cochran
(COCHRAN-CB-06921 AT Al AT SASRS2)
To: Thomas G. Campbell (CAMPBELL-TG-05094 @Al@SASR52)

CC: DON F. PADDLEFORD
(PADDLEFORD-DF-H0010 AT Al AT SLSRPl)
CC: Lee Hyder (HYDER-ML-T3258 AT Al AT SLSRPl)
CC: James R. Schornhorst
(SCHORNHORST-JR-Y4538 AT Al AT SLSRPl)
CC: William E. Harris (HARRIS-WE-05596 @Al@SASRS2)
CC: Ray Lux (LUX-CR-T7244 AT Al AT SLSRPl)
CC: ONELIO M. EBRA-LIMA
(EBRALIMA-OM-T5452 AT Al AT SLSRPl)
CC: David F. Chostner (CHOSTNER-DF-03090 @AlQSASR52)
CC: CLINT R. WOLFE (WOLFE-CR-H0021 AT Al AT SLSRPl)
CC: Jim Knight (KNIGHT-JR-T3559 AT Al AT SLSRPl)
CC: Frank R. Graham (GRAHAM-FR-T6413 AT Al AT SLSRPl)
CC: Neguib M. Hassan (HASSAN-NM-L2267 @AlQSASR52)
CC: Major C. Thompson (THOMPSON-MC-T3324 @Al@SASRS2)

INTER-OFFICE MEMORANDUM
Savannah River Site

22-Jul-1994 11:02am EST

To: See Below

From: Thomas G. Campbell
(CAMPBELL-TG-05094 AT Al AT SASR52
Dept: NMPD Safety Documentation
Tel : 2-3319

RE: Good News About Mixing Tests

I've got to make one more comment on this subject.

If covering the top set of agitator blades is what is important for sampling organic, then a tank certainly does not have to be "full". In canyon tanks, both sets of agitator blades are covered by the time the tank is about half full. In 8xll and lOxll tanks, there is four feet between the bottom of the lower set of blades and the bottom of the upper set of blades. The bottom set of blades is within about six inches of the bottom of the tank. Therefore both sets of blades should be covered before the tank contains five feet of solution. In bicell tanks, which are 15 feet high, there is six feet from bottom to bottom of the agitator blades. Again, the upper set of blades are covered by the time the tank is about half full.

From what Neguib said in his message, I'm not sure your test equipment is scaled correctly. He said the upper impeller is uncovered at 5'3" of liquid level. In an actual canyon 8xll tank, the upper set of agitator blades would be covered by at least 3 inches of solution at that level.

Distribution:

To: Tracy 5. Rudisill
(RUDISILL-TS-T6876 AT Al AT SLSRPl)

CC: Charlene B. Cochran
(COCHRAN-CB-06921 AT Al AT SASRS2)
CC: DON F. PADDLEFORD
(PADDLEFORD-DF-HOO10 AT Al AT SLSRPl)
CC: Lee Hyder (HYDER-ML-T3258 AT Al AT SLSRPl)
CC: James R. Schornhorst
(SCHORNHORST-JR-Y4538 AT Al AT SLSRPl)
CC: William E Harris (HARRIS-WE-05596 QAl@SASRS2)
CC: Ray Lux (LUX-CR-T7244 AT Al AT SLSRPl)
CC: ONELIO M EBRA-LIMA
(EBRALIMA-OM-T5452 AT Al AT SLSRPl)
CC: David F Chostner (CHOSTNER-DF-03090 @Al@SASRS2)
CC: CLINT R. WOLFE (WOLFE-CR-H0021 AT Al AT SLSRPl)
CC: Jim Knight (KNIGHT-JR-T3559 AT Al AT SLSRPl)
CC: Frank R. Graham (GRAHAM-FR-T6413 AT Al AT SLSRPl)
CC: Neguib M Hassan (HASSAN-NM-L2267 QAl@SASRS2)
CC: Major C Thomp-on (THOMPSON-MC-T3324 @Al@SASR52)

INTER-OFFICE MEMORANDUM
Savannah River Site

22-Jul-1994 11:40am EST

To: See Below

From: DON F. PADDLEFORD
(PADDLEFORD-DF-HOO10 AT A1 AT SLSRP1 Dept: WESTINGHOUSE STAFF
Tel :45420

RE: Good News About Mixing Tests

I guess I meant---filled above upper stirrer blades--- instead of full. Apparently this would only be half full according to T. Campbell's response. You may well be right that full could represent a bad situation too?? I don't know whether the scale tests covered this "full" depth or not.

Don

Distribution:

To: Charlene B. Cochran
(COCHRAN-CB-06921 AT A1 AT SASRS2)

CC: DON F. PADDLEFORD
(PADDLEFORD-DF-HOO10 AT A1 AT SLSRP1)
CC: Tracy S. Rudisill
(RUDISILL-TS-T6876 AT A1 AT SLSRP1)
CC: Lee Hyder (HYDER-ML-T3258 AT A1 AT SLSRP1)
CC: James R. Schornhorst
(SCHORNHORST-JR-Y4538 AT A1 AT SLSRP1)
CC: William E. Harris (HARRIS-WE-05596 @A1@SASRS2)
CC: Ray Lux (LUX-CR-T7244 AT A1 AT SLSRP1)
CC: ONELIO M. EBRA-LIMA
(EBRALIMA-OM-T5452 AT A1 AT SLSRP1)
CC: Thomas G. Campbell (CAMPBELL-TG-05094 @A1@SASRS2)
CC: David F. Chostner (CHOSTNER-DF-03090 @A1@SASRS2)
CC: Charlene B. Cochran (COCHRAN-CB-06921 @A1@SASRS2)
CC: CLINT R. WOLFE (WOLFE-CR-H0021 AT A1 AT SLSRP1)
CC: Jim Knight (~NIGHT-JR-T3559 AT A1 AT SLSRP1)
CC: Frank R. Graham (GRAHAM-FR-T6413 AT A1 AT SLSRP1)
CC: Neguib M. Hassan (HASSAN-NM-L2267 @A1@SASR52)
CC: Major C. Thompson (THOMPSON-MC-T3324 @A1@SASRS2)

INTER-OFFICE MEMORANDUM
Savannah River Site

22-Jul-1994 12:30pm EST

To: See Below

From: Neguib M. Hassan (HASSAN-NM-L2267 AT Al AT SASR52
Dept: CPT/CHEMICAL & HYDROGEN TECH
Tel : x5-5765

RE: Good News About Mixing Tests

The second impeller in our small tank is currently located 14 inches from the bottom of the tank and it can be moved up/down. In the prelimenary test runs, we collected data at 6, 8 and 12 inches with one set of impeller and found that no organic is detectable at the 12 inch level even when the initial concentration of organic was 8% volume. In the current runs, we raised the liquid level above the second impeller to see the effect. As I mentioned we can locate the second impeller at any point in the shaft and repeat an experiment. Thanks for the information

Distribution:

To: Thomas G. Campbell
(CAMPBELL-TG-05094 AT Al AT SASR52)

CC: Tracy S. Rudisill
(RUDISILL-TS-T6876 AT Al AT SLSRPl)
CC: Charlene B. Cochran
(COCHRAN-CB-06921 AT Al AT SASRS2)
CC: DON F. PADDLEFORD
(PADDLEFORD-DF-HOO10 AT Al AT SLSRPl)
CC: Lee Hyder (HYDER-ML-T3258 AT Al AT SLSRPl)
CC: James R. Schornhorst
(SCHORNHORST-JR-Y4538 AT Al AT SLSRPl)
CC: William E. Harris (HARRIS-WE-05596 @Al@SASRS2)
CC: Ray Lux (LUX-CR-T7244 AT Al AT SLSRPl)
CC: ONELIO M. EBRA-LIMA
(EBRALIMA-OM-T5452 AT Al AT SLSRPl)
CC: David F Chostner (CHOSTNER-DF-03090 @Al@SASR52)
CC: CLINT R. WOLFE (WOLFE-CR-H0021 AT Al AT SLSRPl)
CC: Jim Knight (KNIGHT-JR-T3559 AT Al AT SLSRPl)
CC: Frank R. Graham (GRAHAM-FR-T6413 AT Al AT SLSRPl)
CC: Neguib M. Hassan (HASSAN-NM-L2267 @Al@SASRS2)
CC: Major C. Thompson (THOMPSON-MC-T3324 @Al@SASR52)

INTER-OFFICE MEMORANDUM
Savannah River Site

30-Aug-1994 03:35pm EST

To: See Below

From: Thomas G. Campbell
(CAMPBELL-TG-05094 AT A1 AT SASR52)
Dept: NMPD Safety Documentation
Tel : 2-3319

See Attached

It looks like it will be a long time before we have anything conclusive on O/A sampling reliability from SRTC. As Dave has suggested, an in-canyon test is still probably our best bet to get useful information anytime soon.

Diatribution:

To:	Andrew P. Mock	(MOCK-AP-L0498 AT A1 AT SASR52)
To:	Charlene B. Cochran (COCHRAN-CB-06921 AT A1 AT SASRS2)	
To:	Renee H. Spires	(SPIRES-RH-06630 AT A1 AT SASRS2)
To:	David F. Chostner (CHOSTNER-DF-03090 AT A1 AT SASR52)	
To:	Ray Lux	(LUX-CR-T7244 QA1QSLSRP1)
To:	Eric V. Browne	(BROWNE-EV-Y8089 QA1QSLSRP1)
To:	J. Stuart Evans	(EVANS-JS-07266 AT A1 AT SASRS2)

INTER-OFFICE MEMORANDUM
Savannah River Site

04-Aug-199408:26am EDT

To: Eric V. Browne (BROWNE-EV-Y8089 eAlQSLSRPl)

CC: Charlene B. Cochran
(COCHRAN-CB-06921 AT Al AT SASRS2)
CC: Ronnye A. L. Eubanks
(EUBANKS-RA-06258 AT Al AT SASRS2)
CC: David F. Chostner
(CHOSTNER-DF-03090 AT Al AT SASRS2)

From: Sandra H. Marek (MAREK-SH-07923 AT Al AT SASRS2)
Dept: NMPD/SEP TECH.
Tel : 9524199

8.5 Evaporator Information

Attached is the information you reque~ted for 8.5E. Bryan, one of our STE's, reviewed some blueprints to perform the calculations and verified/corrected the numbers I gave you off the top of my head on Tuesday. I'll call you later today to discuss these numbers and some of your other assumptions.

INTER-OFFICE MEMORANDUM
Savannah River Site

03-Aug-1994 05:28am EDT

To: Sandra H. Marek (MAREK-SH-07923 AT A1 AT SASRS2)

From: Bryan K. Altringer
(ALTRINGER-BK-Y5558 AT A1 AT SASRS2
Dept: SEP TECH
Tel : 952-2153

Info you requested (U)

OK...
By now you should have found the four prints I left you. Hope they are helpful. Sorry about the poor quality of the one showing the trays.

1. The overflow wier is at 96.7", or 15,360 lb water

2. Typical steam rates for 8.5E are 13,500 lb/hr to 16,500 lb/hr (or 15,000+/-1500 lb/hr). It's unusual to see it run outside this range. I normally assume 15,000 lb/hr as the normal rate.

3. Time to lose 1 ft level....this is a fun one.

Assumptions: 15,000 lb/hr steam 90% efficiency (0.9 lb evap per lb steam) initial liquid level at wier height, 96.7" sp gr at 1.0 (this made it easier for me)

Calculations:
Feed rate = (15,000 lb/hr)(0.9) = 13,500 lb/hr
Final liquid level = 96.7" - 12" = 84.7"
Final pounds = ~11,634 lb (per calib chart)

Pounds depletion = 15,360 lb - 11,634 lb
= 3726 lb

Time = (3726 lb)/(13,500 lb/hr) = 0.26 hr
= 16.56 minutes (How 'bout those sig figs!)

NOTE: You know as well as I do how the lb/in varies so much in a continuous evaporator. Ultimately, this calculation is only one of many possibilities for the evaporator...

4. The typical length of a run:

Assumptions:
Full 8.7 at 146,797 lb water
Heel of 36,000 lb water
Typical run rate = 13,500 lb/hr feed

Time =
(146,797 lb - 36,000 lb)/(13,500 lb/hr)
8.2 hr

If you count startup and shutdown heating and cooling times (while the evaporator above 80 degrees C), Ronnve mav have been able to stretch it to 16 hours. I do not believe we could have gotten 16 hours on feed.

5. How far down 'till we uncover the tube bundle? A quickie roundabout calculation based on the prints lead~ me to believe that we could go down as far as 1.5 ft below wier level before uncovering tubes. Unfortunately, this number sounds funny to me. Check it out.

6. Distance between the bottom of the de-entrainment column and the bottoms of the reboiler looks to be about 4.5 feet based on the prints. You can check it out yourself.

I didn't have time to look into any of the instrumentation stuff. I saw the alarm light you saw for the "low hat flow," but that's all I saw.

Havefun...

INTER-OFFICE MEMORANDUM
Savannah River Site

08-Mar-1995 10:31am EST

To: Thomas G. Campbell
(CAMPBELL-TG-O5094 AT A1 AT SASRS2)
To: Ray Lux (LUX-CR-T7244 @A1@SLSRP1)

CC: Dave H Ecklund
(ECKLUND-DH-L1695 AT A1 AT SASRS2)
CC: David F. Chostner
(CHOSTNER-DF-O3090 AT A1 AT SASRS2)

From: Ronnye A. L. Eubanks (EUBANKS-RA-O6258 AT A1 AT SASRS2 fi
Dept: SEP TECH/NMPD
Tel : 2-4074

Solvent additions (U)

Years ago I summarized the amount of solvent added to each cycle. The data I used was from Maurice Meadows records from 1970-1985. This is what I came up with:

Average solvent (n-Paraffin plus TBP) added to:

1st Cycle - 30,500 pounds/year
2nd Pu - 13,200 pounds/year
2nd U - 18,700 pounds/year

Average pounds of solvent/MTU processed through 1st cycle:

1st Cycle - 28 pounds/MTU
2nd Pu - 13 pounds/MTU
2nd U - 17 pounds/MTU

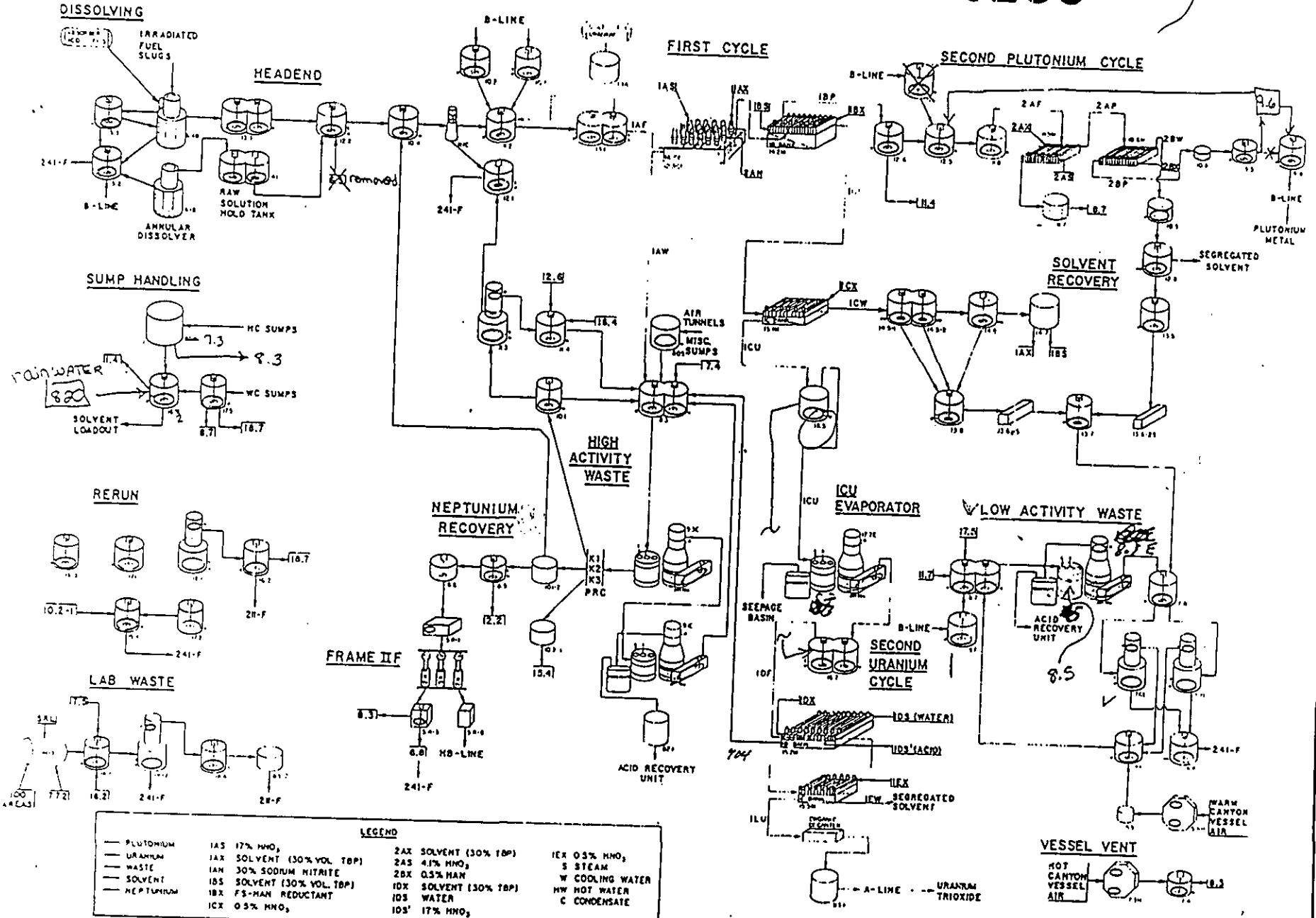
On average the n-paraffin and TBP addition was at 30 vol% TBP. I assumed the TBP lost to solubility in the aqueous was about equal to the evaporation rate of the n-paraffin. Solvent lost to entrainment (or oops) would have been at approximately 30 vol% TBP.

Tom, I hope this is what you told me Ray needed. If not, I will try again.

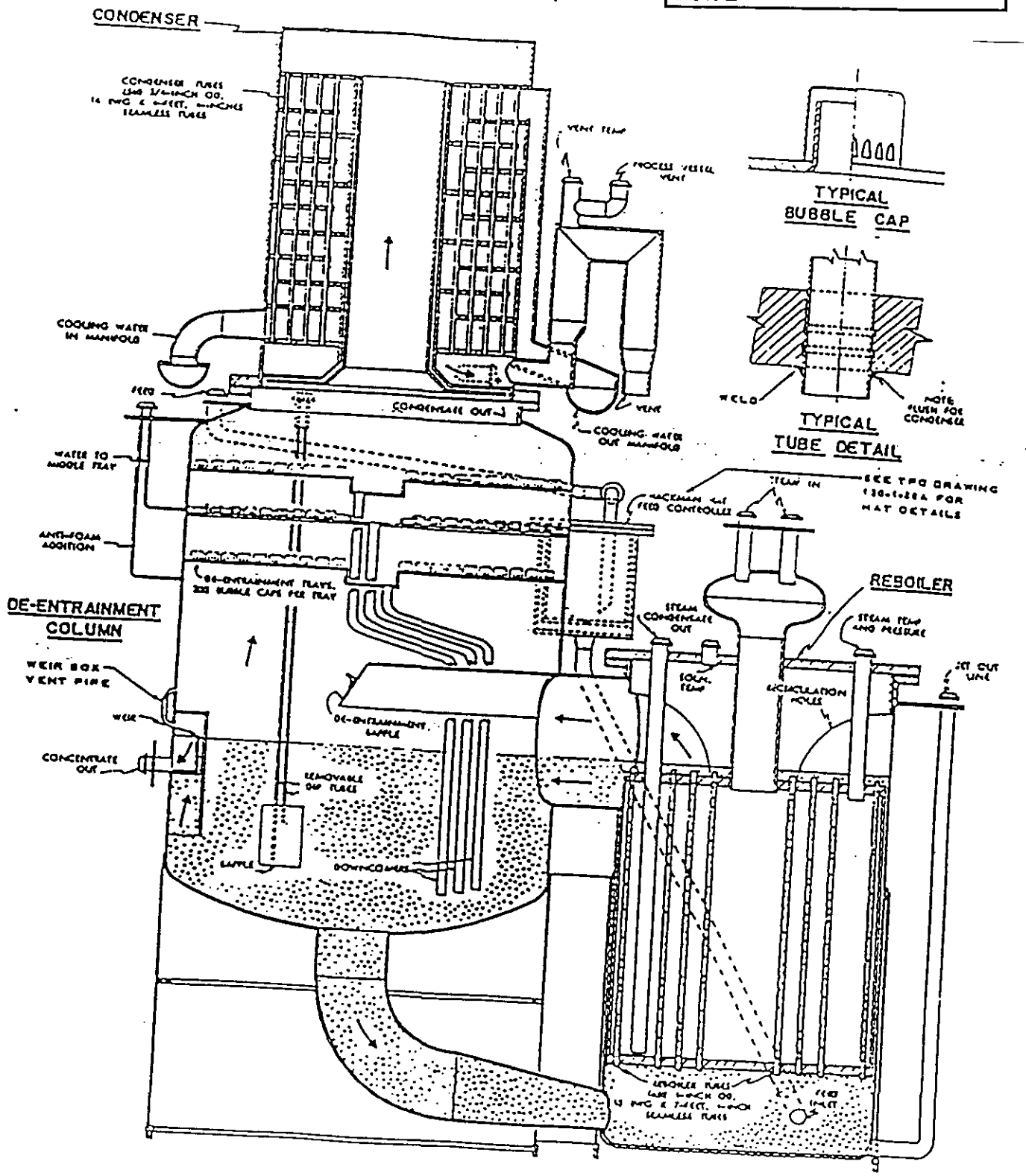
Ronnye

APPENDIX B - DIAGRAMS

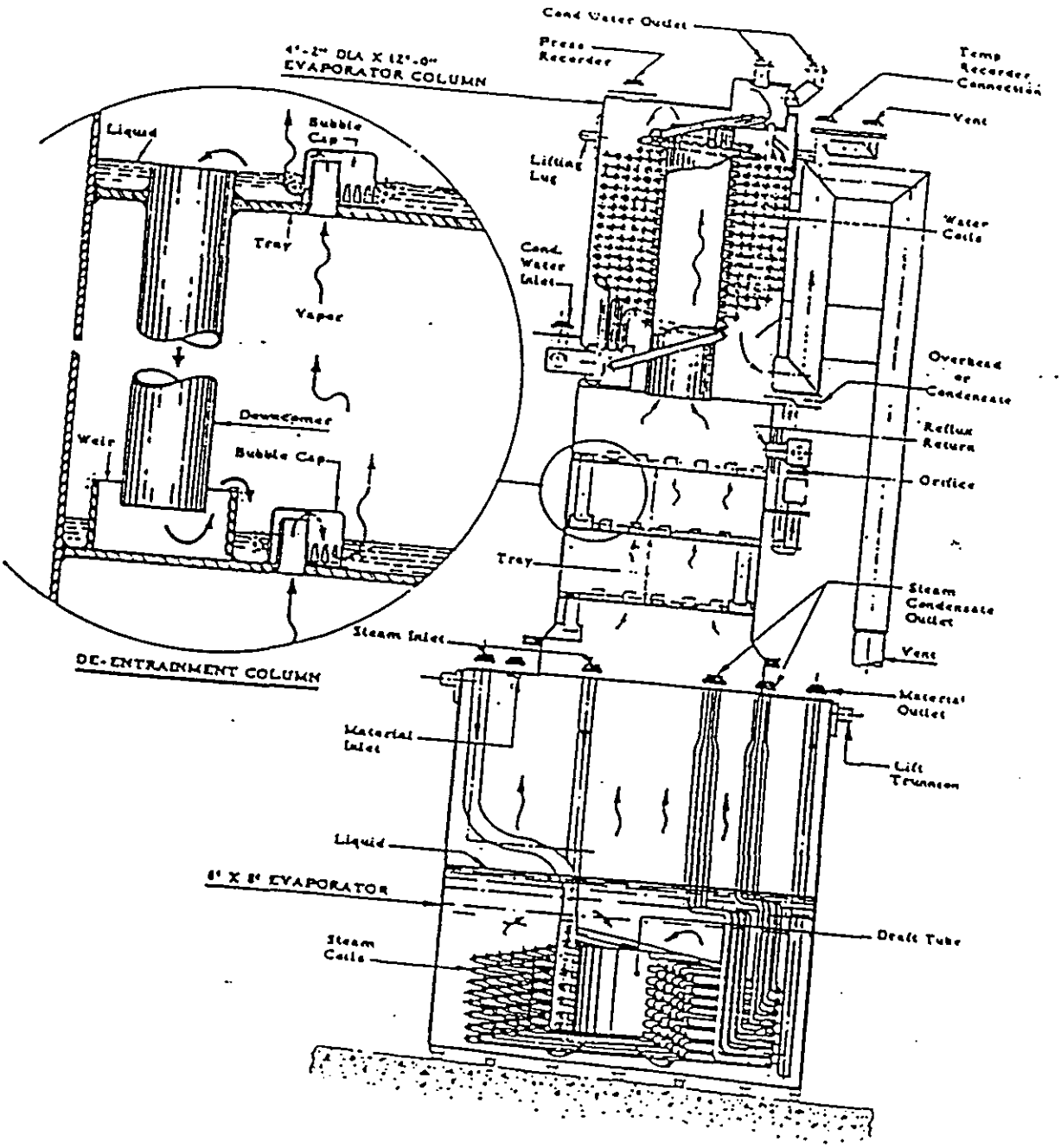
221-F CANYON PUREX PROCESS



Calculation No. S-CLC-F-00140
Sheet No. 26 of 129
Rev. B



Schematic of Continuous Evaporator



Standard Coil Batch Evaporator and Column

APPENDIX C - TABULATION OF HUMAN ERROR EVENTS

The following Appendix contains a tabulation of the human error events for the evaporators considered (8.5E, 9.3E and 7.6E-7.7E). It gives the event names and descriptions of the human error events, as well as information on the probability of human error (Ref. 7). It also contains information on applicable procedures, and actions/equipment involved in the event where necessary.

TASK #	COMMITMENTS	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
	Items A-D are not explicitly modeled in the fault tree. They are commitments the facility must implement in order for the assumptions in the analysis to remain valid.										
A	open item 4		The solvent hold tanks (14.7, 906) inventory will be administratively controlled to prevent losses in excess of 10,000 lbs of organic.							(new procedure/requirement).	
B	open item 5		During start-up, evaporators will not be operated until levels in solvent hold tanks have stabilized (steady state).							(new procedure/requirement).	
C	open item 6		Any actuation of the solvent hold tank's (906, 14.7) low level interlock, or discovery of large solvent losses, will re quire the evaporators to be shut down until accountability of the solvent inventory is performed.							(new procedure/requirement).	
D	open item 7		Solvent hold tank operator (906, 14.7) will ensure that the solvent feed pump (to banks) is shut off if the low level interlock is demanded.							(new procedure/requirement).	
		NEW BRANCH EVENTS SPECIFIC TO THIS TREE									

TASK #	COMMITMENTS	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
	ALL COMMITMENTS FOR THE BATCH EVAPORATOR ARE APPLICABLE TO THE CONTINUOUS EVAPORATOR										
3	ok	OPRCELE-MCNA	Calibration error- Level instrument is calibrated to give a high signal	(8.5E level it can't be too far off because the evap overflows at a known level.)	E&I techn with Operations check	x-mitter & recorder (WZ-19)			0.005	W-770005 (x-mitter); W-798003 (recorder)	
7	ok	OPRGCETEMCNA# consider change to OPRGCETEIRNA#	Evaporator temperature sensor is out of calibration		E&I techn with Operations check	Molytek			consider p=0.01; else 0.005	Molytek	Molytek may be a non-calibratable IPI; event may need to be re-modeled (as a programming data entry error p=0.01).
12	No HRA performed Open Item 15	OPR17.5-ACNA#	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch		Rerun operator					No procedure exist (tranfer 17.5 to 8.7) Must include step restricting to only one transfer every 72 hours	Ensures that two full tanks of sump receipt material are not transferred during one evaporator cycle.
14	No HRA performed Open Item 8	OPR87EM1ACNA#	operator fails to feed remaining tank contents at end of 1st interval- clean out						1.0 til added (then p=0.005)	New Procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic
15	No HRA performed Open Item 8	OPR87EM2ACNA#	operator fails to feed remaining tank contents at end of 2nd interval- clean out						1.0 til added (then p=0.005)	New Procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic

TASK #	COMMITMENTS	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
16	No HRA performed Open Item 8	OPR87EM3ACNA#	operator fails to feed remaining tank contents at end of 3rd interval- clean out						1.0 til added (then p=0.005)	New Procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic
18	OMITTED										
20	Open Item 3	OPRGBLOCDENA#	Operator fails to respond to 8.5E temp., level alarm (close block valve)	alarm acknowledgement, verify no steam flow	LAW operator and Bldg operator				0.01		
26	Open Item 1 setpoints	OPRTK906ACNA# change to OPRTK906CSNA#	Operator fails to respond to low level alarm in tank 906	acknowledge alarm; shutdown process	OF-CR operator; 2nd Pu cycle operator	Outside facilities; CCR	OF-CR occupied at all times	NOTES containing setpoints need to be fixed for both LOW-LEVEL and LOW LOW-LEVEL alarms	0.5 until fixed (then p=0.01)	SOP 211-F-1221 Steps 5.5.1 (LOW), 5.6.1 (LOW LOW-LVL)	(Pump cavitation stops transfer) If no response from Canyon Supervisor, OF will shutdown process within 15 min. (avoid pump cavitation). Credit (0.5) given because of training & alert for pump cavitation
27	ok	OPR906LEMCNA#	Calibration error - level instrument is calibrated to give a false reading		single E&I tech ; Op check	Outside facilities	at tank 906		0.005		This could/would be a relative amount instead of an absolute
54	Open Items 4,5	OPRLV906ACNA#	Operator overfills tank 906 (Level procedurally controlled)	implies an inventory control at regular intervals at various points in the cycle	2nd Pu cycle operator and OF Operator	CCR and Outside Facil. CR			re-modeled with various HEPs	this event needs to be further developed & modified to include (events to the right):	the first response (2nd Pu cycle operator shuts down cycle); LAW operator shuts down evaporator; and maybe Solvent Recovery operator troubleshooting if Solvent recovery cycle is involved

TASK #	COMMITMENT	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
	Items A-D are not explicitly modeled in the fault tree. They are commitments the facility must implement in order for the assumptions in the analysis to remain valid.										
A	open item 4		The solvent hold tanks (14.7, 906) inventory will be administratively controlled to prevent losses in excess of 10,000 lbs of organic.							(new procedure/requirement).	
B	open item 5		During start-up, evaporators will not be operated until levels in solvent hold tanks have stabilized (steady state).							(new procedure/requirement).	
C	open item 6		Any actuation of the solvent hold tank's (906, 14.7) low level interlock, or discovery of large solvent losses, will re quire the evaporators to be shut down until accountability of the solvent inventory is performed.							(new procedure/requirement).	
D	open item 7		Solvent hold tank operator (906, 14.7) will ensure that the solvent feed pump (to banks) is shut off if the low level interlock is demanded.							(new procedure/requirement).	
1	ok	OPR147LEMCNA#	Calibration error - Level instrument is calibrated to give a false reading -14.7		E&I technician	transmitter; recorder			0.005	SOP W-794001 (transmitter); W-798003 (recorder)	

TASK #	COMMITMENT	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
2	open item 1 setpoints	OPRRA147ACNA# change to OPRRA147CSNA#. name changed to DOPRA147CSNA# (dependent event) in part of tree (dep. on OPRTK147ACNA#)	Operator fails to respond to level in tank 14.7		solvent recovery operator, CCR		annun tile and orange status light for "14.7 Lo Level" WS-23) (WT-1A)		0.02 (0.15 for dependent) assuming procedure is written, otherwise 0.5	NO ARP exists (there were & may still be operator aids on the panel boards that indicate wgt ftr when pump loses prime)	
18	no HRA performed, open item 8	OPR83EM1ACNA#	operator fails to feed tank contents after 1st interval-clean tank						1 until added (then p=0.005)	New procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic
19	no HRA performed, open item 8	OPR83EM2ACNA#	operator fails to feed tank contents after 2nd interval-clean tank						1 until added (then p=0.005)	New procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic
20	no HRA performed, open item 8	OPR83EM3ACNA#	operator fails to feed tank contents after 3rd interval-clean tank						1 until added (then p=0.005)	New procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic
25	no HRA performed, open item 10	OPRQ7.3-ACNA#	second consecutive transfer containing TBP from tank 7.3 is fed to same batch		HAW				0.005	SOP 221-F-40790 should be modified or new procedure written to prohibit 2 transfers within 72 hours	
26	OMITTED										
27	open items 3	OPRQBLOCDENA#	operator fails to respond to 9.3E temp, level alarms (close block valve)	alarm acknowledgement, verify no steam flow	HAW				0.01		
28	ok	OPRQCETEIRNA#	Evaporator temperature sensor is out of calibration		E&I	Molytek			0.01	Molytek	

TASK #	COMMITMENT	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
31	ok	OPRQELE-MCNA#	Calibration error-Level instrument is calibrated to give a high signal		E&I Tech. with operations check				0.005	W-770005 (x-mitter); W-798003 (recorder);	
35	open items 4,5	OPRTK147ACNA#	operator overfills tank 14.7 (level procedurally controlled)	implies an inventory control at regular intervals at various points in the cycle	HAW				0.005	new procedure	

TASK#	COMMITMENTS	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
	Items A-D are not explicitly modeled in the fault tree. They are commitments the facility must implement in order for the assumptions in the analysis to remain valid.										
A	open item 4		The solvent hold tanks (14.7, 906) inventory will be administratively controlled to prevent losses in excess of 10,000 lbs of organic.							(new procedure/requirement).	
B	open item 5		During start-up, evaporators will not be operated until levels in solvent hold tanks have stabilized (steady state).							(new procedure/requirement).	
C	open item 6		Any actuation of the solvent hold tank's (906, 14.7) low level interlock, or discovery of large solvent losses, will require the evaporators to be shut down until accountability of the solvent inventory is performed.							(new procedure/requirement).	
D	open item 7		Solvent hold tank operator (906, 14.7) will ensure that the solvent feed pump (to banks) is shut off if the low level interlock is demanded.							(new procedure/requirement).	

TASK#	COMMITMENTS	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
2	Open Item 3	OPRBBLOCCSNA# \change to OPRBBLOCDENA#	Operator fails to respond to 7.6E temp. alarm (close block valve)	alarm acknowledgement; intiates "221-F-ARP-WX-10-1"; CRO asks Bldg Op to initiate SOP; (may not need to close this BV every time)	LAW operator & Bldg operator	alarm/ annunciator tile (WX-10-1); manual 3 inch valve in piping corridor; don't dress out	alarm/ red light in CCR "OSR 7.6E HI POT TEMP"; in field - rising vlv stem & no position labels; "righty-tighty"; "DIAGNOSIS would include looking at steam flow indicator to see that steam has stopped"	Awareness of what needs to be done; fail to close all the way; CCR Op fails to call Bldg Op when he should have	change to p=0.01	SOP-221-F-40811 Step 4.4; then SOP 221-F-20050 Step 4.2.2;) ADD steam flow diagnosis criterion TO THESE PROCEDURES)	fails to shut off steam; Interlock has to have failed- he needs to diagnose this (should get "OSR 7.6E HI POT TEMP" alarm)
3	ok	OPRGBETEMCNA#	Tank Temperature sensor is miscalibrated	whole temp loop cal; yields false low	single E&I tech; ops checks the functionality	sensor in 7.6 tank in Warm Canyon; transmitter on 2nd Level, recorder in CCR			0.005	for Molytek	to check- look for "100C" boiling- can tell if cal is "off"
5	Open Item 11	OPRG7.8-DEHA# change to OPRG7.8-ACHA#	Operator fails to assure SPG is within range	reading spg at tank 7.8 during decanting procedure; he expects & looks for the "break"	LAW operator; SUPVPERM keylock to jet to transfer	CCR panel	spg meter; graph recorder; conversion from % to sp gr required; equation below recorder	fails to recognize the break	1.0 until added, then p=0.05	NO procedure currently for this decanting	procedure to include info on "looking for the spg break"
26	Open Item 1 setpoints	OPRTK906ACNA# change to OPRTK906CSNA#	Operator fails to respond to low level alarm in tank 906	acknowledge alarm; shutdown process	OF-CR operator; 2nd Pu cycle operator	Outside facilities; CCR	OF-CR occupied at all times	NOTES containing setpoints need to be fixed for both LOW-LEVEL and LOW LOW-LEVEL alarms	0.5 until fixed (then p=0.01)	SOP 211-F-1221 Steps 5.5.1 (LOW), 5.6.1 (LOW LOW-LVL)	(Pump cavitation stops transfer) If no response from Canyon Supervisor, OF will shutdown process within 15 min. (avoid pump cavitation). Credit (0.5) given because of training & alert for pump cavitation
27	ok	OPR906LEMCNA#	Calibration error - level instrument is calibrated to give a false reading		single E&I tech ; Op check	Outside facilities	at tank 906		0.005		This could/would be a relative amount instead of an absolute

TASK#	COMMITMENTS	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
54	Open Items 4, 5	OPRLV906ACNA#	Operator fills tank 906 (Level procedurally controlled)	implies an inventory control at regular intervals at various points in the cycle	2nd Pu cycle operator and OF Operator	CCR and Outside Facil. CR			re-modeled with various HEPs	this event needs to be further developed & modified to include (events to the right):	the first response (2nd Pu cycle operator shuts down cycle); LAW operator shuts down evaporator; and maybe Solvent Recovery operator troubleshooting if Solvent recovery cycle is involved
61	OMITTED										
62	No HRA performed Open Item 8	OPR87EM1ACNA#	operator fails to feed tank contents after 1st interval-clean tank						1.0 til added (then p=0.005)	New procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic
63	No HRA performed Open Item 8	OPR87EM2ACNA#	operator fails to feed tank contents after 2nd interval-clean tank						1.0 til added (then p=0.005)	New procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic
9	No HRA performed Open Item 8	OPR87EM3ACNA#	operator fails to feed tank contents after 3rd interval-clean tank						1.0 til added (then p=0.005)	New procedure required to clean (empty out) feed tank periodically to prevent accumulation of organic	prevents accumulation of organic

TASK#	COMMITMENTS	ERROR CODE	ERROR DESCRIPTION	ACTION INVOLVED	OPERATOR (ACTOR)	EQUIPMENT	FEEDBACK/ INDICATION	ERRORS	HEP	PROCEDURE	NOTES
11	No HRA performed Open Item 10	OPR17.5-ACNA#	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch		Rerun operator					No procedure exists (transfer 17.5 to 8.7) Must include step restricting to only one transfer every 72 hours	Ensures that two full tanks of sump receipt material are not transferred during one evaporator cycle.

APPENDIX D - 8.5E EVAPORATOR FAULT TREE AND DATA

The following abbreviations appear on the fault tree print out and in the basic event file for the fault tree:

FR=Failure Rate

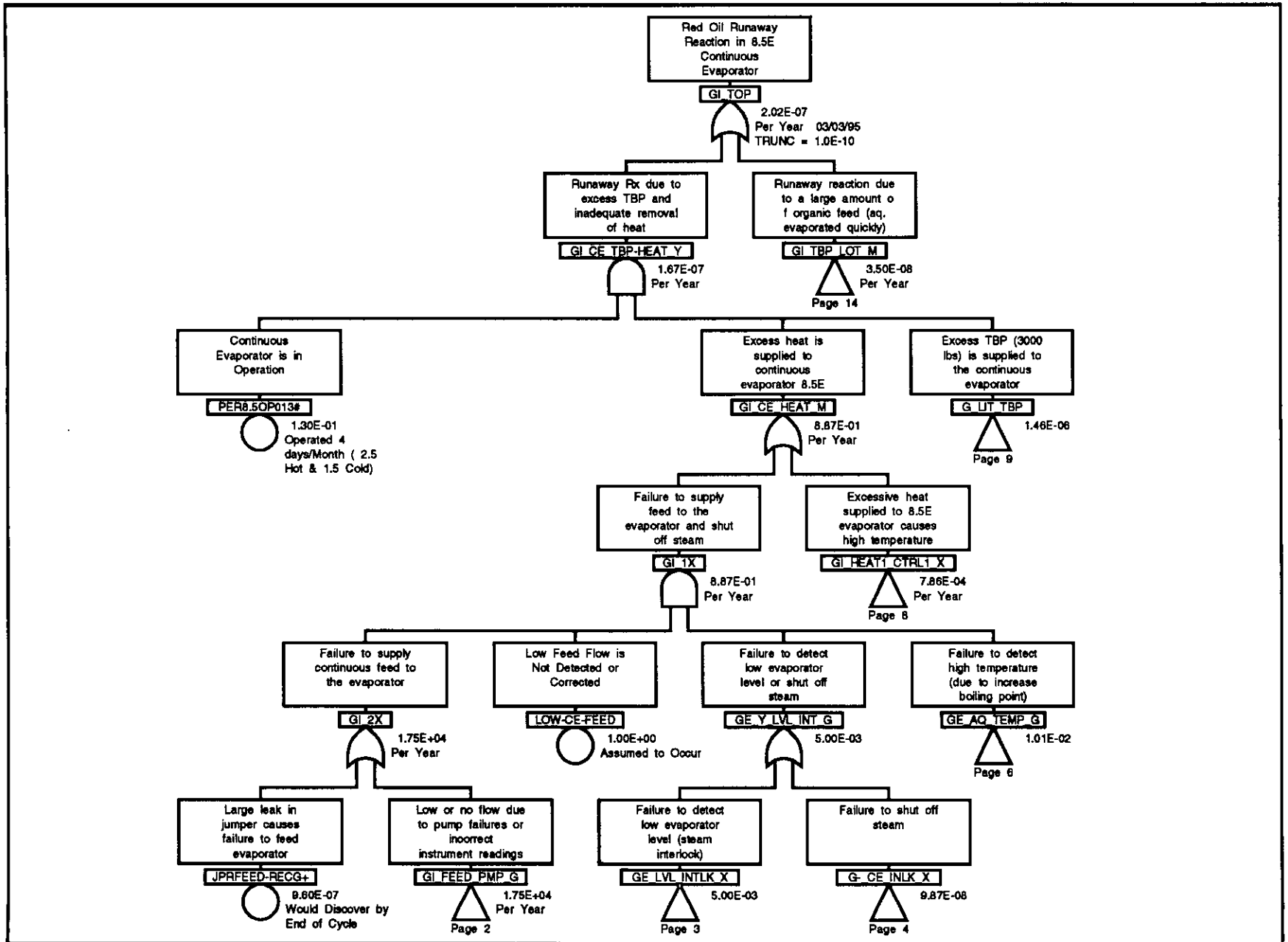
a: = assumption

COG= cognizant engineer estimate/information

TRUNC= Truncation limit of cutset evaluator

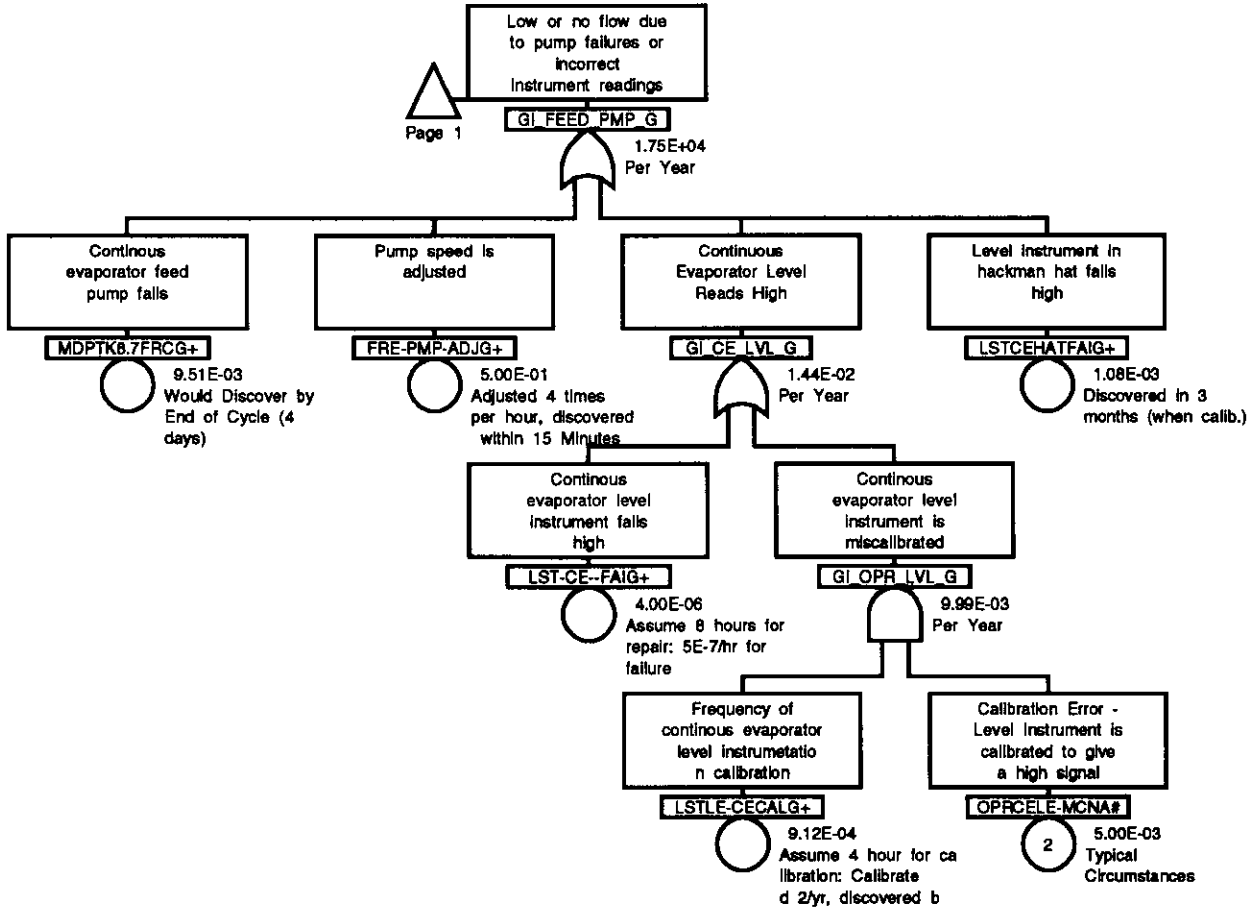
The Beta Factor method used to estimate common cause alarm failure is explained in Reference 15.

NOTE: Events in this tree with a probability of "1E-32" are incredible. They do not contribute to the top event frequency and were included only to show that they had been considered. The number "1E-32" was used because it is the smallest number CAFTA is capable of handling.

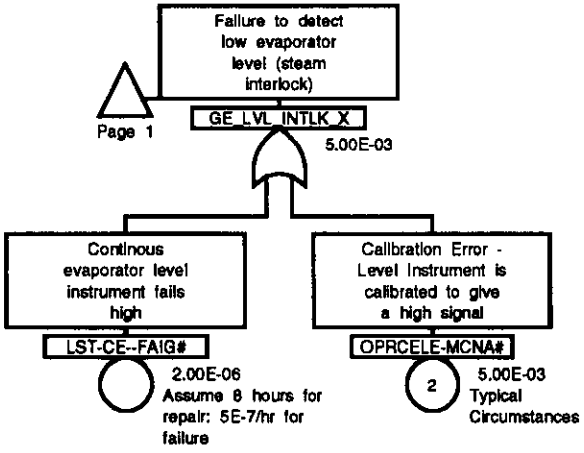


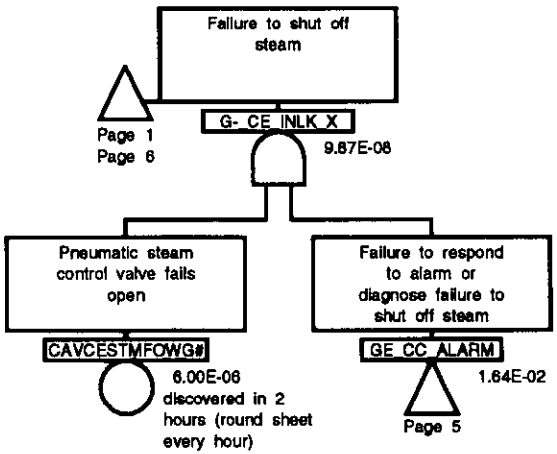
Runaway TBP Reaction in 8.5E	C:\CAFTA\REDOIL\SCI85B.CAF	3-14-95	Page 1

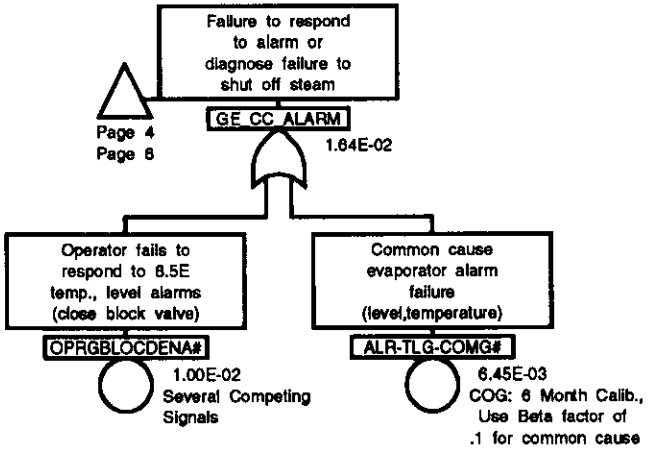
Calculation No. S-CLC-F-00140
Sheet No. 41 of 129
Rev. B

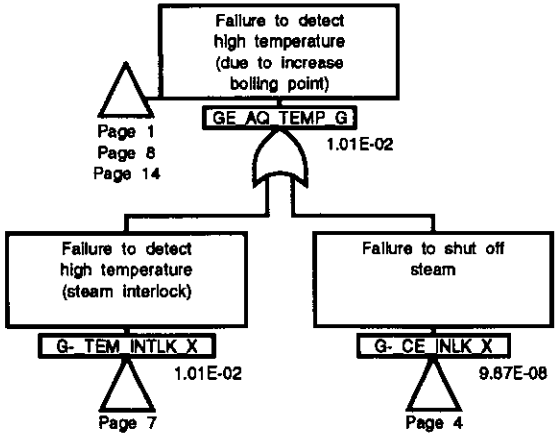


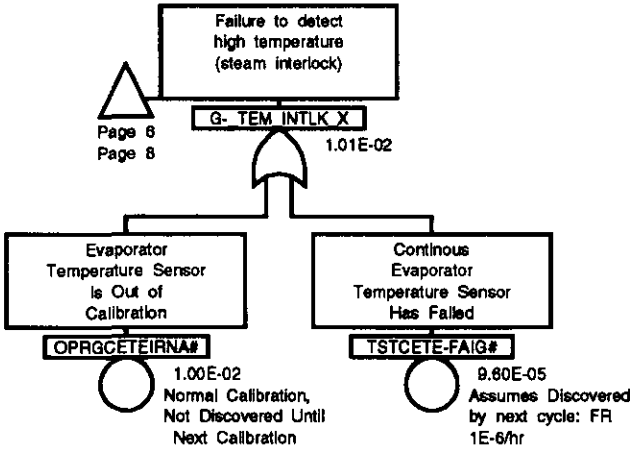
Runaway TBP Reaction in 8.5E	C:\CAFTA\REDOIL\SCI85B.CAF	3-14-95	Page 2

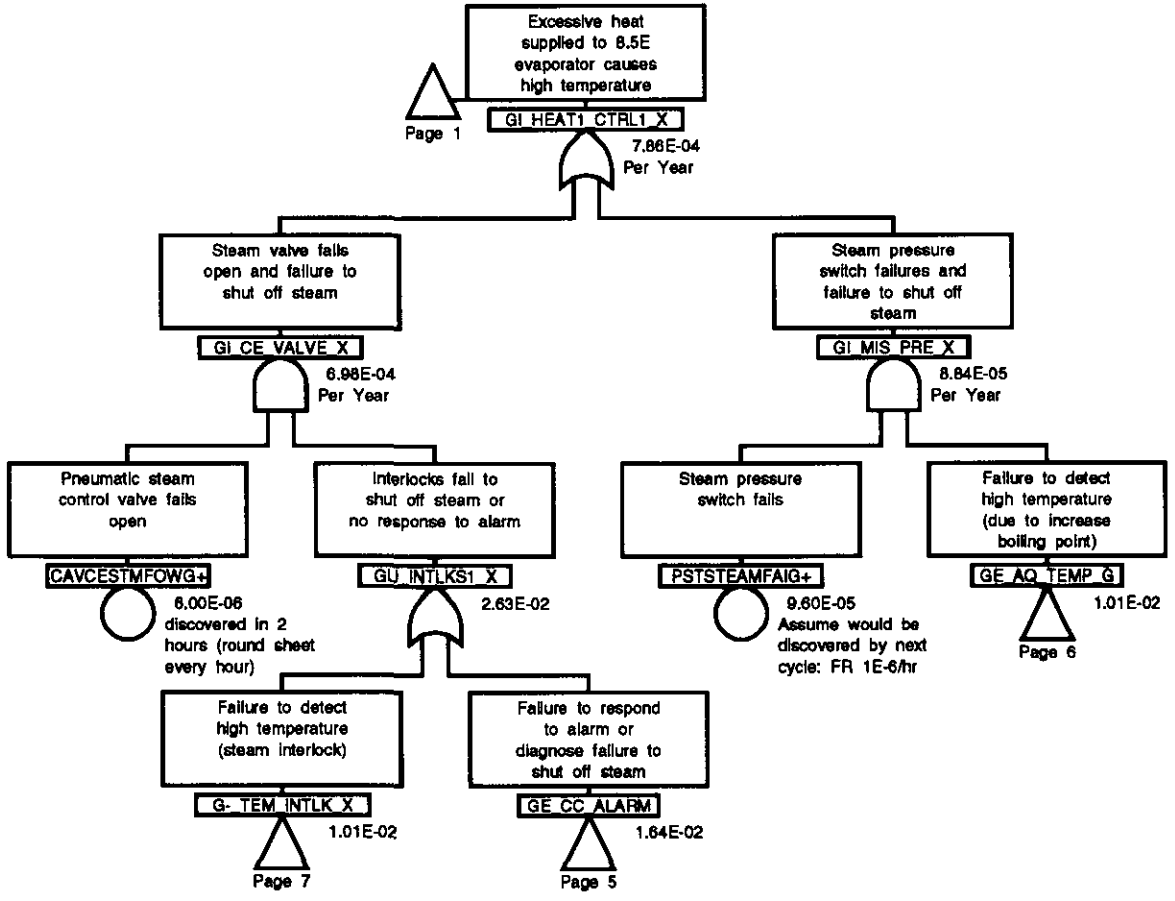

Failure to detect low evaporator level (steam interlock)
GE_LVL_INTLK_X
5.00E-03
Page 1
Continous evaporator level instrument fails high
LST-CE--FAIG#
2.00E-06
Assume 8 hours for repair: 5E-7/hr for failure
Calibration Error - Level Instrument is calibrated to give a high signal
OPRCELE-MCNA#
2
5.00E-03
Typical Circumstances

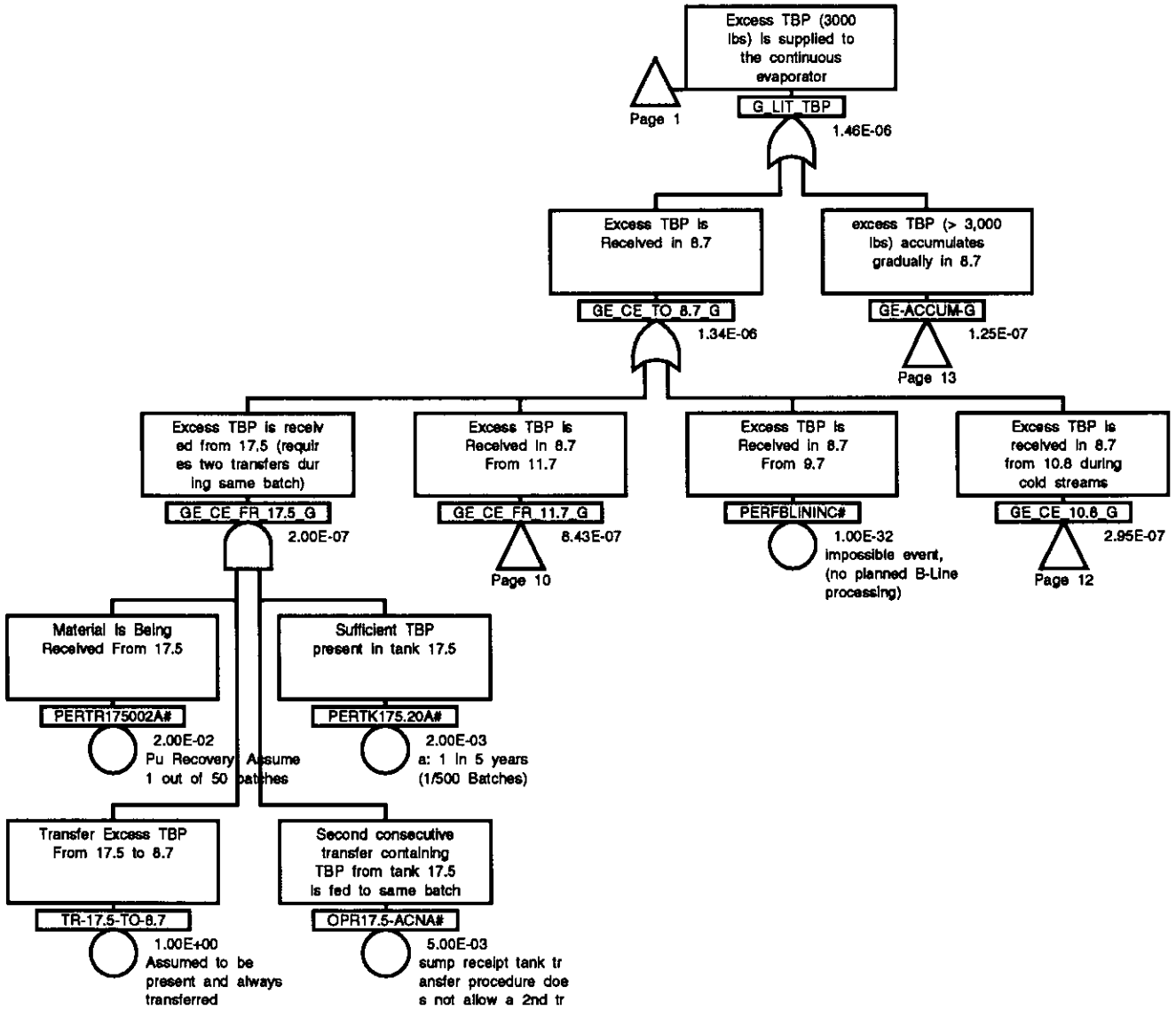

Failure to shut off steam
Page 1
Page 6
G-_CE_INLK_X
9.87E-08
Pneumatic steam control valve fails open
Failure to respond to alarm or diagnose failure to shut off steam
CAVCESTMFOWG#
6.00E-06
discovered in 2 hours (round sheet every hour)
GE_CC_ALARM
1.64E-02
Page 5

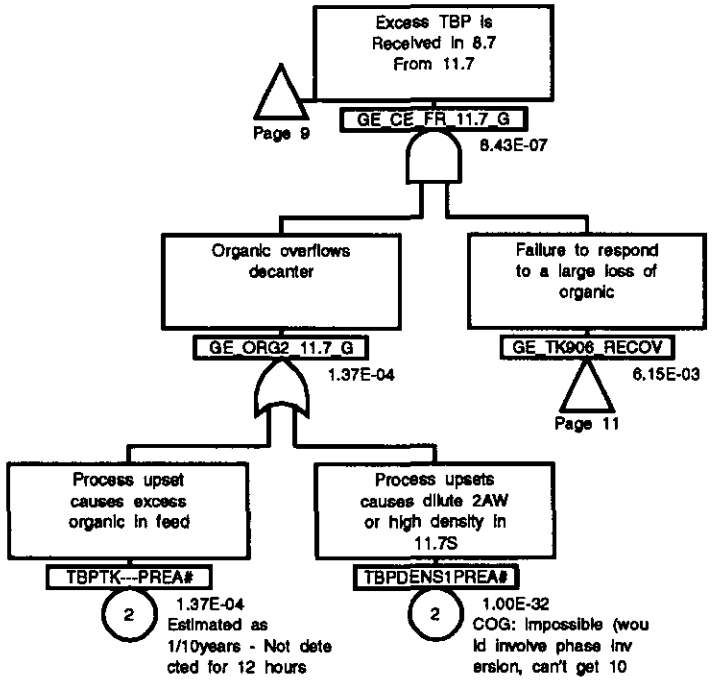

Failure to respond to alarm or diagnose failure to shut off steam
GE_CC_ALARM
1.64E-02
Page 4
Page 8
Operator fails to respond to 8.5E temp., level alarms (close block valve)
OPRGBLOCDENA#
1.00E-02
Several Competing Signals
Common cause evaporator alarm failure (level,temperature)
ALR-TLG-COMG#
6.45E-03
COG: 6 Month Calib., Use Beta factor of .1 for common cause

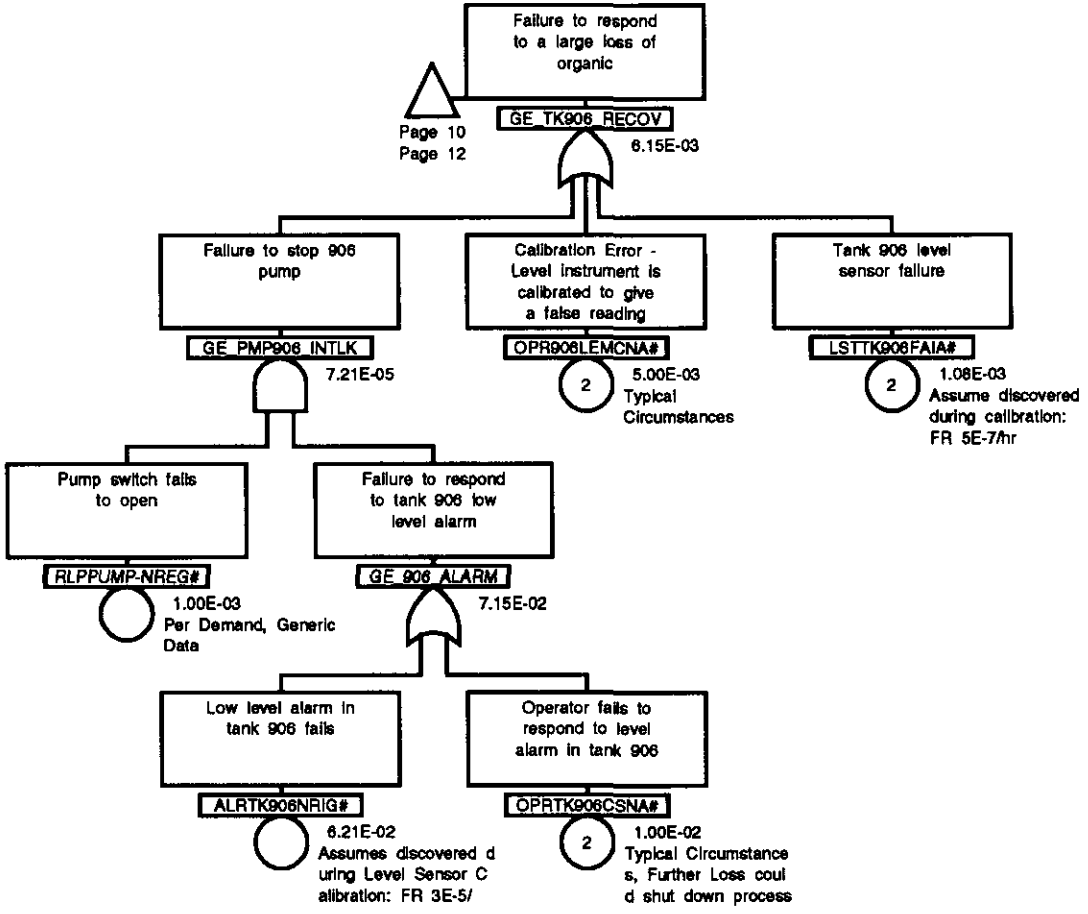

Failure to detect high temperature (due to increase boiling point)
GE_AQ_TEMP_G
1.01E-02
Page 1
Page 8
Page 14
Failure to detect high temperature (steam interlock)
G-_TEM_INTLK_X
1.01E-02
Page 7
Failure to shut off steam
G-_CE_INLK_X
9.87E-08
Page 4

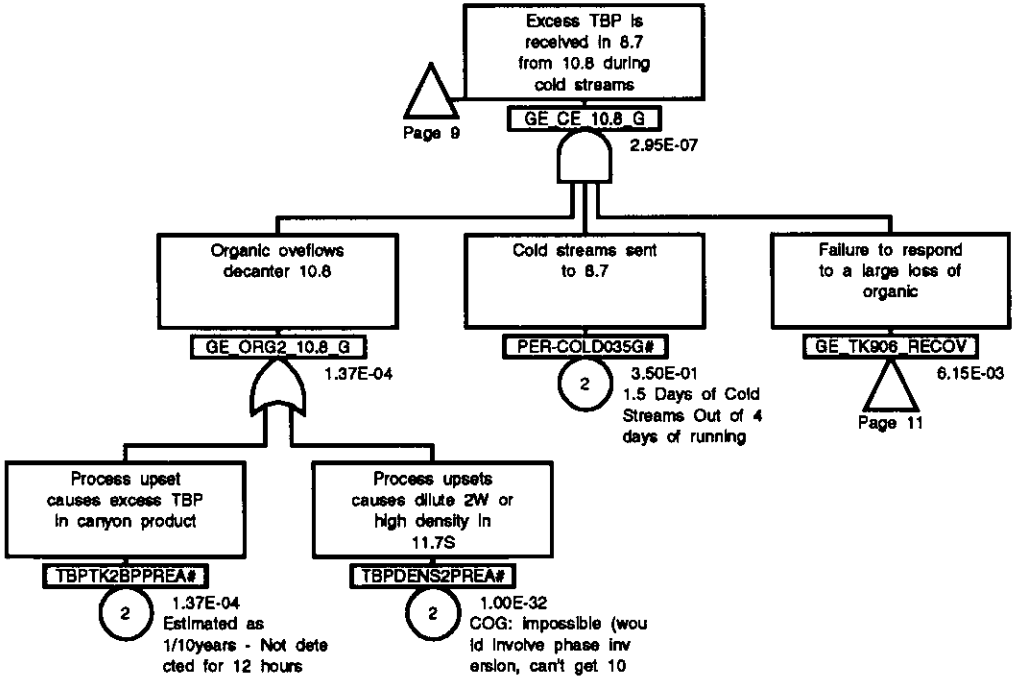

Failure to detect high temperature (steam interlock)
G- TEM INTLK X
1.01E-02
Page 6
Page 8
Evaporator Temperature Sensor Is Out of Calibration
OPRGCETEIRNA#
1.00E-02
Normal Calibration, Not Discovered Until Next Calibration
Continous Evaporator Temperature Sensor Has Failed
TSTCETE-FAIG#
9.60E-05
Assumes Discovered by next cycle: FR 1E-6/hr

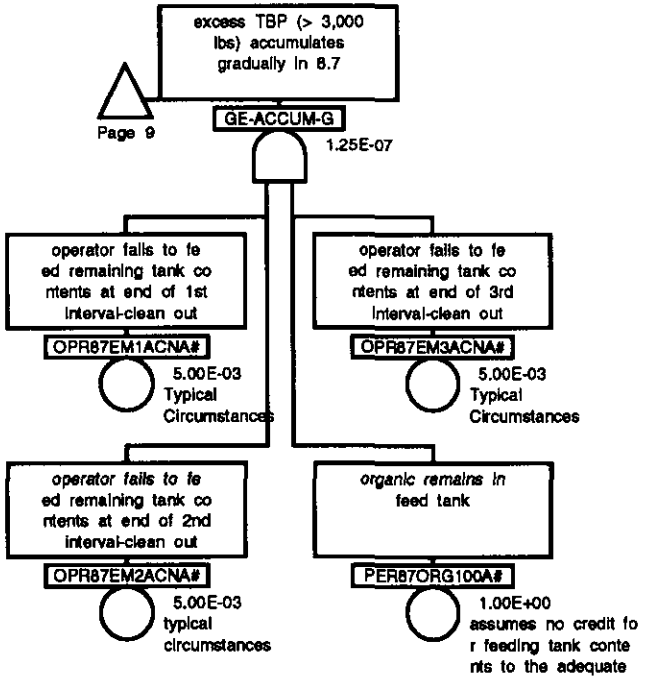

Excessive heat supplied to 8.5E evaporator causes high temperature
Page 1
GI_HEAT1_CTRL1_X
7.86E-04 Per Year
Steam valve fails open and failure to shut off steam
GI_CE_VALVE_X
6.98E-04 Per Year
Steam pressure switch failures and failure to shut off steam
GI_MIS_PRE_X
8.84E-05 Per Year
Pneumatic steam control valve fails open
CAVCESTMFOWG+
6.00E-06 discovered in 2 hours (round sheet every hour)
Interlocks fail to shut off steam or no response to alarm
GU_INTLKS1_X
2.63E-02
Steam pressure switch fails
PSTSTEAMFAIG+
9.60E-05 Assume would be discovered by next cycle: FR 1E-6/hr
Failure to detect high temperature (due to increase boiling point)
GE_AQ_TEMP_G
1.01E-02
Page 6
Failure to detect high temperature (steam interlock)
G-_TEM_INTLK_X
1.01E-02
Page 7
Failure to respond to alarm or diagnose failure to shut off steam
GE_CC_ALARM
1.64E-02
Page 5

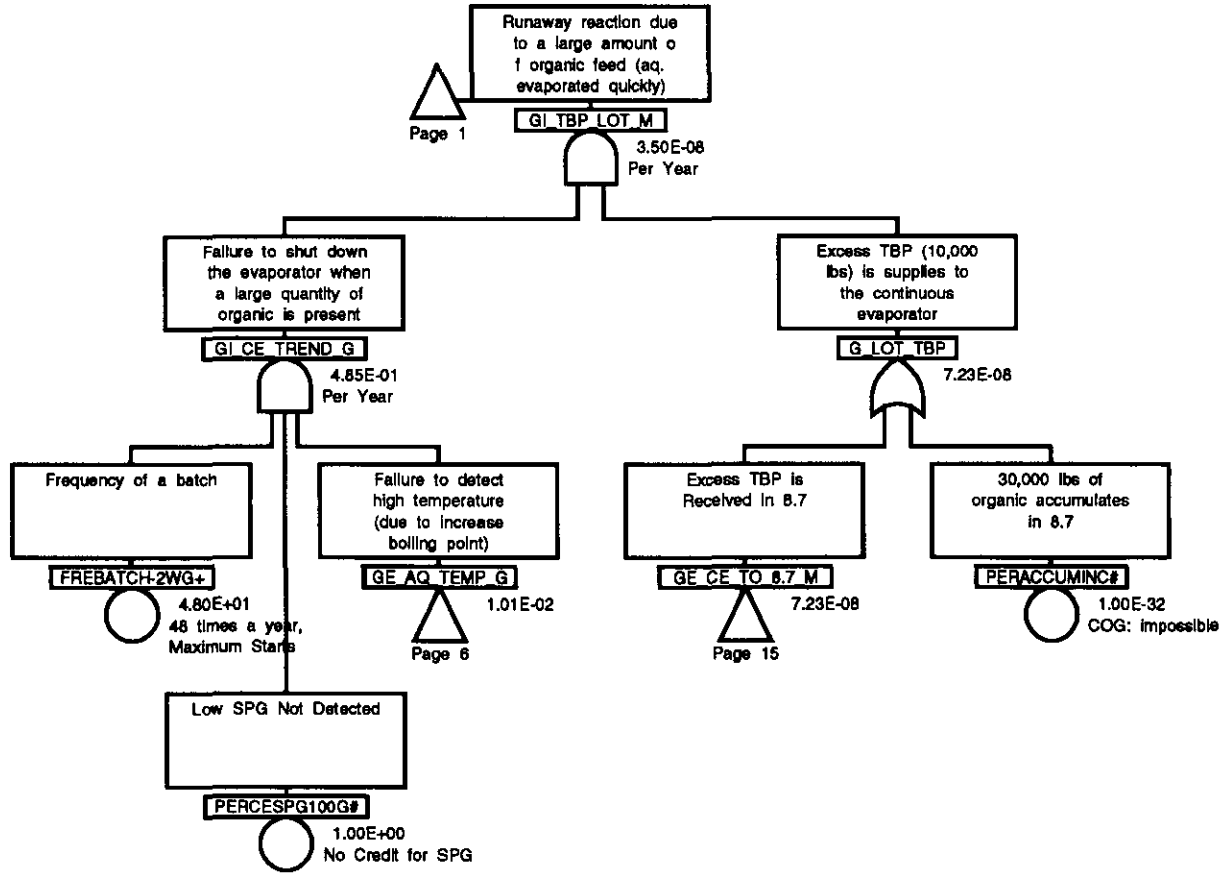

Excess TBP (3000 lbs) is supplied to the continuous evaporator
Page 1
G_LIT_TBP
1.46E-06
Excess TBP is Received in 8.7
excess TBP (> 3,000 lbs) accumulates gradually in 8.7
GE_CE_TO_8.7_G
1.34E-06
GE-ACCUM-G
1.25E-07
Page 13
Excess TBP is receiv ed from 17.5 (requir es two transfers dur ing same batch)
Excess TBP is Received in 8.7 From 11.7
Excess TBP is Received in 8.7 From 9.7
Excess TBP is received in 8.7 from 10.8 during cold streams
GE_CE_FR_17.5_G
2.00E-07
GE_CE_FR_11.7_G
8.43E-07
Page 10
PERFBLININC#
1.00E-32
impossible event, (no planned B-Line processing)
GE_CE_10.8_G
2.95E-07
Page 12
Material is Being Received From 17.5
Sufficient TBP present in tank 17.5
PERTR175002A#
2.00E-02
Pu Recovery Assume 1 out of 50 batches
PERTK175.20A#
2.00E-03
a: 1 In 5 years (1/500 Batches)
Transfer Excess TBP From 17.5 to 8.7
Second consecutive transfer containing TBP from tank 17.5 is fed to same batch
TR-17.5-TO-8.7
1.00E+00
Assumed to be present and always transferred
OPR17.5-ACNA#
5.00E-03
sump receipt tank tr ansfer procedure doe s not allow a 2nd tr

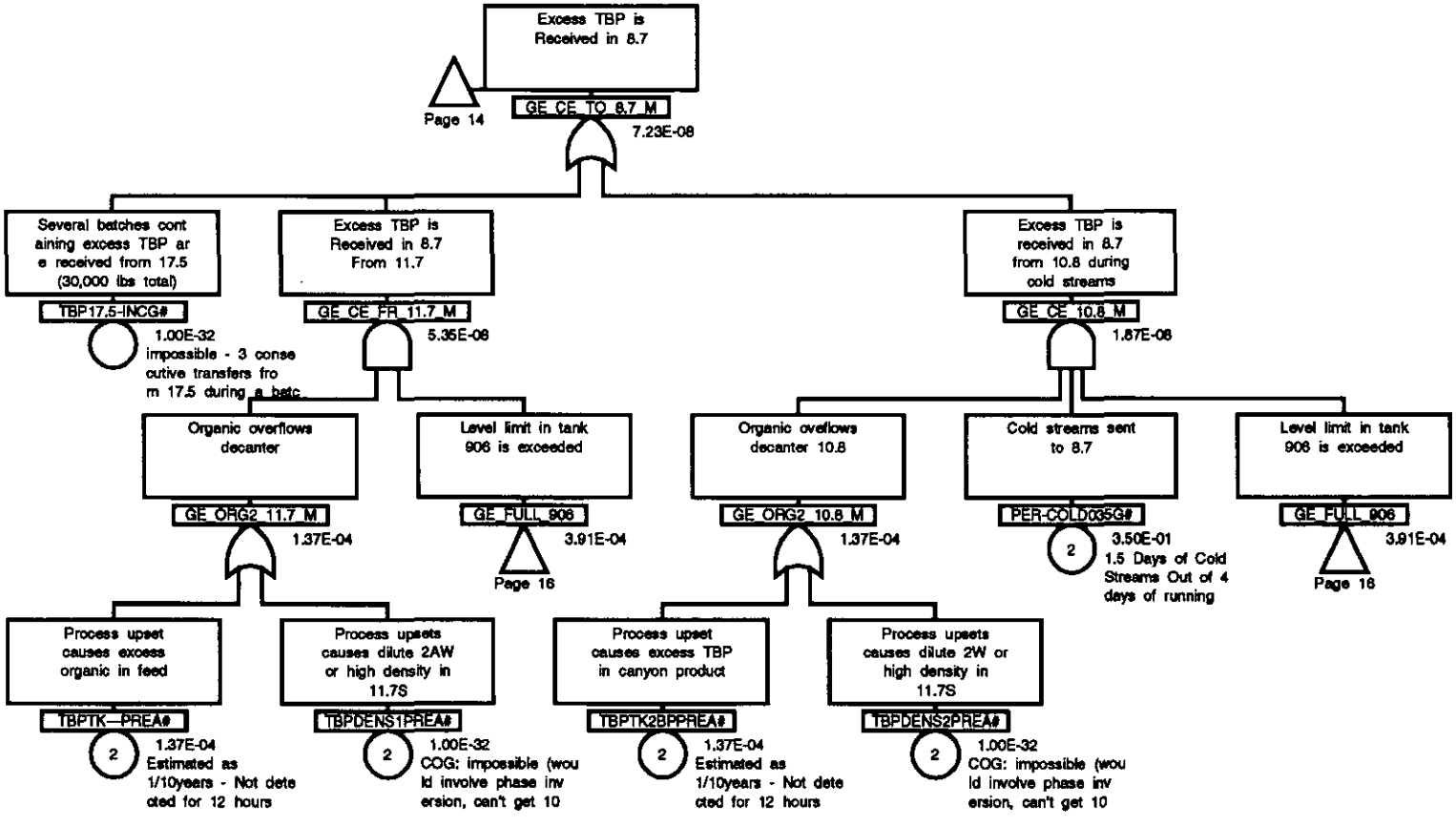

Excess TBP is Received in 8.7 From 11.7
Page 9
GE_CE_FR_11.7_G
8.43E-07
Organic overflows decanter
Failure to respond to a large loss of organic
GE_ORG2_11.7_G
1.37E-04
GE_TK906_RECOV
6.15E-03
Page 11
Process upset causes excess organic in feed
Process upsets causes dilute 2AW or high density in 11.7S
TBPTK---PREA#
2
1.37E-04
Estimated as 1/10years - Not detected for 12 hours
TBPDENS1PREA#
2
1.00E-32
COG: Impossible (would involve phase inversion, can't get 10

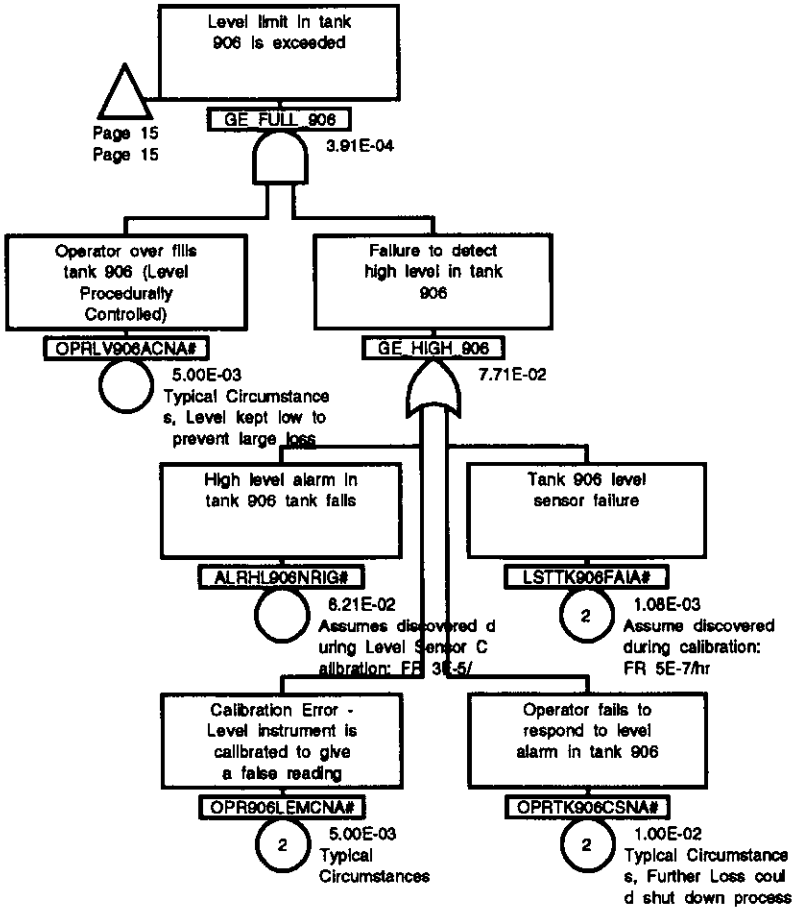

Failure to respond to a large loss of organic
Page 10
Page 12
GE_TK906_RECOV
6.15E-03
Failure to stop 906 pump
Calibration Error - Level instrument is calibrated to give a false reading
Tank 906 level sensor failure
GE_PMP906_INTLK
7.21E-05
OPR906LEMCNA#
2
5.00E-03
Typical Circumstances
LSTTK906FAIA#
2
1.08E-03
Assume discovered during calibration: FR 5E-7/hr
Pump switch fails to open
Failure to respond to tank 906 low level alarm
RLPPUMP-NREG#
1.00E-03
Per Demand, Generic Data
GE_906_ALARM
7.15E-02
Low level alarm in tank 906 fails
Operator fails to respond to level alarm in tank 906
ALRTK906NRIG#
6.21E-02
Assumes discovered during Level Sensor Calibration: FR 3E-5/
OPRTK906CSNA#
2
1.00E-02
Typical Circumstances, Further Loss could shut down process


Excess TBP is received in 8.7 from 10.8 during cold streams
Page 9
GE_CE_10.8_G
2.95E-07
Organic oveflows decanter 10.8
GE_ORG2_10.8_G
1.37E-04
Cold streams sent to 8.7
PER-COLD035G#
2
3.50E-01
1.5 Days of Cold Streams Out of 4 days of running
Failure to respond to a large loss of organic
GE_TK906_RECOV
6.15E-03
Page 11
Process upset causes excess TBP in canyon product
TBPTK2BPPREA#
2
1.37E-04
Estimated as 1/10years - Not dete cted for 12 hours
Process upsets causes dilute 2W or high density in 11.7S
TBPDENS2PREA#
2
1.00E-32
COG: impossible (wou id involve phase inv ersion, can't get 10


excess TBP (> 3,000 lbs) accumulates gradually in 8.7
Page 9
GE-ACCUM-G
1.25E-07
operator fails to fe ed remaining tank co ntents at end of 1st interval-clean out
OPR87EM1ACNA#
5.00E-03
Typical Circumstances
operator fails to fe ed remaining tank co ntents at end of 3rd interval-clean out
OPR87EM3ACNA#
5.00E-03
Typical Circumstances
operator fails to fe ed remaining tank co ntents at end of 2nd interval-clean out
OPR87EM2ACNA#
5.00E-03
typical circumstances
organic remains in feed tank
PER87ORG100A#
1.00E+00
assumes no credit fo r feeding tank conte nts to the adequate


Runaway reaction due to a large amount o f organic feed (aq. evaporated quickly)
GI_TBP_LOT_M
3.50E-08
Per Year
Page 1
Failure to shut down the evaporator when a large quantity of organic is present
GI_CE_TREND_G
4.85E-01
Per Year
Excess TBP (10,000 lbs) is supplies to the continuous evaporator
G_LOT_TBP
7.23E-08
Frequency of a batch
FREBATCH-2WG+
4.80E+01
48 times a year, Maximum Starts
Failure to detect high temperature (due to increase boiling point)
GE_AQ_TEMP_G
1.01E-02
Page 6
Excess TBP is Received in 8.7
GE_CE_TO_8.7_M
7.23E-08
Page 15
30,000 lbs of organic accumulates in 8.7
PERACCUMINC#
1.00E-32
COG: impossible
Low SPG Not Detected
PERCESPG100G#
1.00E+00
No Credit for SPG


Excess TBP is Received in 8.7
Page 14
GE_CE_TO_8.7_M
7.23E-08
Several batches containing excess TBP are received from 17.5 (30,000 lbs total)
TBP17.5-INCG#
1.00E-32
impossible - 3 consecutive transfers from 17.5 during a batc
Excess TBP is Received in 8.7 From 11.7
GE_CE_FR_11.7_M
5.35E-08
Excess TBP is received in 8.7 from 10.8 during cold streams
GE_CE_10.8_M
1.87E-08
Organic overflows decanter
GE_ORG2_11.7_M
1.37E-04
Level limit in tank 906 is exceeded
GE_FULL_906
3.91E-04
Page 16
Organic overflows decanter 10.8
GE_ORG2_10.8_M
1.37E-04
Cold streams sent to 8.7
PER-COLD035G#
2
3.50E-01
1.5 Days of Cold Streams Out of 4 days of running
Level limit in tank 906 is exceeded
GE_FULL_906
3.91E-04
Page 16
Process upset causes excess organic in feed
TBPTK_PREA#
2
1.37E-04
Estimated as 1/10years - Not detected for 12 hours
Process upsets causes dilute 2AW or high density in 11.7S
TBPDENS1PREA#
2
1.00E-32
COG: impossible (would involve phase inversion, can't get 10
Process upset causes excess TBP in canyon product
TBPTK2BPPREA#
2
1.37E-04
Estimated as 1/10years - Not detected for 12 hours
Process upsets causes dilute 2W or high density in 11.7S
TBPDENS2PREA#
2
1.00E-32
COG: impossible (would involve phase inversion, can't get 10


Level limit in tank 906 is exceeded
Page 15
Page 15
GE_FULL_906
3.91E-04
Operator over fills tank 906 (Level Procedurally Controlled)
Failure to detect high level in tank 906
OPRLV906ACNA#
5.00E-03
Typical Circumstance s, Level kept low to prevent large loss
GE_HIGH_906
7.71E-02
High level alarm in tank 906 tank fails
Tank 906 level sensor failure
ALRHL906NRIG#
6.21E-02
Assumes discovered d uring Level Sensor C alibration: FR 3E-5/
LSTTK906FAIA#
2
1.08E-03
Assume discovered during calibration: FR 5E-7/hr
Calibration Error - Level instrument is calibrated to give a false reading
Operator fails to respond to level alarm in tank 906
OPR906LEMCNA#
2
5.00E-03
Typical Circumstances
OPRTK906CSNA#
2
1.00E-02
Typical Circumstance s, Further Loss coul d shut down process

Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone
ALR-TLG-COMG#	5		GE_LVL_INTLK_X	3		MDPTK8.7FRCG+	2				
ALRHL906NRIG#	16		GE_ORG2_10.8_G	12		OPR17.5-ACNA#	9				
ALRTK906NRIG#	11		GE_ORG2_10.8_M	15		OPR87EM1ACNA#	13				
CAVCESTMFOWG#	4		GE_ORG2_11.7_G	10		OPR87EM2ACNA#	13				
CAVCESTMFOWG+	8		GE_ORG2_11.7_M	15		OPR87EM3ACNA#	13				
FRE-PMP-ADJG+	2		GE_PMP906_INTLK	11		OPR906LEMCNA#	11				
FREBATCH-2WG+	14		GE_TK906_RECOV	10		OPR906LEMCNA#	16				
G-_CE_INLK_X	1		GE_TK906_RECOV	11		OPRCELE-MCNA#	2				
G-_CE_INLK_X	4		GE_TK906_RECOV	12		OPRCELE-MCNA#	3				
G-_CE_INLK_X	6		GE_Y_LVL_INT_G	1		OPRGBLOCDENA#	5				
G-_TEM_INTLK_X	6		GI_1X	1		OPRGCETEIRNA#	7				
G-_TEM_INTLK_X	7		GI_2X	1		OPRLV906ACNA#	16				
G-_TEM_INTLK_X	8		GI_CE_HEAT_M	1		OPRTK906CSNA#	11				
GE-ACCUM-G	9		GI_CE_LVL_G	2		OPRTK906CSNA#	16				
GE-ACCUM-G	13		GI_CE_TBP-HEAT_Y	1		PER-COLD035G#	12				
GE_906_ALARM	11		GI_CE_TREND_G	14		PER-COLD035G#	15				
GE_AQ_TEMP_G	1		GI_CE_VALVE_X	8		PER8.5OP013#	1				
GE_AQ_TEMP_G	6		GI_FEED_PMP_G	1		PER87ORG100A#	13				
GE_AQ_TEMP_G	8		GI_FEED_PMP_G	2		PERACCUMINC#	14				
GE_AQ_TEMP_G	14		GI_HEAT1_CTRL1_X	1		PERCESPG100G#	14				
GE_CC_ALARM	4		GI_HEAT1_CTRL1_X	8		PERFBLININC#	9				
GE_CC_ALARM	5		GI_MIS_PRE_X	8		PERTK175.20A#	9				
GE_CC_ALARM	8		GI_OPR_LVL_G	2		PERTR175002A#	9				
GE_CE_10.8_G	9		GI_TBP_LOT_M	1		PSTSTEAMFAIG+	8				
GE_CE_10.8_G	12		GI_TBP_LOT_M	14		RLPPUMP-NREG#	11				
GE_CE_10.8_M	15		GI_TOP	1		TBP17.5-INCG#	15				
GE_CE_FR_11.7_G	9		GU_INTLKS1_X	8		TBPDENS1PREA#	10				
GE_CE_FR_11.7_G	10		G_LIT_TBP	1		TBPDENS1PREA#	15				
GE_CE_FR_11.7_M	15		G_LIT_TBP	9		TBPDENS2PREA#	12				
GE_CE_FR_17.5_G	9		G_LOT_TBP	14		TBPDENS2PREA#	15				
GE_CE_TO_8.7_G	9		JPRFEED-RECG+	1		TBPTK---PREA#	10				
GE_CE_TO_8.7_M	14		LOW-CE-FEED	1		TBPTK---PREA#	15				
GE_CE_TO_8.7_M	15		LST-CE--FAIG#	3		TBPTK2BPPREA#	12				
GE_FULL_906	15		LST-CE--FAIG+	2		TBPTK2BPPREA#	15				
GE_FULL_906	15		LSTCEHATFAIG+	2		TR-17.5-TO-8.7	9				
GE_FULL_906	16		LSTLE-CECALG+	2		TSTCETE-FAIG#	7				
GE_HIGH_906	16		LSTTK906FAIA#	11							
GE_LVL_INTLK_X	1		LSTTK906FAIA#	16							

Cutset Report for 8.5E Evaporator

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	GI_TOP					2.02E-07	
1.	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01	7.80E-08	100.0
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRCELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
2.	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01	2.73E-08	100.0
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRCELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
3.	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01	2.28E-08	100.0
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR17.5-ACNA#	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch	1	1N 5.0E-3 N	5.00E-03N		
	OPRCELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	PERTK175.20A#	Sufficient TBP present in tank 17.5	1	1N 2.00E-03N	2.00E-03N		
	PERTR175002A#	Material Is Being Received From 17.5	1	1N 2.00E-02N	2.00E-02N		
	TR-17.5-TO-8.7	Transfer Excess TBP From 17.5 to 8.7		1N	1.00E+00		

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
4.	ALRHL906NRIG#	High level alarm in tank 906 tank fails	5	6M	6.21E-02	2.04E-08	100.0
	FREBATCH-2WG+	Frequency of a batch		3.00E-05H 48Y	4.80E+01Y		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N	1.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1.0E-2 N 1N	5.00E-03N		
	PERCESPG100G#	Low SPG Not Detected	1	5.0E-3 N 1N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	1.00E+00N 12H	1.37E-04		
				0.1Y			
5.	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H	5.00E-01	1.68E-08	100.0
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		4H 1.0N	1.00E+00		
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M	1.08E-03		
	OPRCELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	5.00E-07 H 1N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	5.0E-3 N 1N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1.0E-2 N 1N	1.30E-01N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	1.30E-01N 12H	1.37E-04		
				0.1Y			
6.	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H	5.00E-01	1.42E-08	100.0
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		4H 1.0N	1.00E+00		
	OPR87EM1ACNA#	operator fails to feed remaining tank contents at end of 1st interval-clean out	1	1N 5.0E-3 N	5.00E-03N		
	OPR87EM2ACNA#	operator fails to feed remaining tank contents at end of 2nd interval-clean out	1	1N 5.0E-3 N	5.00E-03N		
	OPR87EM3ACNA#	operator fails to feed remaining tank contents at end of 3rd interval-clean out	1	1N 5.0E-3 N	5.00E-03N		
	OPRCELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	PER87ORG100A#	organic remains in feed tank	1	1N 1.00E+00N	1.00E+00N		
7.	ALRHL906NRIG#	High level alarm in tank 906 tank fails	5	6M	6.21E-02	7.14E-09	100.0
	FREBATCH-2WG+	Frequency of a batch		3.00E-05H 48Y	4.80E+01Y		

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
8.	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01	5.89E-09	100.0
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRCELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
9.	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y	3.29E-09	100.0
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	OPRTK906CSNA#	Operator fails to respond to level alarm in tank 906	1	1N 1.0E-2 N	1.00E-02N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
10.	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y	1.64E-09	100.0
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
11.	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y	1.15E-09	100.0
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	OPRTK906CSNA#	Operator fails to respond to level alarm in tank 906	1	1N 1.0E-2 N	1.00E-02N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
12.	ALRTK906NRIG#	Low level alarm in tank 906 fails	5	6M 3.00E-05H	6.21E-02	9.69E-10	100.0
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPRCELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	RLPPUMP-NREG#	Pump switch fails to open	1	1N 1.0E-3N	1.00E-03N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
13.	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01	7.49E-10	100.0
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRCELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
	TSTCETE-FAIG#	Continous Evaporator Temperature Sensor Has Failed	3	4D 1.00E-06 H	9.60E-05		
14.	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y	5.75E-10	100.0

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
15.	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y	3.55E-10	100.0
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
16.	ALRHL906NRIG#	High level alarm in tank 906 tank fails	5	6M 3.00E-05H	6.21E-02	1.96E-10	100.0
	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
	TSTCETE-FAIG#	Continous Evaporator Temperature Sensor Has Failed	3	4D 1.00E-06 H	9.60E-05		
17.	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y	1.24E-10	100.0
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
18.	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06	9.36E-11	100.0
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRGBLOCDENA#	Operator fails to respond to 8.5E temp., level alarms (close block valve)	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
19.	ALRHL906NRIG#	High level alarm in tank 906 tank fails	5	6M 3.00E-05H	6.21E-02	6.86E-11	100.0
	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
	TSTCETE-FAIG#	Continous Evaporator Temperature Sensor Has Failed	3	4D 1.00E-06 H	9.60E-05		
20.	ALR-TLG-COMG#	Common cause evaporator alarm failure (level,temperature)	5	6M 3.00E-06H	6.45E-03	6.04E-11	100.0
	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06		
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
21.	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06	3.28E-11	100.0

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRGBLOCDENA#	Operator fails to respond to 8.5E temp., level alarms (close block valve)	1	1N 1.0E-2 N	1.00E-02N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
22.	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y	3.16E-11	100.0
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	OPRTK906CSNA#	Operator fails to respond to level alarm in tank 906	1	1N 1.0E-2 N	1.00E-02N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
	TSTCETE-FAIG#	Continous Evaporator Temperature Sensor Has Failed	3	4D 1.00E-06 H	9.60E-05		
23.	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01	3.12E-11	100.0
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	LST-CE--FAIG#	Continous evaporator level instrument fails high	5	8H 5.00E-07 H	2.00E-06		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRGCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
24.	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06	2.73E-11	100.0
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR17.5-ACNA#	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch	1	1N 5.0E-3 N	5.00E-03N		

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	OPRGBLOCDENA#	Operator fails to respond to 8.5E temp., level alarms (close block valve)	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	PERTK175.20A#	Sufficient TBP present in tank 17.5	1	1N 2.00E-03N	2.00E-03N		
	PERTR175002A#	Material Is Being Received From 17.5	1	1N 2.00E-02N	2.00E-02N		
	TR-17.5-TO-8.7	Transfer Excess TBP From 17.5 to 8.7		1N	1.00E+00		
25.	ALR-TLG-COMG#	Common cause evaporator alarm failure (level,temperature)	5	6M 3.00E-06H	6.45E-03	2.11E-11	100.0
	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06		
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
26.	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06	2.02E-11	100.0
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRGBLOCDENA#	Operator fails to respond to 8.5E temp., level alarms (close block valve)	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
27.	ALR-TLG-COMG#	Common cause evaporator alarm failure (level,temperature)	5	6M 3.00E-06H	6.45E-03	1.76E-11	100.0
	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06		
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	OPR17.5-ACNA#	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch	1	1N 5.0E-3 N	5.00E-03N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	PERTK175.20A#	Sufficient TBP present in tank 17.5	1	1N 2.00E-03N	2.00E-03N		
	PERTR175002A#	Material Is Being Received From 17.5	1	1N 2.00E-02N	2.00E-02N		
	TR-17.5-TO-8.7	Transfer Excess TBP From 17.5 to 8.7		1N	1.00E+00		
28.	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06	1.71E-11	100.0
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		
	OPR87EM1ACNA#	operator fails to feed remaining tank contents at end of 1st interval-clean out	1	1N 5.0E-3 N	5.00E-03N		
	OPR87EM2ACNA#	operator fails to feed remaining tank contents at end of 2nd interval-clean out	1	1N 5.0E-3 N	5.00E-03N		
	OPR87EM3ACNA#	operator fails to feed remaining tank contents at end of 3rd interval-clean out	1	1N 5.0E-3 N	5.00E-03N		
	OPRGBLOCDENA#	Operator fails to respond to 8.5E temp., level alarms (close block valve)	1	1N 1.0E-2 N	1.00E-02N		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	PER87ORG100A#	organic remains in feed tank	1	1N 1.00E+00N	1.00E+00N		
29.	FREBATCH-2WG+	Frequency of a batch		48Y	4.80E+01Y	1.58E-11	100.0
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PERCESPG100G#	Low SPG Not Detected	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
	TSTCETE-FAIG#	Continous Evaporator Temperature Sensor Has Failed	3	4D 1.00E-06 H	9.60E-05		
30.	ALR-TLG-COMG#	Common cause evaporator alarm failure (level,temperature)	5	6M 3.00E-06H	6.45E-03	1.30E-11	100.0
	CAVCESTMFOWG#	Pneumatic steam control valve fails open	3	2H 3.00E-06 H	6.00E-06		
	FRE-PMP-ADJG+	Pump speed is adjusted	4	0.25H 4H	5.00E-01		
	LOW-CE-FEED	Low Feed Flow is Not Detected or Corrected		1.0N	1.00E+00		

Cutset Report for 8.5E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	PER8.5OP013#	Continuous Evaporator is in Operation	1	1N 1.30E-01N	1.30E-01N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		

Basic Event Data for 8.5E Evaporator

Event	C	Input	Calc.	Description	Source
ALR-TLG-COMG#	5	6M 3.00E-06H	6.45E-03	Common cause evaporator alarm failure (level,temperature)	COG: 6 Month Calib., Use Beta factor of .1 for common cause
ALRHL906NRIG#	5	6M 3.00E-05H	6.21E-02	High level alarm in tank 906 tank fails	Assumes discovered during Level Sensor Calibration: FR 3E-5/hr
ALRTK906NRIG#	5	6M 3.00E-05H	6.21E-02	Low level alarm in tank 906 fails	Assumes discovered during Level Sensor Calibration: FR 3E-5/hr
CAVCESTMFOWG#	3	2H 3.00E-06 H	6.00E-06	Pneumatic steam control valve fails open	discovered in 2 hours (round sheet every hour)
CAVCESTMFOWG+	4	2H 3.00E-06 H	6.00E-06	Pneumatic steam control valve fails open	discovered in 2 hours (round sheet every hour)
FRE-PMP-ADJG+	4	0.25H 4H	5.00E-01	Pump speed is adjusted	Adjusted 4 times per hour, discovered within 15 Minutes
FREBATCH-2WG+		48Y	4.80E+01Y	Frequency of a batch	48 times a year, Maximum Starts
JPRFEED-RECG+	4	96H 1.00E-08 H	9.60E-07	Large leak in jumper causes failure to feed evaporator	Would Discover by End of Cycle
LOW-CE-FEED		1.0N	1.00E+00	Low Feed Flow is Not Detected or Corrected	Assumed to Occur
LST-CE--FAIG#	5	8H 5.00E-07 H	2.00E-06	Continous evaporator level instrument fails high	Assume 8 hours for repair: 5E-7/hr for failure
LST-CE--FAIG+	4	8H 5.00E-07 H	4.00E-06	Continous evaporator level instrument fails high	Assume 8 hours for repair: 5E-7/hr for failure
LSTCEHATFAIG+	4	3M 5.00E-07 H	1.08E-03	Level instrument in hackman hat fails high	Discovered in 3 months (when calib.)
LSTLE-CECALG+	4	4H 2.0Y	9.12E-04	Frequency of continous evaporator level instrumetation calibration	Assume 4 hour for calibration: Calibrated 2/yr, discovered before next cycle
LSTTK906FAIA#	5	6M 5.00E-07 H	1.08E-03	Tank 906 level sensor failure	Assume discovered during calibration: FR 5E-7/hr
MDPTK8.7FRCG+	4	96H 1.00E-04 H	9.51E-03	Continous evaporator feed pump fails	Would Discover by End of Cycle (4 days)
OPR17.5-ACNA#	1	1N 5.0E-3 N	5.00E-03N	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch	sump receipt tank transfer procedure does not allow a 2nd transfer
OPR87EM1ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents at end of 1st interval-clean out	Typical Circumstances
OPR87EM2ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents at end of 2nd interval-clean out	typical circumstances
OPR87EM3ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents at end of 3rd interval-clean out	Typical Circumstances
OPR906LEMCNA#	1	1N 5.0E-3 N	5.00E-03N	Calibration Error - Level instrument is calibrated to give a false reading	Typical Circumstances
OPRCELE-MCNA#	1	1N 5.0E-3 N	5.00E-03N	Calibration Error - Level Instrument is calibrated to give a high signal	Typical Circumstances
OPRGBLOCDENA#	1	1N 1.0E-2 N	1.00E-02N	Operator fails to respond to 8.5E temp., level alarms (close block valve)	Several Competing Signals

Basic Event Data for 8.5E Evaporator (CONT.)

Event	C	Input	Calc.	Description	Source
OPRGCETEIRNA#	1	1N 1.0E-2 N	1.00E-02N	Evaporator Temperature Sensor is Out of Calibration	Normal Calibration, Not Discovered Until Next Calibration
OPRLV906ACNA#	1	1N 5.0E-3 N	5.00E-03N	Operator over fills tank 906 (Level Procedurally Controlled)	Typical Circumstances, Level kept low to prevent large loss of organic
OPRTK906CSNA#	1	1N 1.0E-2 N	1.00E-02N	Operator fails to respond to level alarm in tank 906	Typical Circumstances, Further Loss could shut down process
PER-COLD035G#	1	1N 3.50E-01N	3.50E-01N	Cold streams sent to 8.7	1.5 Days of Cold Streams Out of 4 days of running
PER8.5OP013#	1	1N 1.30E-01N	1.30E-01N	Continuous Evaporator is in Operation	Operated 4 days/Month (2.5 Hot & 1.5 Cold)
PER87ORG100A#	1	1N 1.00E+00N	1.00E+00N	organic remains in feed tank	assumes no credit for feeding tank contents to the adequate mixing point
PERACCUMINC#	1	1N 1.00E-32N	1.00E-32N	30,000 lbs of organic accumulates in 8.7	COG: impossible
PERCESPG100G#	1	1N 1.00E+00N	1.00E+00N	Low SPG Not Detected	No Credit for SPG
PERFBLININC#	1	1N 1.00E-32N	1.00E-32N	Excess TBP is Received in 8.7 From 9.7	impossible event, (no planned B-Line processing)
PERTK175.20A#	1	1N 2.00E-03N	2.00E-03N	Sufficient TBP present in tank 17.5	a: 1 in 5 years (1/500 Batches)
PERTR175002A#	1	1N 2.00E-02N	2.00E-02N	Material Is Being Received From 17.5	Pu Recovery, Assume 1 out of 50 batches
PSTSTEAMFAIG+	4	4D 1.00E-06 H	9.60E-05	Steam pressure switch fails	Assume would be discovered by next cycle: FR 1E-6/hr
RLPPUMP-NREG#	1	1N 1.0E-3N	1.00E-03N	Pump switch fails to open	Per Demand, Generic Data
TBP17.5-INCG#		1.0E-32N	1.00E-32	Several batches containing excess TBP are received from 17.5 (30,000 lbs total)	impossible - 3 consecutive transfers from 17.5 during a batch
TBPDENS1PREA#		1.0E-32N	1.00E-32	Process upsets causes dilute 2AW or high density in 11.7S	COG: impossible (would involve phase inversion, can't get 10,000 lbs organic)
TBPDENS2PREA#		1.0E-32H	8.76E-29Y	Process upsets causes dilute 2W or high density in 11.7S	COG: impossible (would involve phase inversion, can't get 10,000 lbs organic)
TBPTK---PREA#	3	12H 0.1Y	1.37E-04	Process upset causes excess organic in feed	Estimated as 1/10years - Not detected for 12 hours
TBPTK2BPPREA#	3	12H 0.1Y	1.37E-04	Process upset causes excess TBP in canyon product	Estimated as 1/10years - Not detected for 12 hours
TR-17.5-TO-8.7		1N	1.00E+00	Transfer Excess TBP From 17.5 to 8.7	Assumed to be present and always transferred
TSTCETE-FAIG#	3	4D 1.00E-06 H	9.60E-05	Continous Evaporator Temperature Sensor Has Failed	Assumes Discovered by next cycle: FR 1E-6/hr

Type Code Data for 8.5E Evaporator

Type Code	Rate	Description	Source	EF	D
ALR COM	3.00E-06H	Alarm/Annunciator, Fails to alarm (Instr. & Control)	WSRC-TR-93-262, ALR-NR-I		
ALR NRI	3.00E-05H	Alarm/Annunciator, Fails to alarm (Instr. & Control)	WSRC-TR-93-262, ALR-NR-I	10	L
CAV FOW	3.00E-06 H	Valve (Control), Air-Operated, Fails open (Water)	WSRC-TR-93-262, CAV-FO-W	10	L
FRE ADJ	4H	Speed of Feed Pump Adjusted 4 Times per hour	Operations personnel		
JPR REC	1.00E-08 H	Jumper, Rupture (external) (Chemical)	WSRC-TR-93-262, JPR-RE-C	30	L
LST CAL	2.0Y	Level Instrument Calibration Frequency	Assumed Value		
LST FAI	5.00E-07 H	Sensor/Transmitter/, Transducer/Proc. Switch, Level, Failure (Instr. & Control)	WSRC-TR-93-262, LST-FA-I	3	L
MDP FRC	1.00E-04 H	Pump, Motor-Driven, Fails to run (Chemical)	WSRC-TR-93-262, MDP-FR-C	10	L
OPR ACN	5.0E-3 N	Failure of Administrative Control (Nominal)	WSRC-TR-93-581, Table 4, Item 1, Nominal	10	L
OPR CSN	1.0E-2 N	Failure to respond to compelling signal (Nominal)	WSRC-TR-93-581, Table 4, Item 2, Nominal	5	L
OPR DEN	1.0E-2 N	Diagnosis error (Nominal)	WSRC-TR-93-581, Table 4, Item 30, Nominal	5	L
OPR IRN	1.0E-2 N	Incorrect reading or recording of data (Nominal)	WSRC-TR-93-581, Table 4, Item 11, Nominal	5	L
OPR MCN	5.0E-3 N	Miscalibration (Nominal)	WSRC-TR-93-581, Table 4, Item 12, Nominal	10	L
PER .20	2.00E-03N	0.2% chance			
PER 002	2.00E-02N	2% chance			
PER 013	1.30E-01N	13% Chance			
PER 035	3.50E-01N	35% chance			
PER 100	1.00E+00N	100% chance			
PER INC	1.00E-32N	Incredible Event			
PST FAI	1.00E-06 H	Sensor/Transmitter/, Transducer/Proc. Sw., Press., Failure (Instr. & Control)	WSRC-TR-93-262, PST-FA-I	3	L
RLP NRE	1.0E-3N	Relay fails to open	WSRC-TR-93-262m RLP-NRE		
TBP PRE	0.1Y	Process upset causes excess organic in feed	Never Seen, Estimated as Once in Ten Years		
TST FAI	1.00E-06 H	Sensor/Transmitter/, Transducer/Proc. Switch, Temp., Failure (Instr. & Control)	WSRC-TR-93-262, TST-FA-I	3	L

APPENDIX E - 9.3E EVAPORATOR FAULT TREE AND DATA

The following abbreviations appear on the fault tree print out and in the basic event file for the fault tree:

FR=Failure Rate

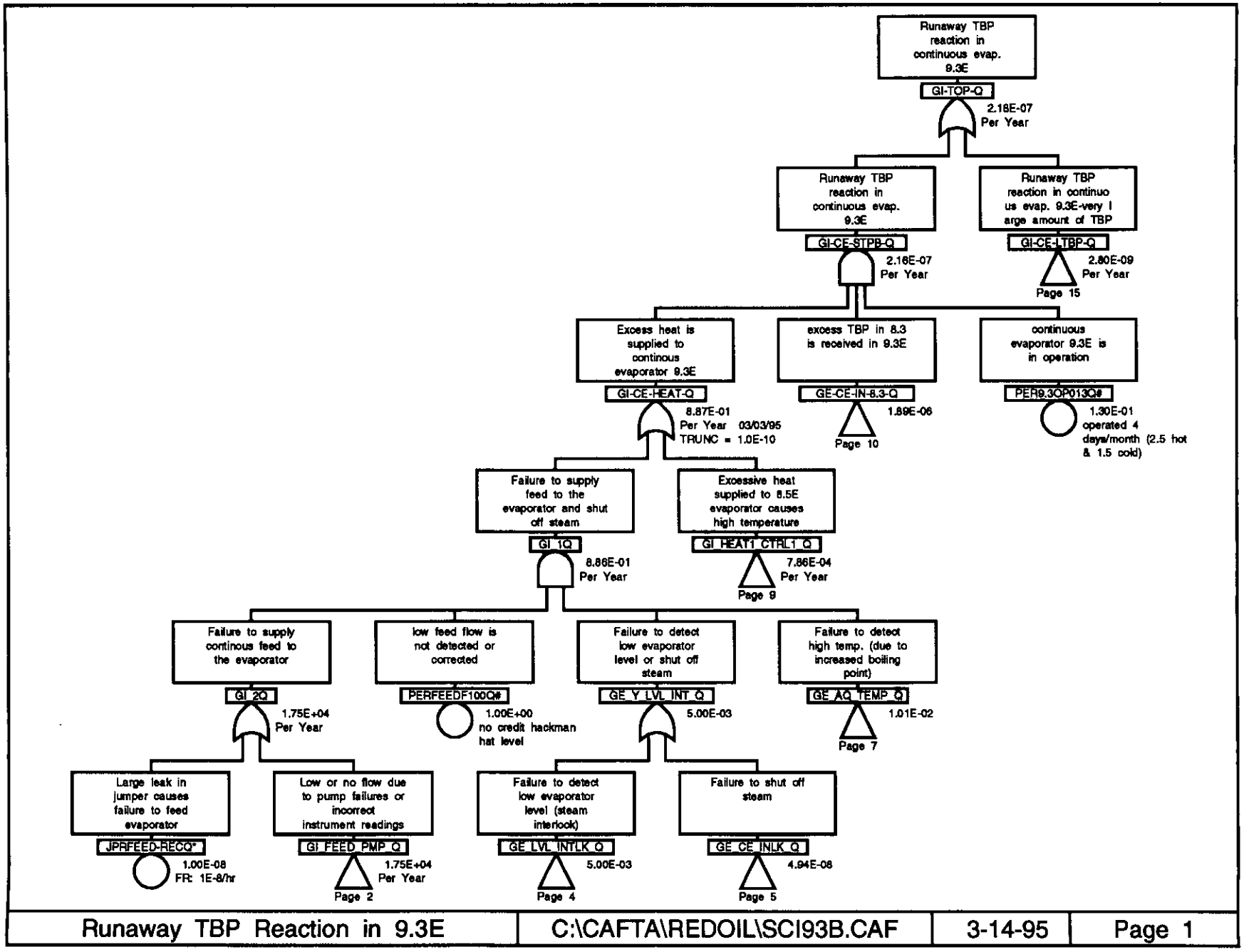
a: = assumption

COG= cognizant engineer estimate/information

TRUNC= Truncation limit of cutset evaluator

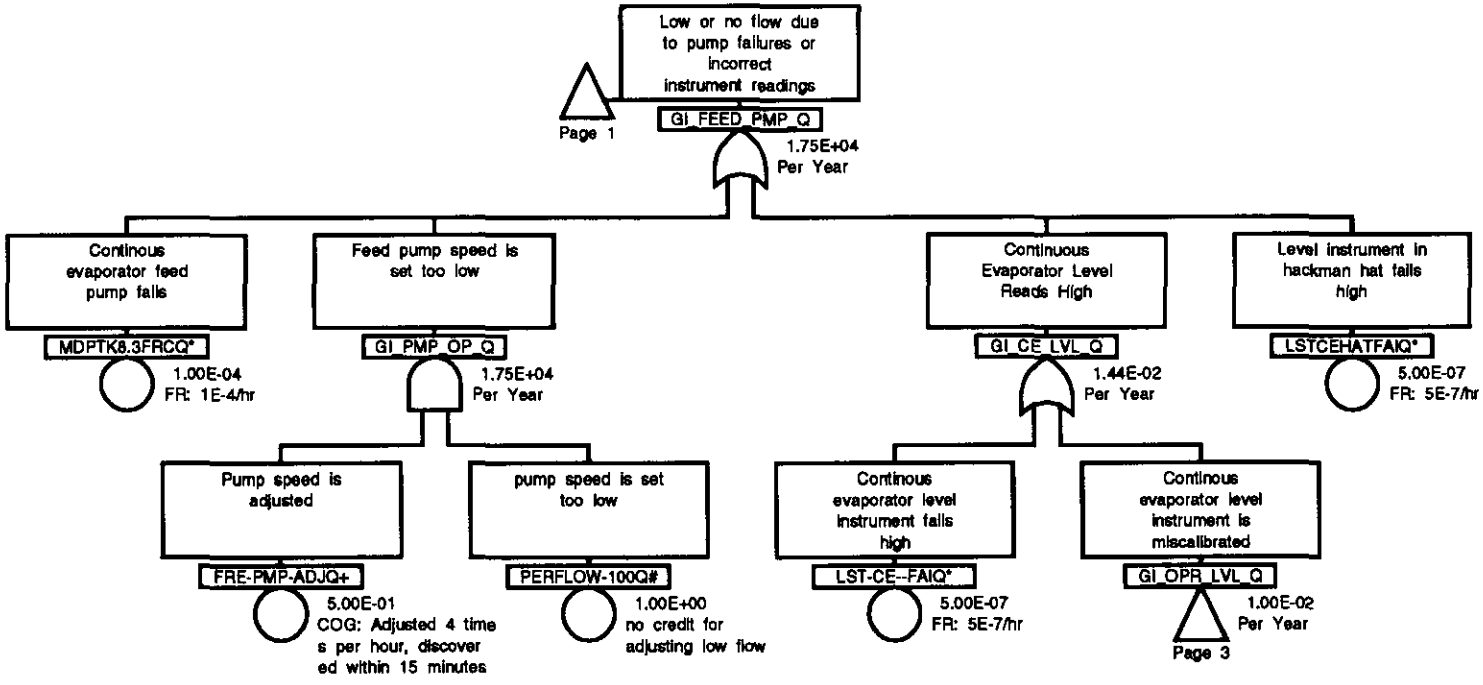
The Beta Factor method used to estimate common cause alarm failure is explained in Reference 15.

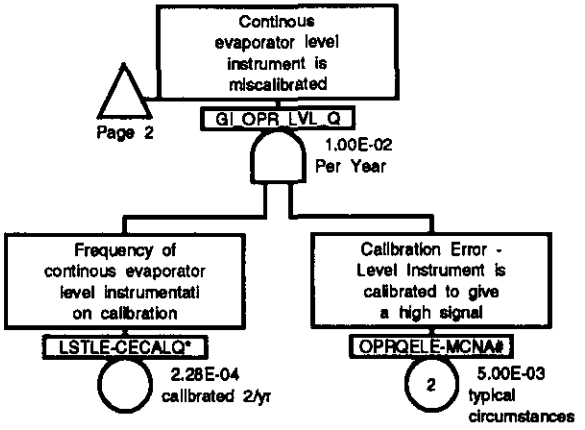
NOTE: Events in this tree with a probability of "1E-32" are incredible. They do not contribute to the top event frequency and were included only to show that they had been considered. The number "1E-32" was used because it is the smallest number CAFTA is capable of handling.

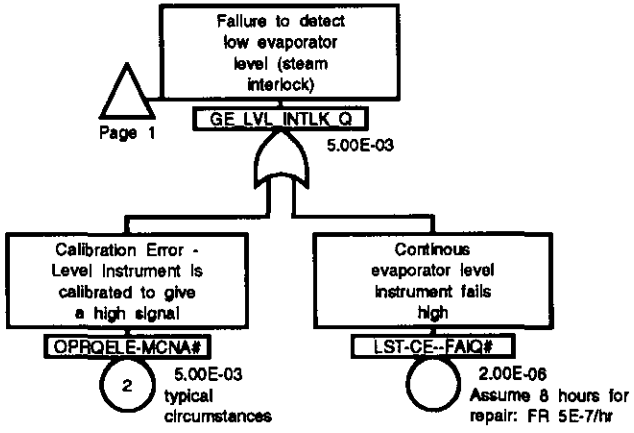


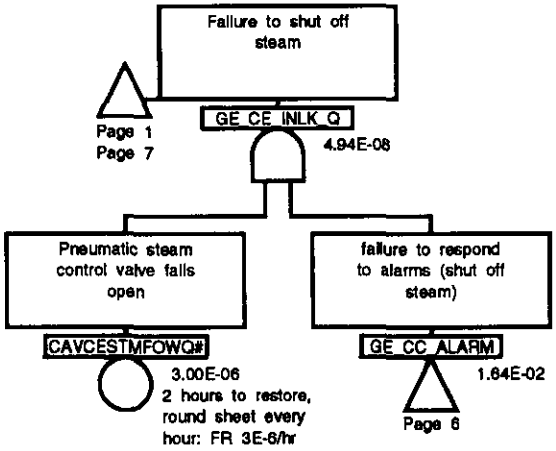
Runaway TBP Reaction in 9.3E	C:\CAFTA\REDOIL\SCI93B.CAF	3-14-95	Page 1

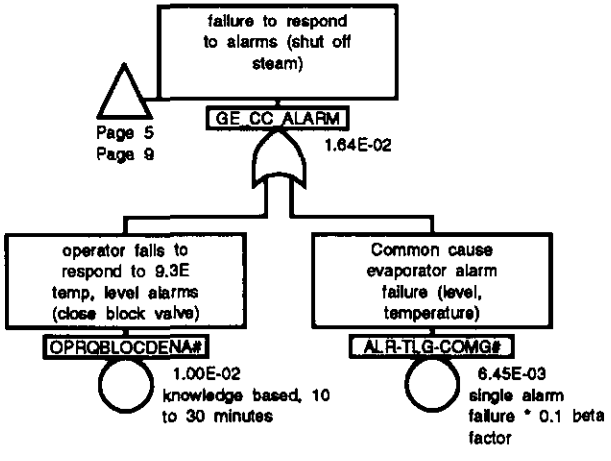
Calculation No. S-CLC-F-00140
Sheet No. 72 of 129
Rev. B

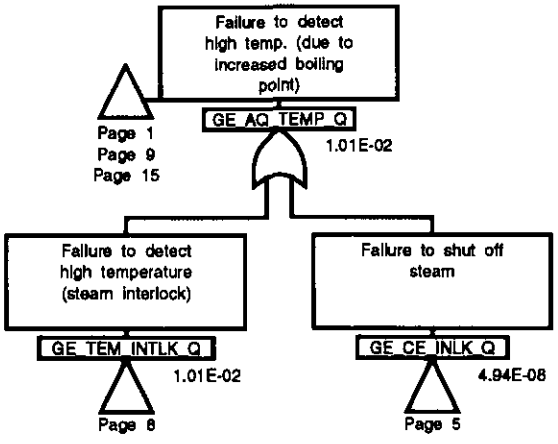

Low or no flow due to pump failures or incorrect instrument readings
Page 1
GI_FEED_PMP_Q
1.75E+04
Per Year
Continous evaporator feed pump fails
MDPTK8.3FRCQ*
1.00E-04
FR: 1E-4/hr
Feed pump speed is set too low
GI_PMP_OP_Q
1.75E+04
Per Year
Pump speed is adjusted
FRE-PMP-ADJQ+
5.00E-01
COG: Adjusted 4 time s per hour, discover ed within 15 minutes
pump speed is set too low
PERFLOW-100Q#
1.00E+00
no credit for adjusting low flow
Continuous Evaporator Level Reads High
GI_CE_LVL_Q
1.44E-02
Per Year
Continous evaporator level instrument fails high
LST-CE--FAIQ*
5.00E-07
FR: 5E-7/hr
Continous evaporator level instrument is miscalibrated
GI_OPR_LVL_Q
1.00E-02
Per Year
Page 3
Level instrument in hackman hat fails high
LSTCEHATFAIQ*
5.00E-07
FR: 5E-7/hr

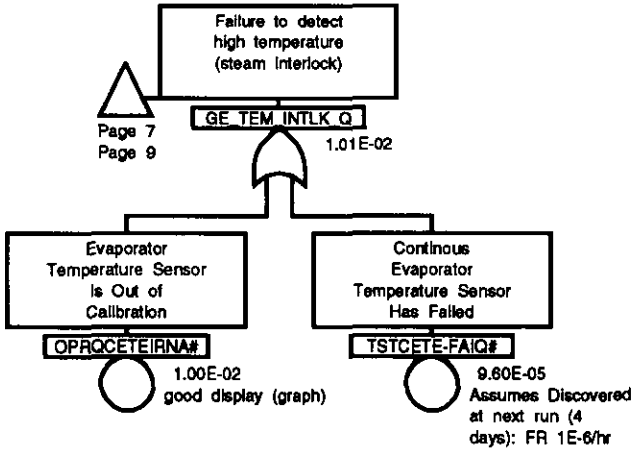

Continous evaporator level instrument is miscalibrated
Page 2
GI_OPR_LVL_Q
1.00E-02
Per Year
Frequency of continous evaporator level instrumentati on calibration
Calibration Error - Level Instrument is calibrated to give a high signal
LSTLE-CECALQ*
OPRQELE-MCNA#
2.28E-04
calibrated 2/yr
2
5.00E-03
typical circumstances

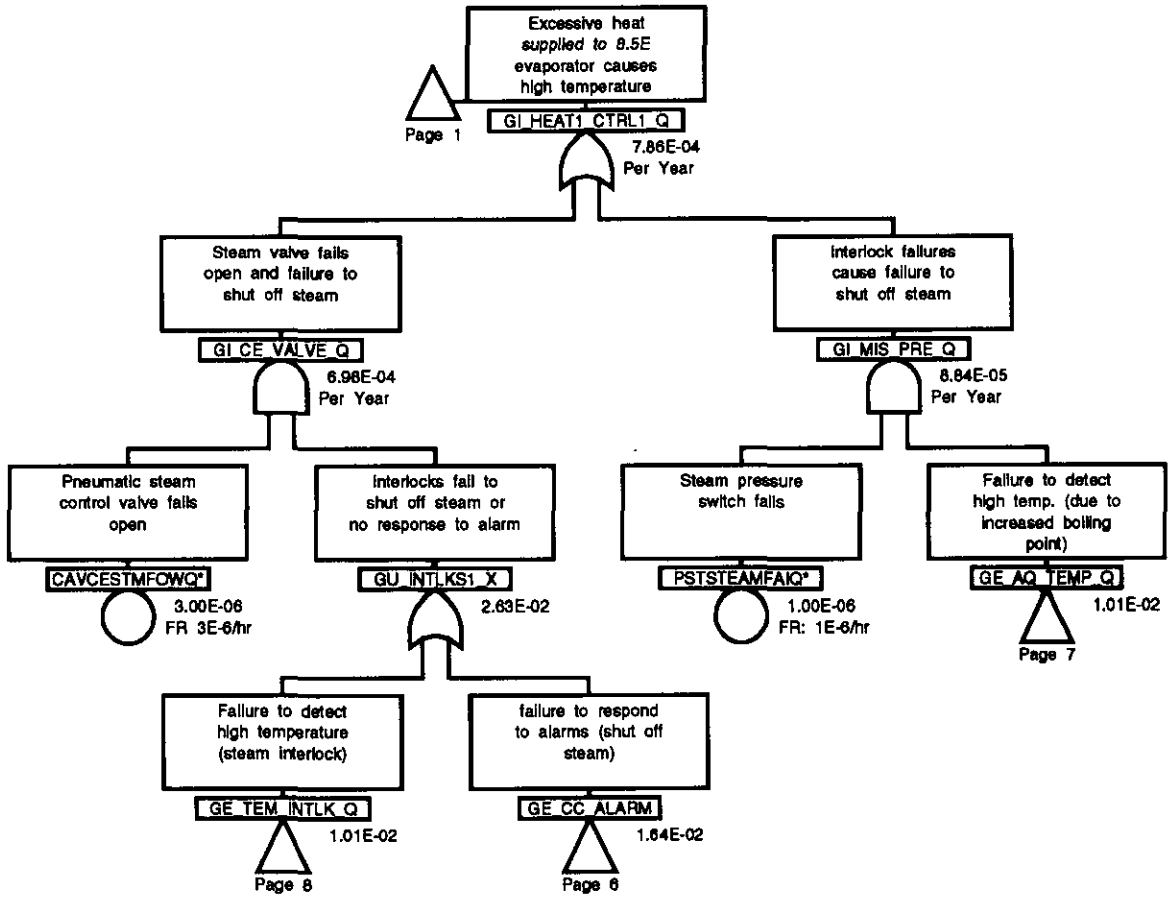

Failure to detect low evaporator level (steam interlock)
GE_LVL_INTLK_Q
5.00E-03
Page 1
Calibration Error - Level Instrument is calibrated to give a high signal
OPRQELE-MCNA#
2
5.00E-03
typical circumstances
Continous evaporator level instrument fails high
LST-CE--FAIQ#
2.00E-06
Assume 8 hours for repair: FR 5E-7/hr

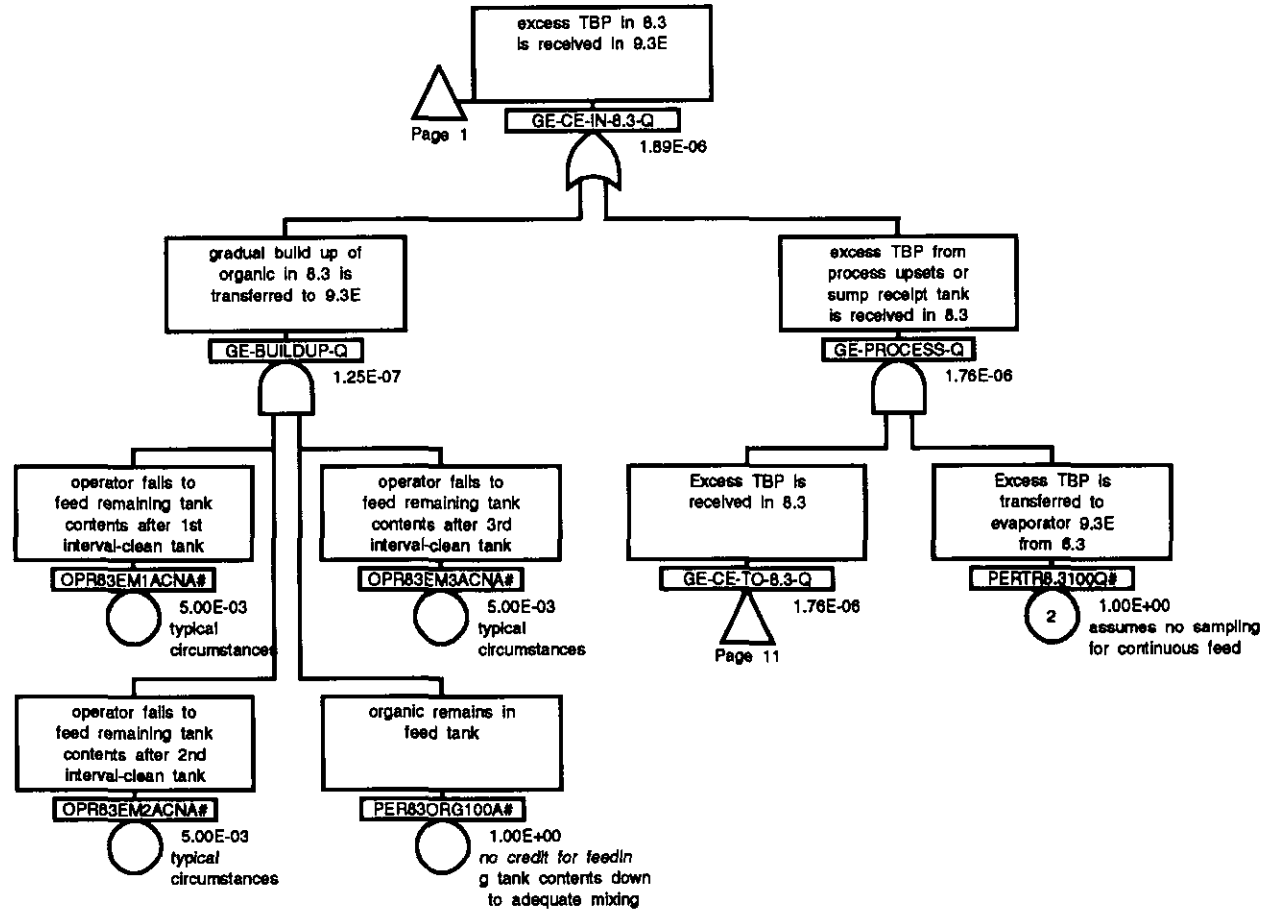

Failure to shut off steam
Page 1
Page 7
GE_CE_INLK_Q
4.94E-08
Pneumatic steam control valve fails open
failure to respond to alarms (shut off steam)
CAVCESTMFOWQ#
3.00E-06
2 hours to restore, round sheet every hour: FR 3E-6/hr
GE_CC_ALARM
1.64E-02
Page 6

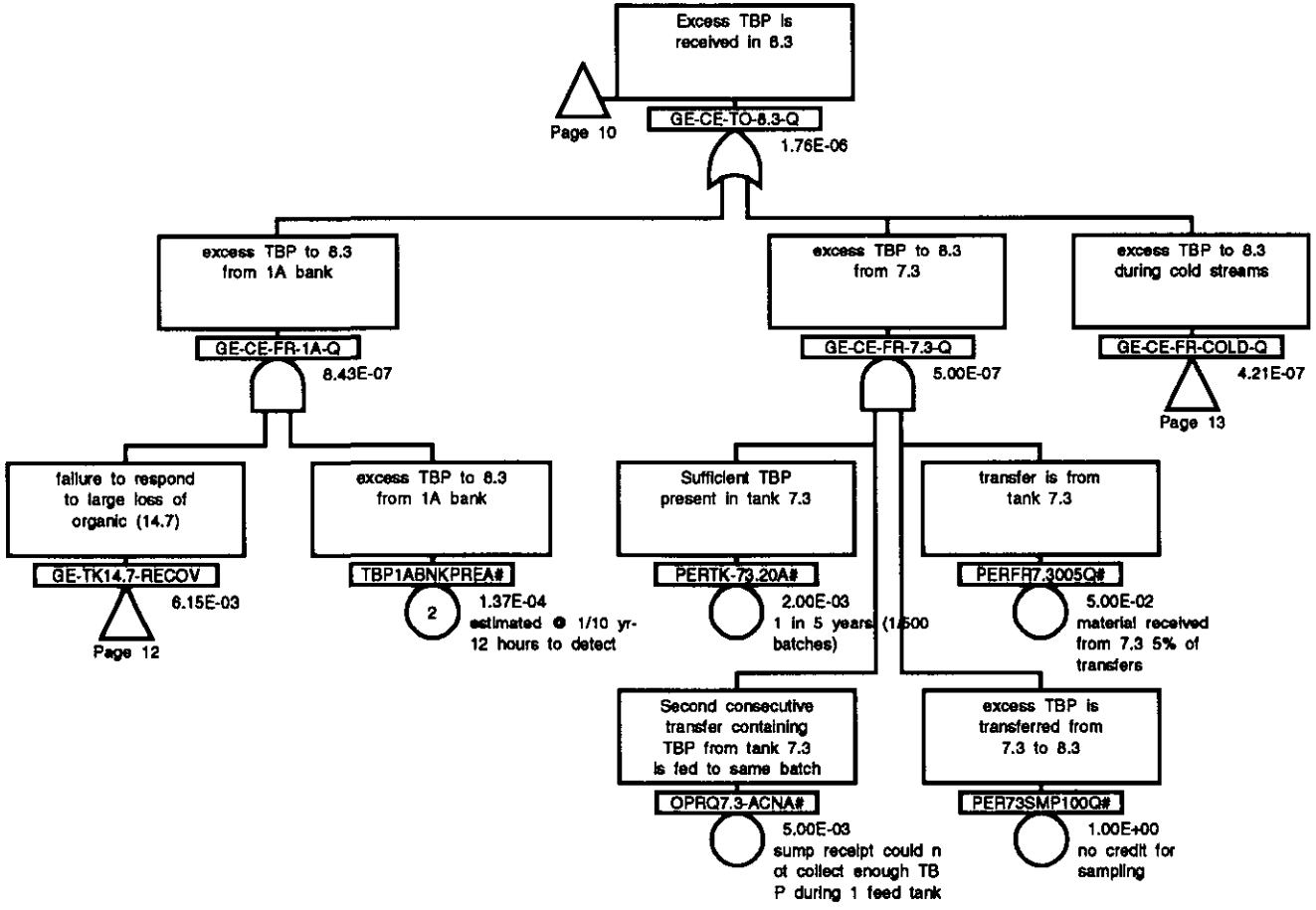

failure to respond to alarms (shut off steam)
GE_CC_ALARM
1.64E-02
Page 5
Page 9
operator fails to respond to 9.3E temp, level alarms (close block valve)
OPRQBLOCDENA#
1.00E-02
knowledge based, 10 to 30 minutes
Common cause evaporator alarm failure (level, temperature)
ALR-TLG-COMG#
6.45E-03
single alarm failure * 0.1 beta factor

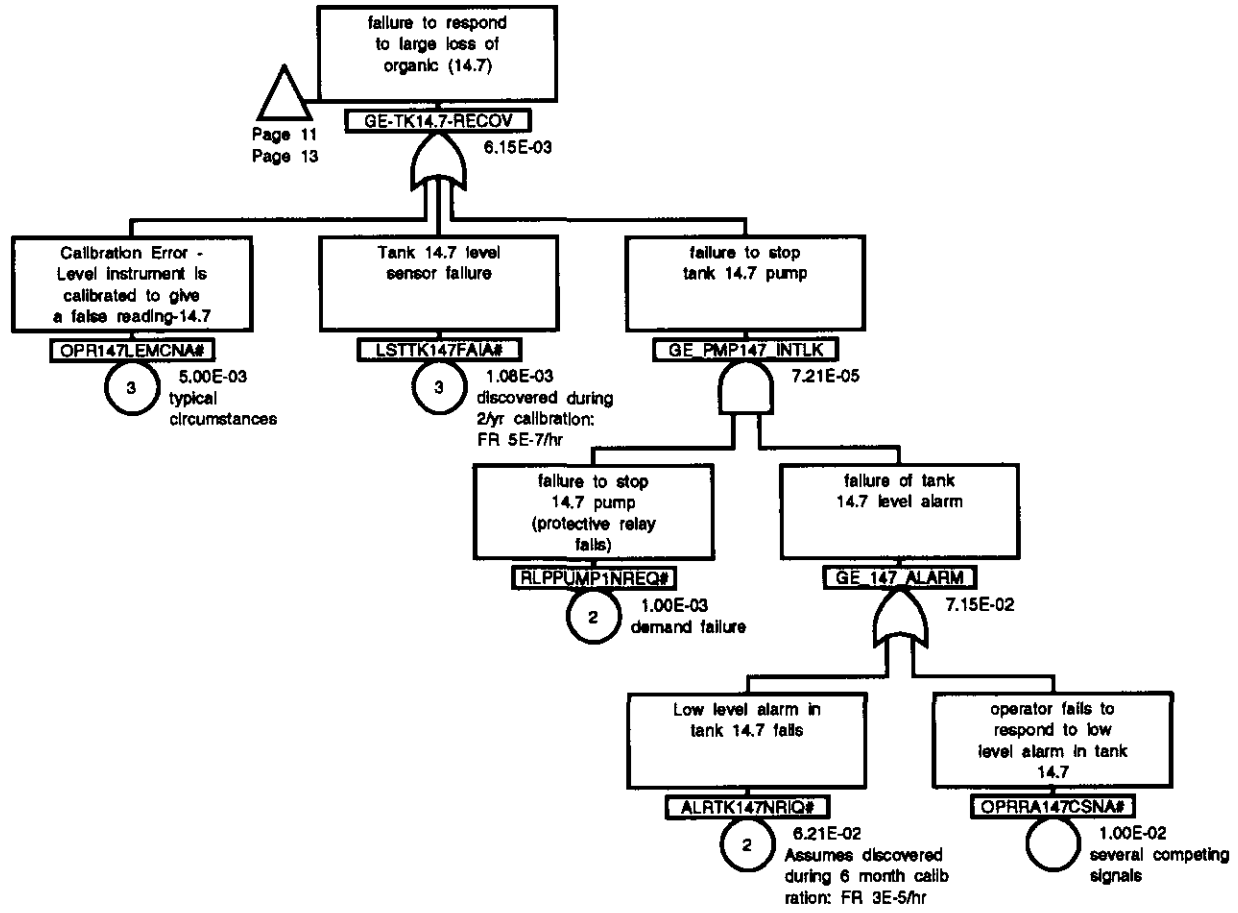

Failure to detect high temp. (due to increased boiling point)
GE_AQ_TEMP_Q
1.01E-02
Page 1
Page 9
Page 15
Failure to detect high temperature (steam interlock)
Failure to shut off steam
GE_TEM_INTLK_Q
1.01E-02
GE_CE_INLK_Q
4.94E-08
Page 8
Page 5

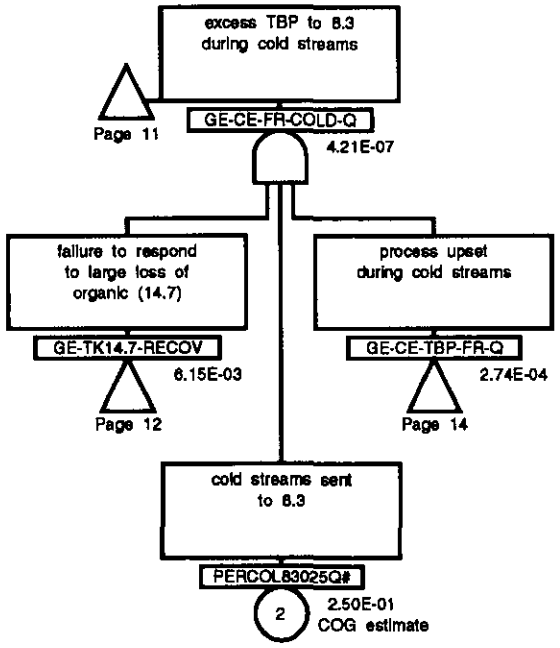

Failure to detect high temperature (steam interlock)
GE_TEM_INTLK_Q
1.01E-02
Page 7
Page 9
Evaporator Temperature Sensor Is Out of Callbration
Continous Evaporator Temperature Sensor Has Failed
OPRQCETEIRNA#
TSTCETE-FAIQ#
1.00E-02
good display (graph)
9.60E-05
Assumes Discovered at next run (4 days): FR 1E-6/hr

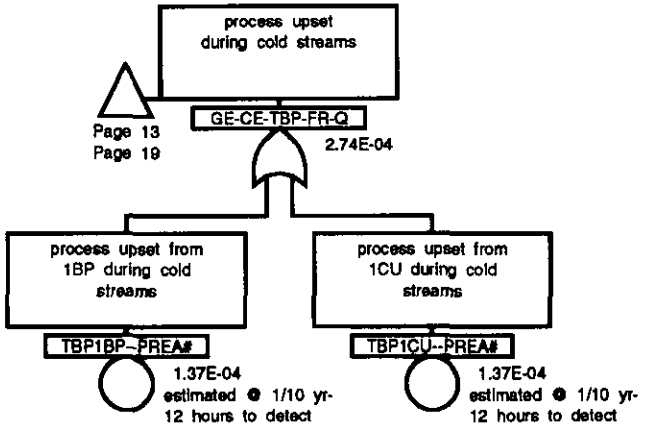

Excessive heat supplied to 8.5E evaporator causes high temperature
GI_HEAT1_CTRL1_Q
7.86E-04 Per Year
Page 1
Steam valve fails open and failure to shut off steam
GI_CE_VALVE_Q
6.96E-04 Per Year
Interlock failures cause failure to shut off steam
GI_MIS_PRE_Q
8.84E-05 Per Year
Pneumatic steam control valve fails open
CAVCESTMFOWQ*
3.00E-06 FR 3E-6/hr
Interlocks fail to shut off steam or no response to alarm
GU_INTLKS1_X
2.63E-02
Steam pressure switch fails
PSTSTEAMFAIQ*
1.00E-06 FR: 1E-6/hr
Failure to detect high temp. (due to increased boiling point)
GE_AQ_TEMP_Q
1.01E-02
Page 7
Failure to detect high temperature (steam interlock)
GE_TEM_INTLK_Q
1.01E-02
Page 8
failure to respond to alarms (shut off steam)
GE_CC_ALARM
1.64E-02
Page 6

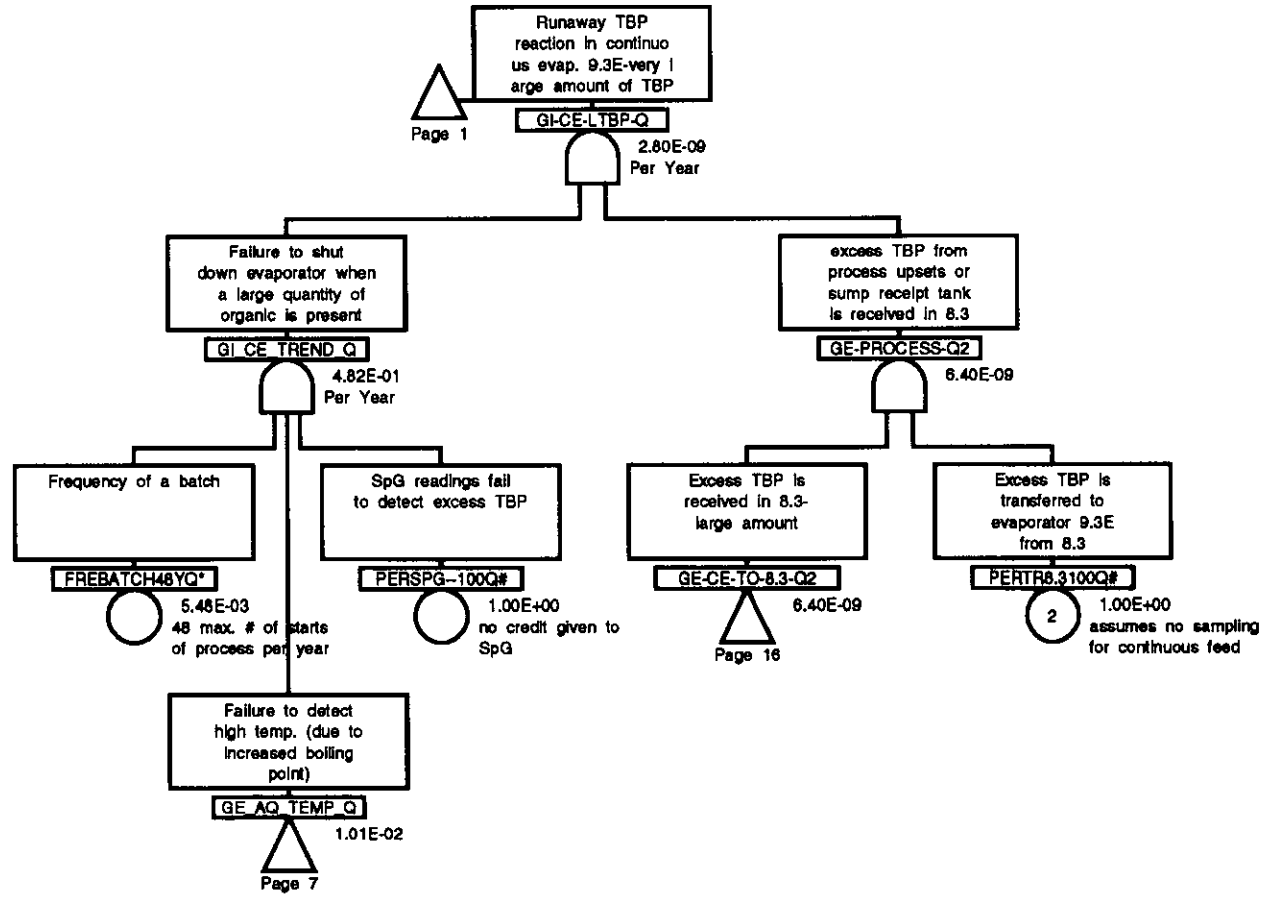

excess TBP in 8.3 is received in 9.3E
Page 1
GE-CE-IN-8.3-Q
1.89E-06
gradual build up of organic in 8.3 is transferred to 9.3E
GE-BUILDUP-Q
1.25E-07
excess TBP from process upsets or sump receipt tank is received in 8.3
GE-PROCESS-Q
1.76E-06
operator fails to feed remaining tank contents after 1st interval-clean tank
OPR83EM1ACNA#
5.00E-03
typical circumstances
operator fails to feed remaining tank contents after 3rd interval-clean tank
OPR83EM3ACNA#
5.00E-03
typical circumstances
Excess TBP is received in 8.3
GE-CE-TO-8.3-Q
1.76E-06
Page 11
Excess TBP is transferred to evaporator 9.3E from 8.3
PERTR8.3100Q#
2
1.00E+00
assumes no sampling for continuous feed
operator fails to feed remaining tank contents after 2nd interval-clean tank
OPR83EM2ACNA#
5.00E-03
typical circumstances
organic remains in feed tank
PER83ORG100A#
1.00E+00
no credit for feedin g tank contents down to adequate mixing

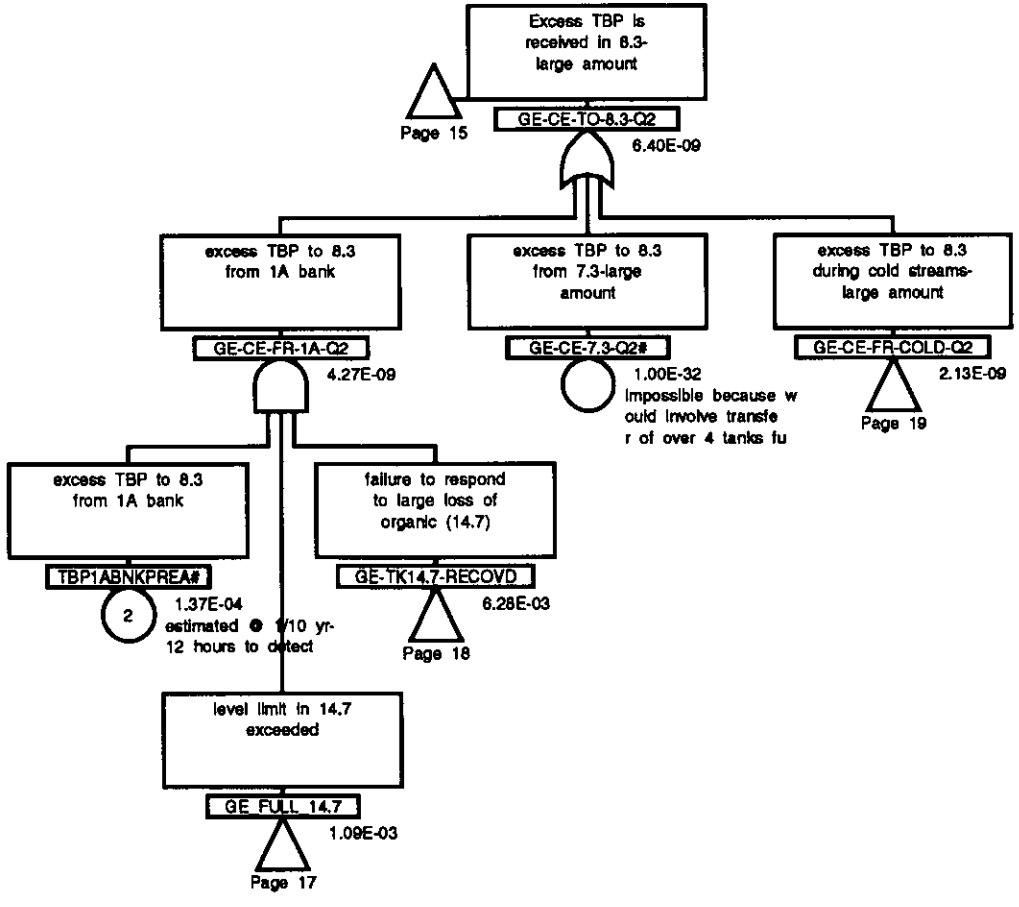

Excess TBP is received in 8.3
Page 10
GE-CE-TO-8.3-Q
1.76E-06
excess TBP to 8.3 from 1A bank
GE-CE-FR-1A-Q
8.43E-07
excess TBP to 8.3 from 7.3
GE-CE-FR-7.3-Q
5.00E-07
excess TBP to 8.3 during cold streams
GE-CE-FR-COLD-Q
4.21E-07
Page 13
failure to respond to large loss of organic (14.7)
GE-TK14.7-RECOV
6.15E-03
Page 12
excess TBP to 8.3 from 1A bank
TBP1ABNKPREA#
2
1.37E-04
estimated @ 1/10 yr-
12 hours to detect
Sufficient TBP present in tank 7.3
PERTK-73.20A#
2.00E-03
1 in 5 years (1500 batches)
transfer is from tank 7.3
PERFR7.3005Q#
5.00E-02
material received from 7.3 5% of transfers
Second consecutive transfer containing TBP from tank 7.3 is fed to same batch
OPRQ7.3-ACNA#
5.00E-03
sump receipt could n ot collect enough TB P during 1 feed tank
excess TBP is transferred from 7.3 to 8.3
PER73SMP100Q#
1.00E+00
no credit for sampling

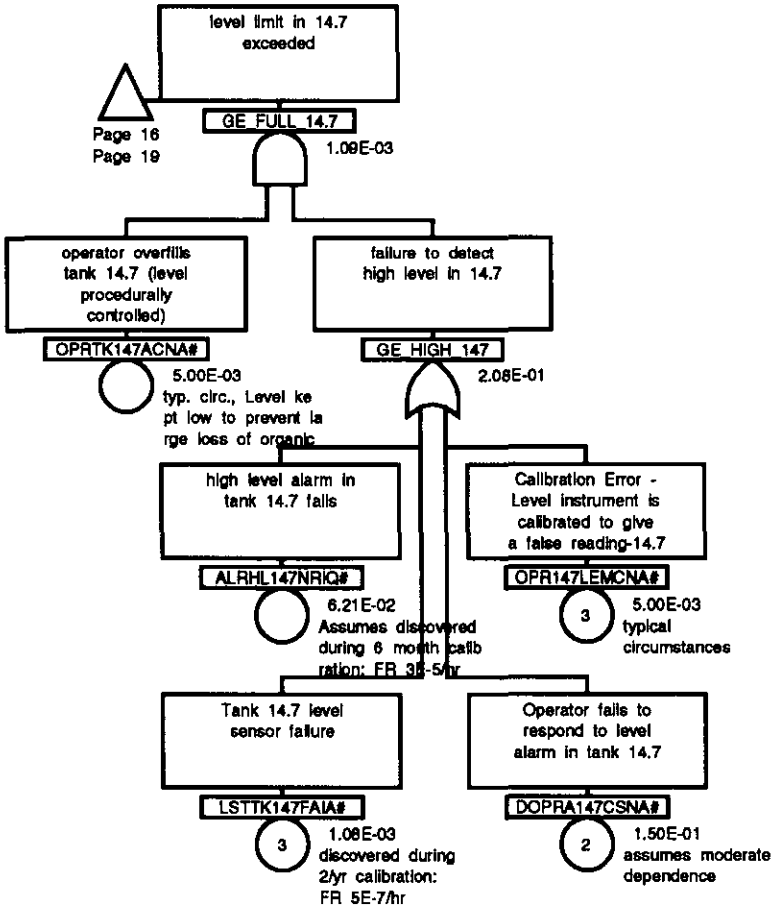

failure to respond to large loss of organic (14.7)
GE-TK14.7-RECOV
6.15E-03
Page 11
Page 13
Calibration Error - Level instrument is calibrated to give a false reading-14.7
OPR147LEMCNA#
3
5.00E-03
typical circumstances
Tank 14.7 level sensor failure
LSTTK147FAIA#
3
1.08E-03
discovered during 2/yr calibration: FR 5E-7/hr
failure to stop tank 14.7 pump
GE_PMP147_INTLK
7.21E-05
failure to stop 14.7 pump (protective relay fails)
RLPPUMP1NREQ#
2
1.00E-03
demand failure
failure of tank 14.7 level alarm
GE_147_ALARM
7.15E-02
Low level alarm in tank 14.7 fails
ALRTK147NRIQ#
2
6.21E-02
Assumes discovered during 6 month calib ration: FR 3E-5/hr
operator fails to respond to low level alarm in tank 14.7
OPRRA147CSNA#
1.00E-02
several competing signals

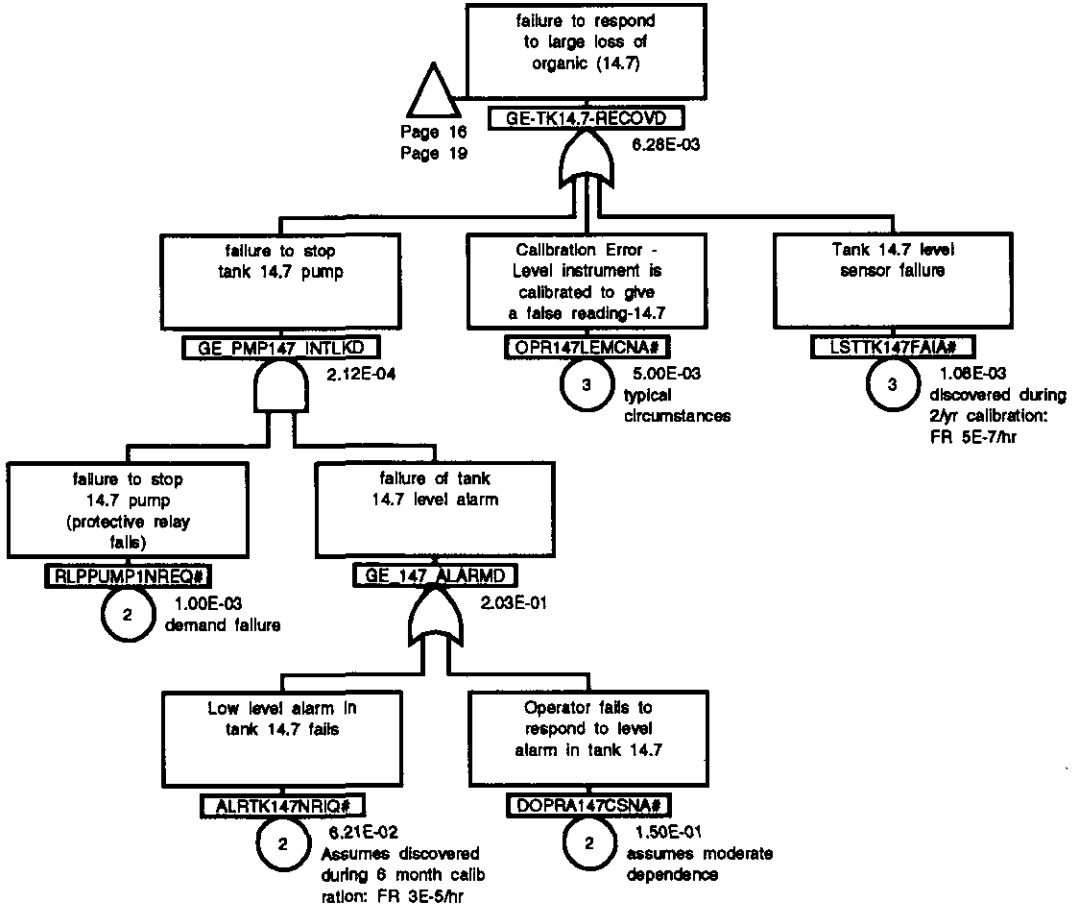

excess TBP to 8.3
during cold streams
Page 11
GE-CE-FR-COLD-Q
4.21E-07
failure to respond
to large loss of
organic (14.7)
process upset
during cold streams
GE-TK14.7-RECOV
6.15E-03
GE-CE-TBP-FR-Q
2.74E-04
Page 12
Page 14
cold streams sent
to 8.3
PERCOL83025Q#
2
2.50E-01
COG estimate

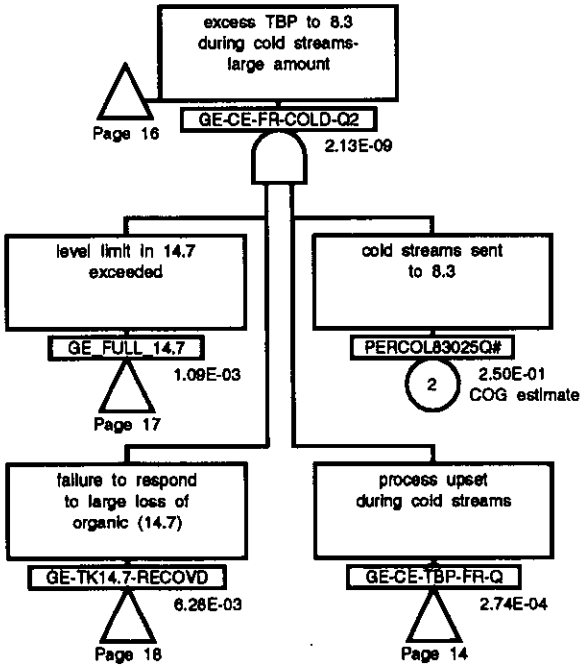

process upset
during cold streams
Page 13
Page 19
GE-CE-TBP-FR-Q
2.74E-04
process upset from
1BP during cold
streams
process upset from
1CU during cold
streams
TBP1BP--PREA#
TBP1CU--PREA#
1.37E-04
estimated @ 1/10 yr-
12 hours to detect
1.37E-04
estimated @ 1/10 yr-
12 hours to detect


Runaway TBP reaction in continuo us evap. 9.3E-very l arge amount of TBP
GI-CE-LTBP-Q
2.80E-09
Per Year
Page 1
Failure to shut down evaporator when a large quantity of organic is present
GI_CE_TREND_Q
4.82E-01
Per Year
excess TBP from process upsets or sump receipt tank is received in 8.3
GE-PROCESS-Q2
6.40E-09
Frequency of a batch
FREBATCH48YQ*
5.48E-03
48 max. # of starts of process per year
SpG readings fail to detect excess TBP
PERSPG--100Q#
1.00E+00
no credit given to SpG
Excess TBP is received in 8.3-large amount
GE-CE-TO-8.3-Q2
6.40E-09
Page 16
Excess TBP is transferred to evaporator 9.3E from 8.3
PERTR8.3100Q#
2
1.00E+00
assumes no sampling for continuous feed
Failure to detect high temp. (due to increased boiling point)
GE_AQ_TEMP_Q
1.01E-02
Page 7


Excess TBP is received in 8.3-large amount
Page 15
GE-CE-TO-8.3-Q2
6.40E-09
excess TBP to 8.3 from 1A bank
GE-CE-FR-1A-Q2
4.27E-09
excess TBP to 8.3 from 7.3-large amount
GE-CE-7.3-Q2#
1.00E-32
Impossible because w ould involve transfe r of over 4 tanks fu
excess TBP to 8.3 during cold streams-large amount
GE-CE-FR-COLD-Q2
2.13E-09
Page 19
excess TBP to 8.3 from 1A bank
TBP1ABNKPREA#
2
1.37E-04
estimated @ 1/10 yr-
12 hours to detect
failure to respond to large loss of organic (14.7)
GE-TK14.7-RECOVD
6.28E-03
Page 18
level limit in 14.7 exceeded
GE_FULL_14.7
1.09E-03
Page 17


level limit in 14.7 exceeded
GE_FULL 14.7
1.09E-03
Page 16
Page 19
operator overfills tank 14.7 (level procedurally controlled)
failure to detect high level in 14.7
OPRTK147ACNA#
5.00E-03
typ. circ., Level ke pt low to prevent la rge loss of organic
GE_HIGH_147
2.08E-01
high level alarm in tank 14.7 fails
Calibration Error - Level instrument is calibrated to give a false reading-14.7
ALRHL147NRIQ#
6.21E-02
Assumes discovered during 6 month calib ration: FR 3E-5/hr
OPR147LEMCNA#
3
5.00E-03
typical circumstances
Tank 14.7 level sensor failure
Operator fails to respond to level alarm in tank 14.7
LSTTK147FAIA#
3
1.08E-03
discovered during 2/yr calibration: FR 5E-7/hr
DOPRA147CSNA#
2
1.50E-01
assumes moderate dependence


failure to respond to large loss of organic (14.7)
Page 16
Page 19
GE-TK14.7-RECOVD
6.28E-03
failure to stop tank 14.7 pump
GE_PMP147_INTLKD
2.12E-04
Calibration Error - Level instrument is calibrated to give a false reading-14.7
OPR147LEMCNA#
3
5.00E-03
typical circumstances
Tank 14.7 level sensor failure
LSTTK147FAIA#
3
1.08E-03
discovered during 2/yr calibration: FR 5E-7/hr
failure to stop 14.7 pump (protective relay fails)
RLPPUMP1NREQ#
2
1.00E-03
demand failure
failure of tank 14.7 level alarm
GE_147_ALARMD
2.03E-01
Low level alarm in tank 14.7 fails
ALRTK147NRIQ#
2
6.21E-02
Assumes discovered during 6 month calib ration: FR 3E-5/hr
Operator fails to respond to level alarm in tank 14.7
DOPRA147CSNA#
2
1.50E-01
assumes moderate dependence


excess TBP to 8.3 during cold streams- large amount
Page 16
GE-CE-FR-COLD-Q2
2.13E-09
level limit in 14.7 exceeded
GE_FULL_14.7
1.09E-03
Page 17
cold streams sent to 8.3
PERCOL83025Q#
2
2.50E-01
COG estimate
failure to respond to large loss of organic (14.7)
GE-TK14.7-RECOVD
6.28E-03
Page 18
process upset during cold streams
GE-CE-TBP-FR-Q
2.74E-04
Page 14

Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone
ALR-TLG-COMG#	6		GE_AQ_TEMP_Q	1		GI_OPR_LVL_Q	3		RLPPUMP1NREQ#	12	
ALRHL147NRIQ#	17		GE_AQ_TEMP_Q	7		GI_PMP_OP_Q	2		RLPPUMP1NREQ#	18	
ALRTK147NRIQ#	12		GE_AQ_TEMP_Q	9		GU_INTLKS1_X	9		TBP1ABNKPREA#	11	
ALRTK147NRIQ#	18		GE_AQ_TEMP_Q	15		JPRFEED-RECQ*	1		TBP1ABNKPREA#	16	
CAVCESTMFOWQ#	5		GE_CC_ALARM	5		LST-CE--FAIQ#	4		TBP1BP--PREA#	14	
CAVCESTMFOWQ*	9		GE_CC_ALARM	6		LST-CE--FAIQ*	2		TBP1CU--PREA#	14	
DOPRA147CSNA#	17		GE_CC_ALARM	9		LSTCEHATFAIQ*	2		TSTCETE-FAIQ#	8	
DOPRA147CSNA#	18		GE_CE_INLK_Q	1		LSTLE-CECALQ*	3				
FRE-PMP-ADJQ+	2		GE_CE_INLK_Q	5		LSTTK147FAIA#	12				
FREBATCH48YQ*	15		GE_CE_INLK_Q	7		LSTTK147FAIA#	17				
GE-BUILDUP-Q	10		GE_FULL_14.7	16		LSTTK147FAIA#	18				
GE-CE-7.3-Q2#	16		GE_FULL_14.7	17		MDPTK8.3FRCQ*	2				
GE-CE-FR-1A-Q	11		GE_FULL_14.7	19		OPR147LEMCNA#	12				
GE-CE-FR-1A-Q2	16		GE_HIGH_147	17		OPR147LEMCNA#	17				
GE-CE-FR-7.3-Q	11		GE_LVL_INTLK_Q	1		OPR147LEMCNA#	18				
GE-CE-FR-COLD-Q	11		GE_LVL_INTLK_Q	4		OPR83EM1ACNA#	10				
GE-CE-FR-COLD-Q	13		GE_PMP147_INTLK	12		OPR83EM2ACNA#	10				
GE-CE-FR-COLD-Q2	16		GE_PMP147_INTLKD	18		OPR83EM3ACNA#	10				
GE-CE-FR-COLD-Q2	19		GE_TEM_INTLK_Q	7		OPRQ7.3-ACNA#	11				
GE-CE-IN-8.3-Q	1		GE_TEM_INTLK_Q	8		OPRQBLOCDENA#	6				
GE-CE-IN-8.3-Q	10		GE_TEM_INTLK_Q	9		OPRQCETEIRNA#	8				
GE-CE-TBP-FR-Q	13		GE_Y_LVL_INT_Q	1		OPRQELE-MCNA#	3				
GE-CE-TBP-FR-Q	14		GI-CE-HEAT-Q	1		OPRQELE-MCNA#	4				
GE-CE-TBP-FR-Q	19		GI-CE-LTBP-Q	1		OPRRA147CSNA#	12				
GE-CE-TO-8.3-Q	10		GI-CE-LTBP-Q	15		OPRTK147ACNA#	17				
GE-CE-TO-8.3-Q	11		GI-CE-STPB-Q	1		PER73SMP100Q#	11				
GE-CE-TO-8.3-Q2	15		GI-TOP-Q	1		PER83ORG100A#	10				
GE-CE-TO-8.3-Q2	16		GI_1Q	1		PER9.3OP013Q#	1				
GE-PROCESS-Q	10		GI_2Q	1		PERCOL83025Q#	13				
GE-PROCESS-Q2	15		GI_CE_LVL_Q	2		PERCOL83025Q#	19				
GE-TK14.7-RECOV	11		GI_CE_TREND_Q	15		PERFEEDF100Q#	1				
GE-TK14.7-RECOV	12		GI_CE_VALVE_Q	9		PERFLOW-100Q#	2				
GE-TK14.7-RECOV	13		GI_FEED_PMP_Q	1		PERFR7.3005Q#	11				
GE-TK14.7-RECOVD	16		GI_FEED_PMP_Q	2		PERSPG--100Q#	15				
GE-TK14.7-RECOVD	18		GI_HEAT1_CTRL1_Q	1		PERTK-73.20A#	11				
GE-TK14.7-RECOVD	19		GI_HEAT1_CTRL1_Q	9		PERTR8.3100Q#	10				
GE_147_ALARM	12		GI_MIS_PRE_Q	9		PERTR8.3100Q#	15				
GE_147_ALARMD	18		GI_OPR_LVL_Q	2		PSTSTEAMFAIQ*	9				

Cutset Report for 9.3E Evaporator

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	GI-TOP-Q					2.18E-07	
1.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	7.80E-08	100.0
	OPR147LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading-14.7	1	1N 5.0E-3 N	5.00E-03N		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1ABNKPREA#	excess TBP to 8.3 from 1A bank	3	12H 0.1Y	1.37E-04		
2.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	5.69E-08	100.0
	OPRQ7.3-ACNA#	Second consecutive transfer containing TBP from tank 7.3 is fed to same batch	1	1N 5.0E-3 N	5.00E-03N		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER73SMP100Q#	excess TBP is transferred from 7.3 to 8.3	1	1N 1.00E+00N	1.00E+00N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERFR7.3005Q#	transfer is from tank 7.3	1	1N 5.00E-02N	5.00E-02N		
	PERTK-73.20A#	Sufficient TBP present in tank 7.3	1	1N 2.00E-03N	2.00E-03N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
3.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	1.95E-08	100.0
	OPR147LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading-14.7	1	1N 5.0E-3 N	5.00E-03N		

Cutset Report for 9.3E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERCOL83025Q#	cold streams sent to 8.3	1	1N 2.50E-01N	2.50E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1BP--PREA#	process upset from 1BP during cold streams	3	12H 0.1Y	1.37E-04		
4.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	1.95E-08	100.0
	OPR147LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading-14.7	1	1N 5.0E-3 N	5.00E-03N		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERCOL83025Q#	cold streams sent to 8.3	1	1N 2.50E-01N	2.50E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1CU--PREA#	process upset from 1CU during cold streams	3	12H 0.1Y	1.37E-04		
5.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	1.68E-08	100.0
	LSTTK147FAIA#	Tank 14.7 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		

Cutset Report for 9.3E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1ABNKPREA#	excess TBP to 8.3 from 1A bank	3	12H 0.1Y	1.37E-04		
6.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	1.42E-08	100.0
	OPR83EM1ACNA#	operator fails to feed remaining tank contents after 1st interval-clean tank	1	1N 5.0E-3 N	5.00E-03N		
	OPR83EM2ACNA#	operator fails to feed remaining tank contents after 2nd interval-clean tank	1	1N 5.0E-3 N	5.00E-03N		
	OPR83EM3ACNA#	operator fails to feed remaining tank contents after 3rd interval-clean tank	1	1N 5.0E-3 N	5.00E-03N		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER83ORG100A#	organic remains in feed tank	1	1N 1.00E+00N	1.00E+00N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
7.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	4.21E-09	100.0
	LSTTK147FAIA#	Tank 14.7 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERCOL83025Q#	cold streams sent to 8.3	1	1N 2.50E-01N	2.50E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		

Cutset Report for 9.3E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	TBP1CU--PREA#	process upset from 1CU during cold streams	3	12H 0.1Y	1.37E-04		
8.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	4.21E-09	100.0
	LSTTK147FAIA#	Tank 14.7 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERCOL83025Q#	cold streams sent to 8.3	1	1N 2.50E-01N	2.50E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1BP--PREA#	process upset from 1BP during cold streams	3	12H 0.1Y	1.37E-04		
9.	FREBATCH48YQ*	Frequency of a batch	1	1H 48Y	5.48E-03	1.63E-09	100.0
	OPR147LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading-14.7	1	1N 5.0E-3 N	5.00E-03N		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRTK147ACNA#	operator overfills tank 14.7 (level procedurally controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PERSPG--100Q#	SpG readings fail to detect excess TBP	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1ABNKPREA#	excess TBP to 8.3 from 1A bank	3	12H 0.1Y	1.37E-04		
10.	ALRTK147NRIQ#	Low level alarm in tank 14.7 fails	5	6M 3.00E-05 H	6.21E-02	9.69E-10	100.0
	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		

Cutset Report for 9.3E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	RLPPUMP1NREQ#	failure to stop 14.7 pump (protective relay fails)	1	1N 1E-3N	1.00E-03N		
	TBP1ABNKPREA#	excess TBP to 8.3 from 1A bank	3	12H 0.1Y	1.37E-04		
11.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	7.49E-10	100.0
	OPR147LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading-14.7	1	1N 5.0E-3 N	5.00E-03N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1ABNKPREA#	excess TBP to 8.3 from 1A bank	3	12H 0.1Y	1.37E-04		
	TSTCETE-FAIQ#	Continous Evaporator Temperature Sensor Has Failed	3	4D 1.00E-06 H	9.60E-05		
12.	FRE-PMP-ADJQ+	Pump speed is adjusted	4	.25H 4H	5.00E-01	5.47E-10	100.0
	OPRQ7.3-ACNA#	Second consecutive transfer containing TBP from tank 7.3 is fed to same batch	1	1N 5.0E-3 N	5.00E-03N		
	OPRQELE-MCNA#	Calibration Error - Level Instrument is calibrated to give a high signal	1	1N 5.0E-3 N	5.00E-03N		
	PER73SMP100Q#	excess TBP is transferred from 7.3 to 8.3	1	1N 1.00E+00N	1.00E+00N		
	PER9.3OP013Q#	continuous evaporator 9.3E is in operation	1	1N 1.30E-01N	1.30E-01N		
	PERFEEDF100Q#	low feed flow is not detected or corrected	1	1N 1.00E+00N	1.00E+00N		
	PERFLOW-100Q#	pump speed is set too low	1	1N 1.00E+00N	1.00E+00N		
	PERFR7.3005Q#	transfer is from tank 7.3	1	1N 5.00E-02N	5.00E-02N		

Cutset Report for 9.3E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	PERTK-73.20A#	Sufficient TBP present in tank 7.3	1	1N 2.00E-03N	2.00E-03N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TSTCETE-FAIQ#	Continous Evaporator Temperature Sensor Has Failed	3	4D 1.00E-06 H	9.60E-05		
13.	FREBATCH48YQ*	Frequency of a batch	1	1H 48Y	5.48E-03	4.09E-10	100.0
	OPR147LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading-14.7	1	1N 5.0E-3 N	5.00E-03N		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRTK147ACNA#	operator overfills tank 14.7 (level procedurally controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PERCOL83025Q#	cold streams sent to 8.3	1	1N 2.50E-01N	2.50E-01N		
	PERSPG--100Q#	SpG readings fail to detect excess TBP	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1BP--PREA#	process upset from 1BP during cold streams	3	12H 0.1Y	1.37E-04		
14.	FREBATCH48YQ*	Frequency of a batch	1	1H 48Y	5.48E-03	4.09E-10	100.0
	OPR147LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading-14.7	1	1N 5.0E-3 N	5.00E-03N		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		
	OPRTK147ACNA#	operator overfills tank 14.7 (level procedurally controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PERCOL83025Q#	cold streams sent to 8.3	1	1N 2.50E-01N	2.50E-01N		
	PERSPG--100Q#	SpG readings fail to detect excess TBP	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1CU--PREA#	process upset from 1CU during cold streams	3	12H 0.1Y	1.37E-04		
15.	FREBATCH48YQ*	Frequency of a batch	1	1H 48Y	5.48E-03	3.53E-10	100.0
	LSTTK147FAIA#	Tank 14.7 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRQCETEIRNA#	Evaporator Temperature Sensor is Out of Calibration	1	1N 1.0E-2 N	1.00E-02N		

Cutset Report for 9.3E Evaporator (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	OPRTK147ACNA#	operator overfills tank 14.7 (level procedurally controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PERSPG--100Q#	SpG readings fail to detect excess TBP	1	1N 1.00E+00N	1.00E+00N		
	PERTR8.3100Q#	Excess TBP is transferred to evaporator 9.3E from 8.3	1	1N 1.00E+00N	1.00E+00N		
	TBP1ABNKPREA#	excess TBP to 8.3 from 1A bank	3	12H 0.1Y	1.37E-04		

Basic Event Data for 9.3E Evaporator

Event	C	Input	Calc.	Description	Source
ALR-TLG-COMG#	5	6M 3.00E-06H	6.45E-03	Common cause evaporator alarm failure (level, temperature)	single alarm failure * 0.1 beta factor
ALRHL147NRIQ#	5	6M 3.00E-05 H	6.21E-02	high level alarm in tank 14.7 fails	Assumes discovered during 6 month calibration: FR 3E-5/hr
ALRTK147NRIQ#	5	6M 3.00E-05 H	6.21E-02	Low level alarm in tank 14.7 fails	Assumes discovered during 6 month calibration: FR 3E-5/hr
CAVCESTMFOWQ#	5	2H 3.00E-06 H	3.00E-06	Pneumatic steam control valve fails open	2 hours to restore, round sheet every hour: FR 3E-6/hr
CAVCESTMFOWQ*	1	1H 3.00E-06 H	3.00E-06	Pneumatic steam control valve fails open	FR 3E-6/hr
DOPRA147CSNA#		0.15N	1.50E-01	Operator fails to respond to level alarm in tank 14.7	assumes moderate dependence
FRE-PMP-ADJQ+	4	.25H 4H	5.00E-01	Pump speed is adjusted	COG: Adjusted 4 times per hour, discovered within 15 minutes
FREBATCH48YQ*	1	1H 48Y	5.48E-03	Frequency of a batch	48 max. # of starts of process per year
GE-CE-7.3-Q2#		1E-32N	1.00E-32	excess TBP to 8.3 from 7.3-large amount	impossible because would involve transfer of over 4 tanks full
JPRFEED-RECQ*	1	1H 1.00E-08 H	1.00E-08	Large leak in jumper causes failure to feed evaporator	FR: 1E-8/hr
LST-CE--FAIQ#	5	8H 5.00E-07 H	2.00E-06	Continous evaporator level instrument fails high	Assume 8 hours for repair: FR 5E-7/hr
LST-CE--FAIQ*	1	1H 5.00E-07 H	5.00E-07	Continous evaporator level instrument fails high	FR: 5E-7/hr
LSTCEHATFAIQ*	1	1H 5.00E-07 H	5.00E-07	Level instrument in hackman hat fails high	FR: 5E-7/hr
LSTLE-CECALQ*	1	1H 2Y	2.28E-04	Frequency of continous evaporator level instrumentation calibration	calibrated 2/yr
LSTTK147FAIA#	5	6M 5.00E-07 H	1.08E-03	Tank 14.7 level sensor failure	discovered during 2/yr calibration: FR 5E-7/hr
MDPTK8.3FRCQ*	1	1H 1.00E-04 H	1.00E-04	Continous evaporator feed pump fails	FR: 1E-4/hr
OPR147LEMCNA#	1	1N 5.0E-3 N	5.00E-03N	Calibration Error - Level instrument is calibrated to give a false reading-14.7	typical circumstances
OPR83EM1ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents after 1st interval-clean tank	typical circumstances
OPR83EM2ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents after 2nd interval-clean tank	typical circumstances
OPR83EM3ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents after 3rd interval-clean tank	typical circumstances
OPRQ7.3-ACNA#	1	1N 5.0E-3 N	5.00E-03N	Second consecutive transfer containing TBP from tank 7.3 is fed to same batch	sump receipt could not collect enough TBP during 1 feed tank run time
OPRQBLOCDENA#	1	1N 1.0E-2 N	1.00E-02N	operator fails to respond to 9.3E temp, level alarms (close block valve)	knowledge based, 10 to 30 minutes
OPRQCETEIRNA#	1	1N 1.0E-2 N	1.00E-02N	Evaporator Temperature Sensor is Out of Calibration	good display (graph)

Basic Event Data for 9.3E Evaporator (CONT.)

Event	C	Input	Calc.	Description	Source
OPRQELE-MCNA#	1	1N 5.0E-3 N	5.00E-03N	Calibration Error - Level Instrument is calibrated to give a high signal	typical circumstances
OPRRA147CSNA#	1	1N 1E-2N	1.00E-02N	operator fails to respond to low level alarm in tank 14.7	several competing signals
OPRTK147ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator overfills tank 14.7 (level procedurally controlled)	typ. circ., Level kept low to prevent large loss of organic
PER73SMP100Q#	1	1N 1.00E+00N	1.00E+00N	excess TBP is transferred from 7.3 to 8.3	no credit for sampling
PER83ORG100A#	1	1N 1.00E+00N	1.00E+00N	organic remains in feed tank	no credit for feeding tank contents down to adequate mixing point
PER9.3OP013Q#	1	1N 1.30E-01N	1.30E-01N	continuous evaporator 9.3E is in operation	operated 4 days/month (2.5 hot & 1.5 cold)
PERCOL83025Q#	1	1N 2.50E-01N	2.50E-01N	cold streams sent to 8.3	COG estimate
PERFEEDF100Q#	1	1N 1.00E+00N	1.00E+00N	low feed flow is not detected or corrected	no credit hackman hat level
PERFLOW-100Q#	1	1N 1.00E+00N	1.00E+00N	pump speed is set too low	no credit for adjusting low flow
PERFR7.3005Q#	1	1N 5.00E-02N	5.00E-02N	transfer is from tank 7.3	material received from 7.3 5% of transfers
PERSPG--100Q#	1	1N 1.00E+00N	1.00E+00N	SpG readings fail to detect excess TBP	no credit given to SpG
PERTK-73.20A#	1	1N 2.00E-03N	2.00E-03N	Sufficient TBP present in tank 7.3	1 in 5 years (1/500 batches)
PERTR8.3100Q#	1	1N 1.00E+00N	1.00E+00N	Excess TBP is transferred to evaporator 9.3E from 8.3	assumes no sampling for continuous feed
PSTSTEAMFAIQ*	1	1H 1.00E-06 H	1.00E-06	Steam pressure switch fails	FR: 1E-6/hr
RLPPUMP1NREQ#	1	1N 1E-3N	1.00E-03N	failure to stop 14.7 pump (protective relay fails)	demand failure
TBP1ABNKPREA#	3	12H 0.1Y	1.37E-04	excess TBP to 8.3 from 1A bank	estimated @ 1/10 yr- 12 hours to detect
TBP1BP--PREA#	3	12H 0.1Y	1.37E-04	process upset from 1BP during cold streams	estimated @ 1/10 yr- 12 hours to detect
TBP1CU--PREA#	3	12H 0.1Y	1.37E-04	process upset from 1CU during cold streams	estimated @ 1/10 yr- 12 hours to detect
TSTCETE-FAIQ#	3	4D 1.00E-06 H	9.60E-05	Continous Evaporator Temperature Sensor Has Failed	Assumes Discovered at next run (4 days): FR 1E-6/hr

Type Code Data for 9.3E Evaporator

Type Code	Rate	Description	Source	EF	D
ALR COM	3.00E-06H	common cause alarm failure (single * 0.1 beta factor)	WSRC-TR-93-262, ALR-NR-I * 0.1 beta factor for common cause	10	L
ALR NRI	3.00E-05 H	Alarm/Annunciator, Fails to alarm (Instr. & Control)	WSRC-TR-93-262, ALR-NR-I	10	L
CAV FOW	3.00E-06 H	Valve (Control), Air-Operated, Fails open (Water)	WSRC-TR-93-262, CAV-FO-W	10	L
FRE 48Y	48Y	frequency of a batch	operations personnel		
FRE ADJ	4H	Speed of Feed Pump Adjusted 3 Times per shift	Operations personnel		
JPR REC	1.00E-08 H	Jumper, Rupture (external) (Chemical)	WSRC-TR-93-262, JPR-RE-C	30	L
LST CAL	2Y	level instrument calibration	operations personnel		
LST FAI	5.00E-07 H	Sensor/Transmitter/, Transducer/Proc. Switch, Level, Failure (Instr. & Control)	WSRC-TR-93-262, LST-FA-I	3	L
MDP FRC	1.00E-04 H	Pump, Motor-Driven, Fails to run (Chemical)	WSRC-TR-93-262, MDP-FR-C	10	L
OPR ACN	5.0E-3 N	Failure of Administrative Control (Nominal)	WSRC-TR-93-581, Table 4, Item 1, Nominal	10	L
OPR CSN	1E-2N	failure to respond to compelling signal (nominal)	WSRC-TR-93-581, Table 4, Item 2, Nominal		
OPR DEN	1.0E-2 N	Diagnosis error (Nominal)	WSRC-TR-93-581, Table 4, Item 30, Nominal	5	L
OPR IRN	1.0E-2 N	Incorrect reading or recording of data (Nominal)	WSRC-TR-93-581, Table 4, Item 11, Nominal	5	L
OPR MCN	5.0E-3 N	Miscalibration (Nominal)	WSRC-TR-93-581, Table 4, Item 12, Nominal	10	L
PER .20	2.00E-03N	0.2% chance			
PER 005	5.00E-02N	5% chance			
PER 013	1.30E-01N	13% chance			
PER 025	2.50E-01N	25% chance			
PER 100	1.00E+00N	100% chance			
PST FAI	1.00E-06 H	Sensor/Transmitter/, Transducer/Proc. Sw., Press., Failure (Instr. & Control)	WSRC-TR-93-262, PST-FA-I	3	L
RLP NRE	1E-3N	Relay, protective,fails to open/close	WSRC-TR-93-262,RLE-NR-E	10	1
TBP PRE	0.1Y	Process upset causes excess organic in feed	Never Seen, Estimated as Once in Ten Years		
TST FAI	1.00E-06 H	Sensor/Transmitter/, Transducer/Proc. Switch, Temp., Failure (Instr. & Control)	WSRC-TR-93-262, TST-FA-I	3	L

APPENDIX F - 7.6E & 7.7 EVAPORATOR FAULT TREE AND DATA

The following abbreviations appear on the fault tree print out and in the basic event file for the fault tree:

FR=Failure Rate

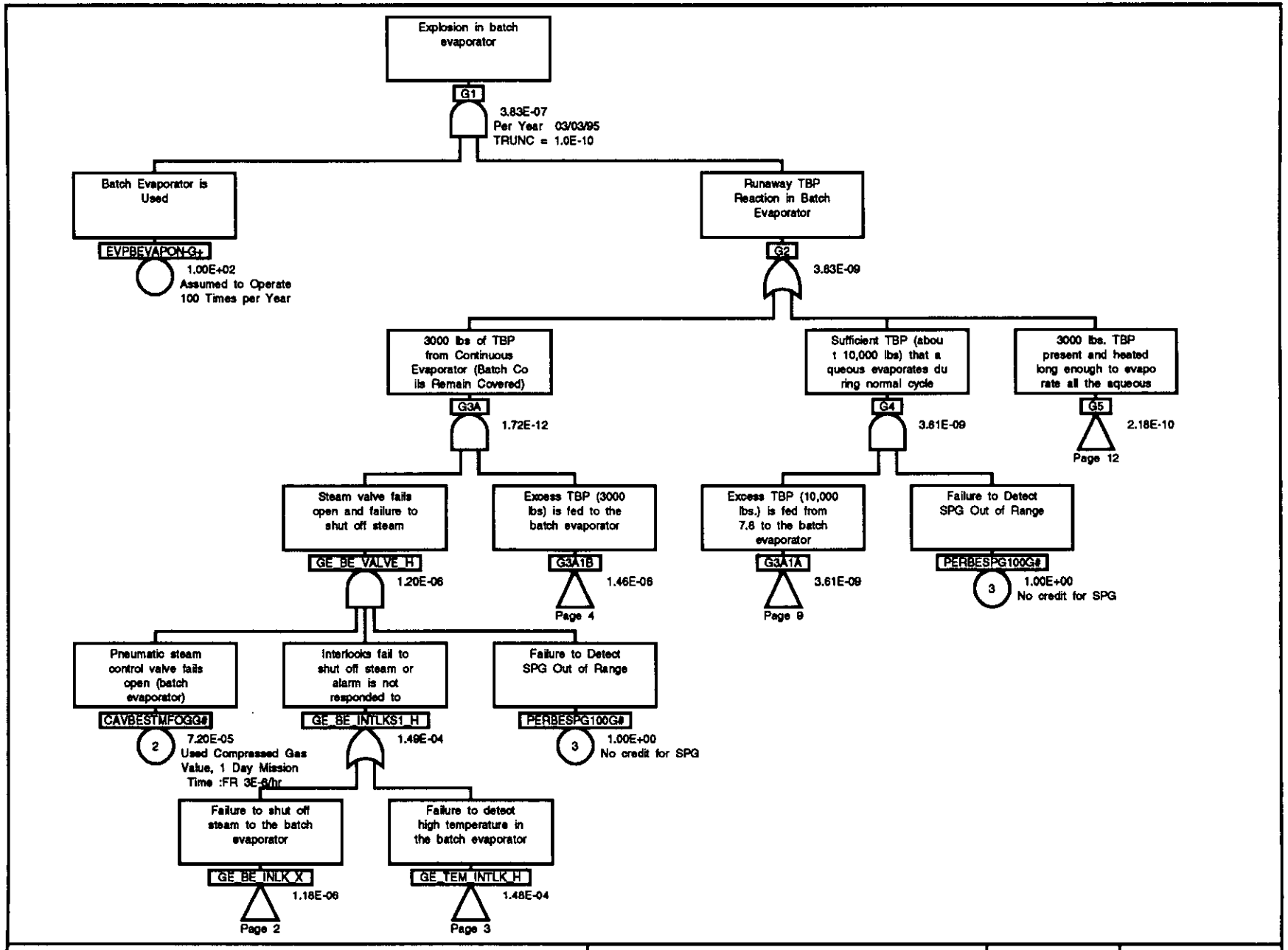
a: = assumption

COG= cognizant engineer estimate/information

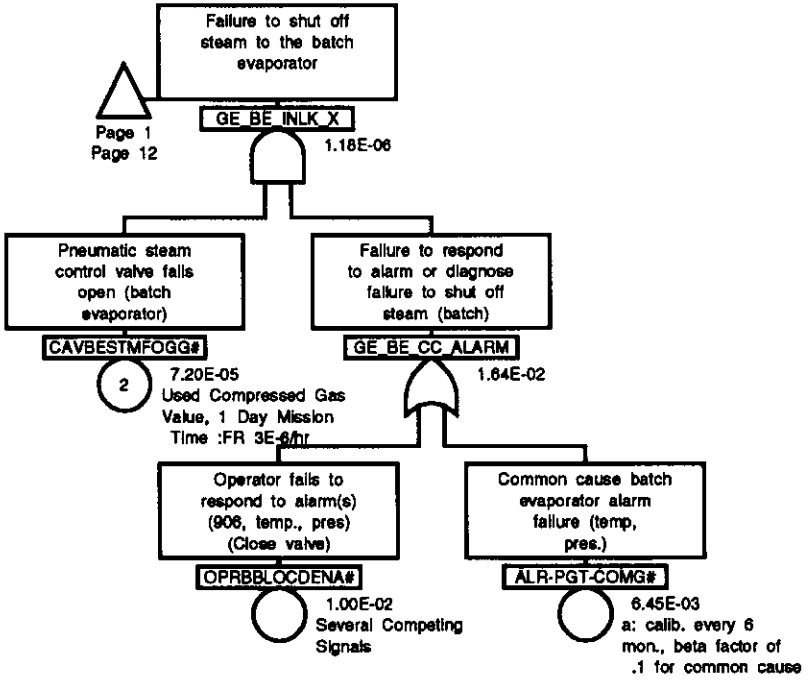
TRUNC= Truncation limit of cutset evaluator

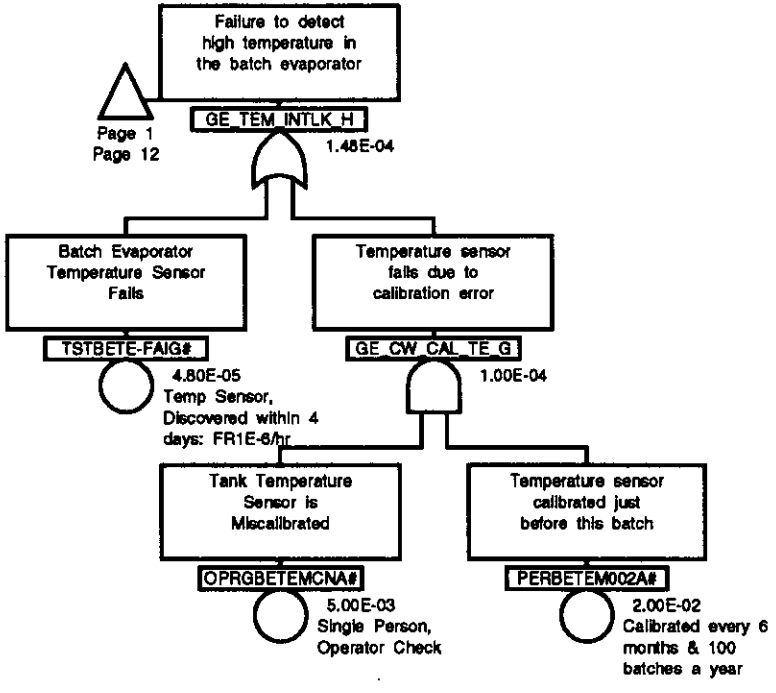
The Beta Factor method used to estimate common cause alarm failure is explained in Reference 15.

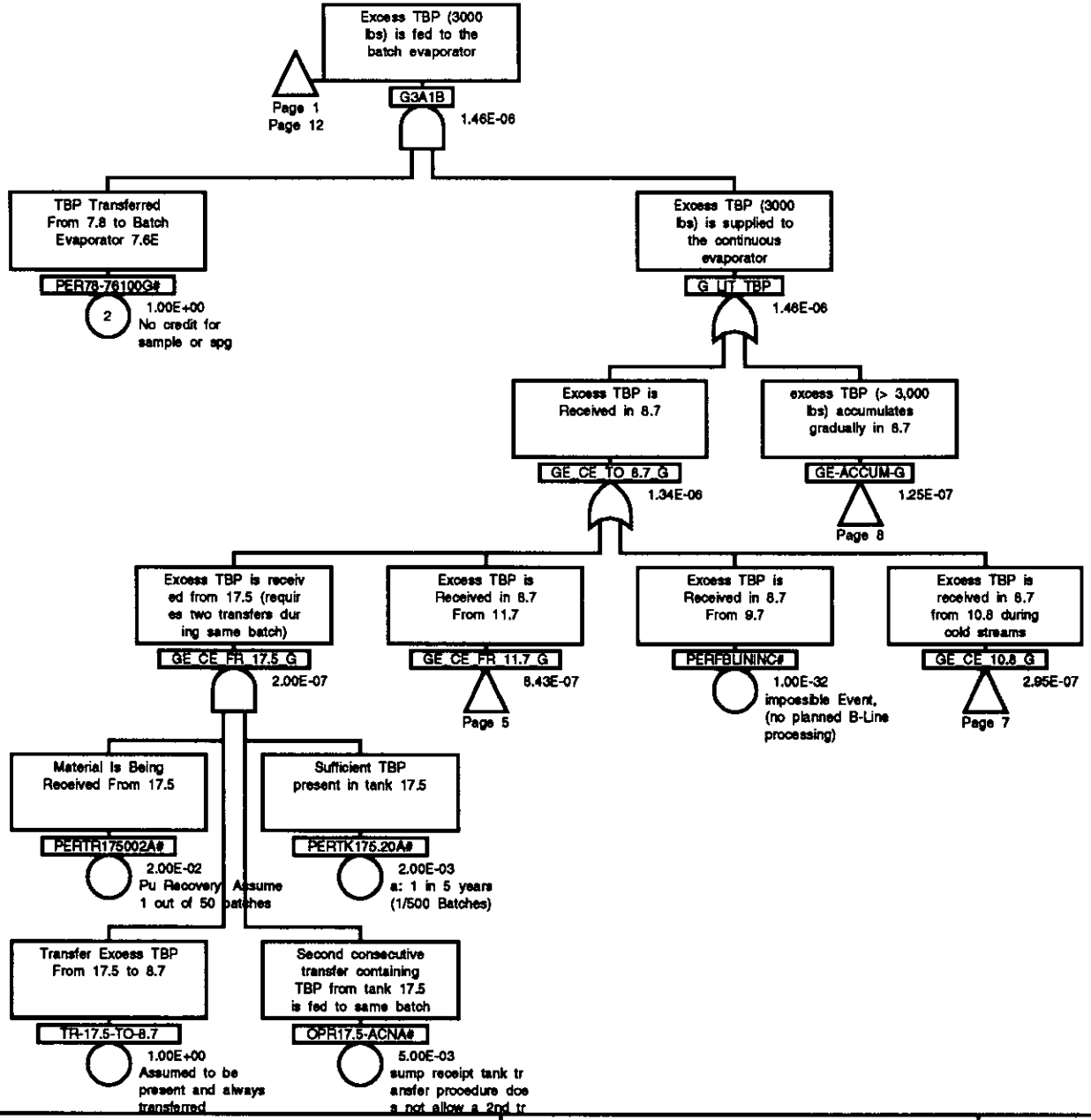
NOTE: Events in this tree with a probability of "1E-32" are incredible. They do not contribute to the top event frequency and were included only to show that they had been considered. The number "1E-32" was used because it is the smallest number CAFTA is capable of handling.



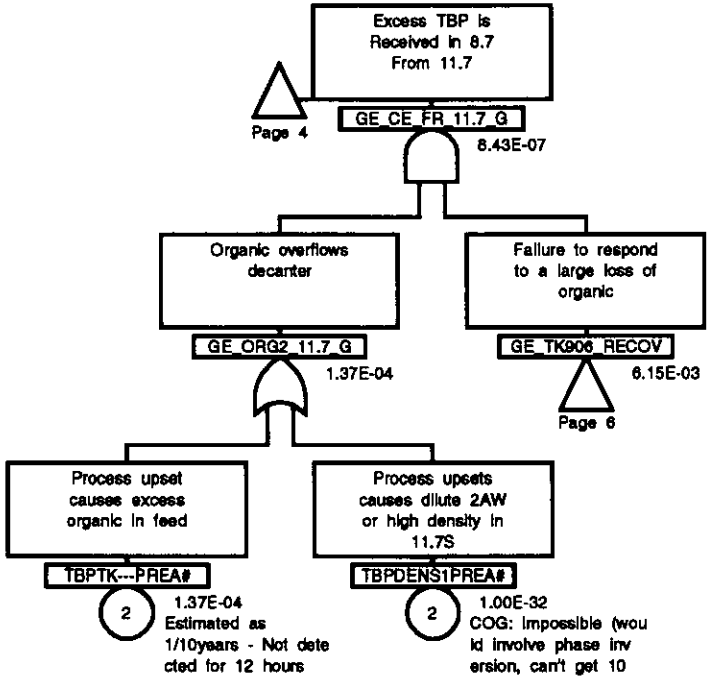
Runaway TBP Rxn in F Batch Evaporators	C:\CAFTA\REDOIL\SCI76B.CAF	3-14-95	Page 1

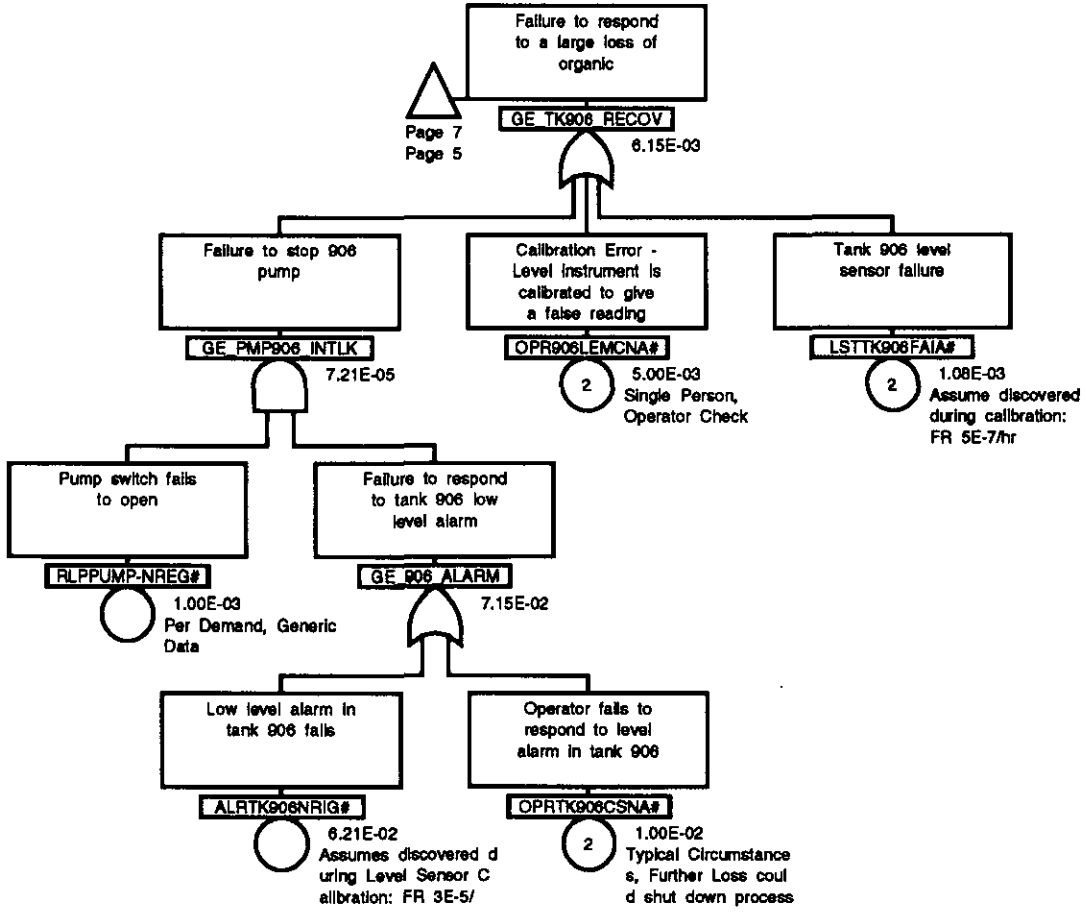

Failure to shut off steam to the batch evaporator
GE_BE_INLK_X
1.18E-06
Page 1
Page 12
Pneumatic steam control valve fails open (batch evaporator)
CAVBESTMFOGG#
2
7.20E-05
Used Compressed Gas Value, 1 Day Mission Time :FR 3E-6/hr
Failure to respond to alarm or diagnose failure to shut off steam (batch)
GE_BE_CC_ALARM
1.64E-02
Operator fails to respond to alarm(s) (906, temp., pres) (Close valve)
OPRBBLOCDENA#
1.00E-02
Several Competing Signals
Common cause batch evaporator alarm failure (temp, pres.)
ALR-PGT-COMG#
6.45E-03
a: calib. every 6 mon., beta factor of .1 for common cause

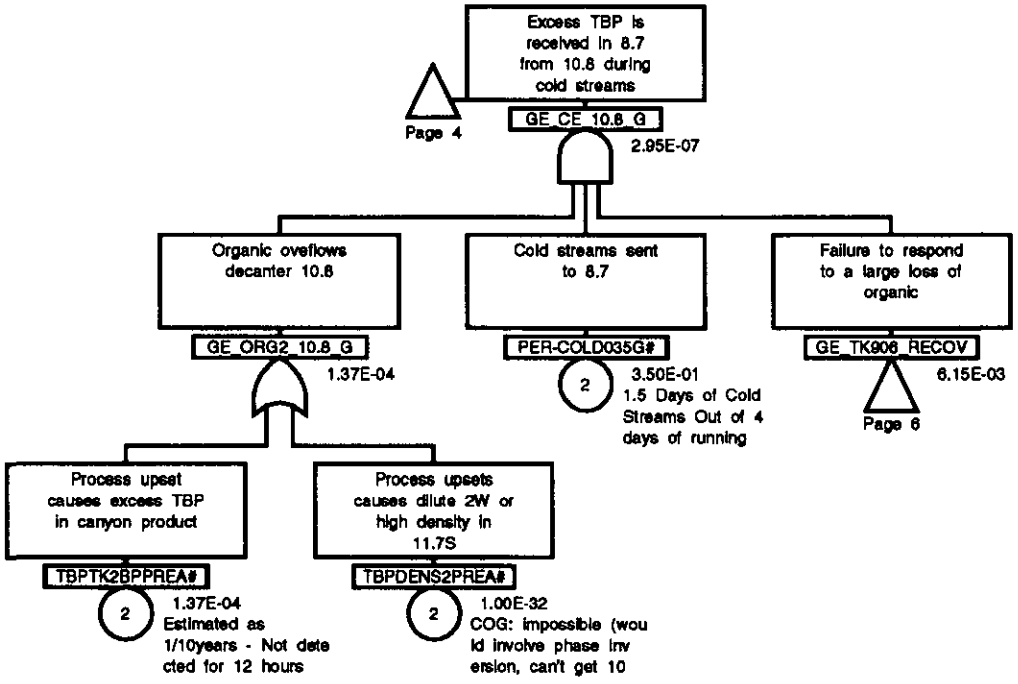

Failure to detect high temperature in the batch evaporator
GE_TEM_INTLK_H
1.48E-04
Page 1
Page 12
Batch Evaporator Temperature Sensor Fails
Temperature sensor fails due to calibration error
TSTBETE-FAIG#
4.80E-05
Temp Sensor, Discovered within 4 days: FR1E-6/hr
GE_CW_CAL_TE_G
1.00E-04
Tank Temperature Sensor is Miscalibrated
Temperature sensor calibrated just before this batch
OPRGBETEMCNA#
5.00E-03
Single Person, Operator Check
PERBETEM002A#
2.00E-02
Calibrated every 6 months & 100 batches a year



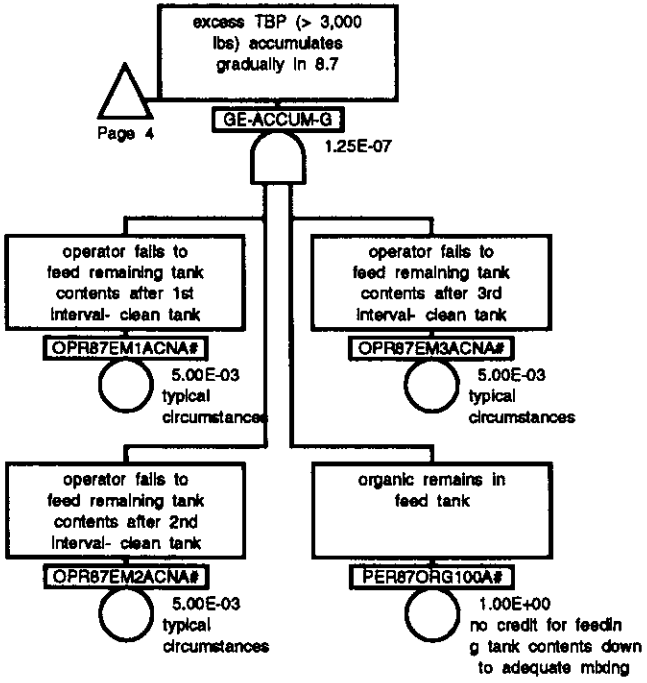
Runaway TBP Rxn in F Batch Evaporators	C:\CAFTA\REDOIL\SCI76B.CAF	3-14-95	Page 4

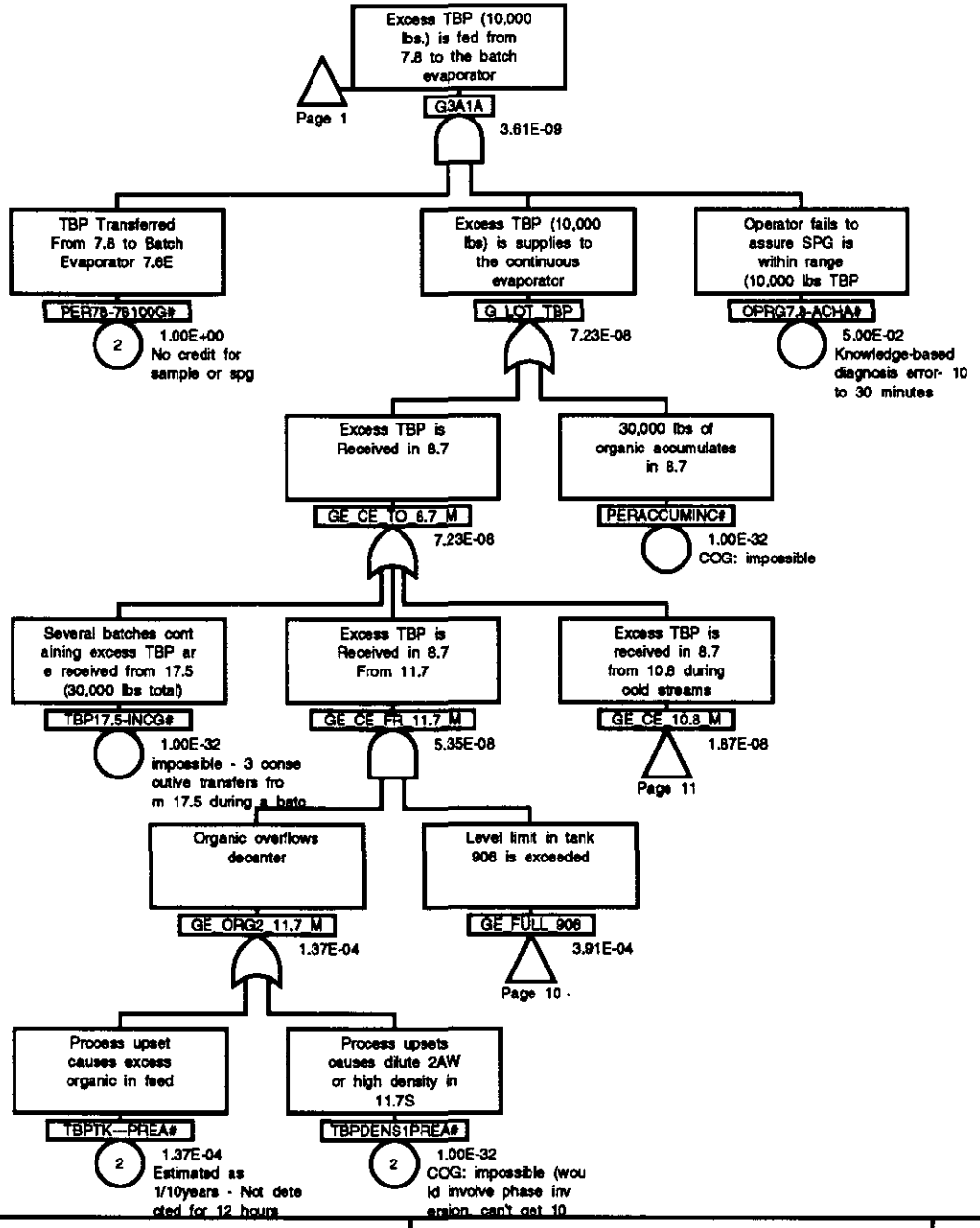

Excess TBP is Received in 8.7 From 11.7
Page 4
GE_CE_FR_11.7_G
8.43E-07
Organic overflows decanter
Failure to respond to a large loss of organic
GE_ORG2_11.7_G
1.37E-04
GE_TK906_RECOV
6.15E-03
Page 6
Process upset causes excess organic in feed
Process upsets causes dilute 2AW or high density in 11.7S
TBPTK---PREA#
TBPDENS1PREA#
2
1.37E-04
Estimated as 1/10years - Not dete cted for 12 hours
2
1.00E-32
COG: Impossible (wou ld involve phase inv ersion, can't get 10

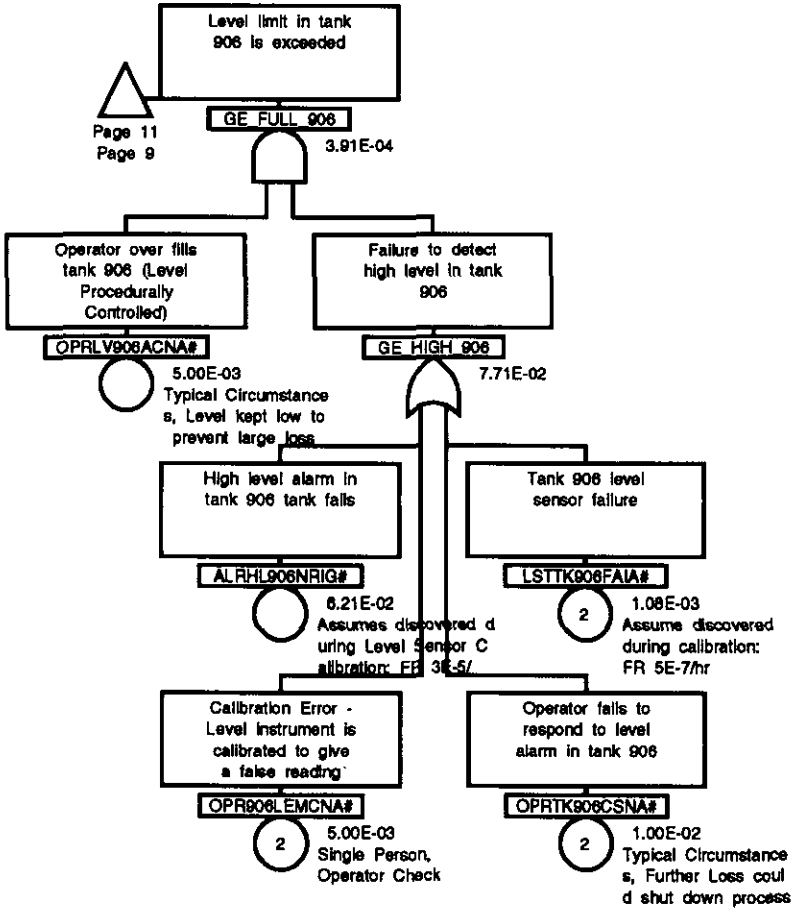

Failure to respond to a large loss of organic
GE_TK906_RECOV
6.15E-03
Page 7
Page 5
Failure to stop 906 pump
GE_PMP906_INTLK
7.21E-05
Calibration Error - Level Instrument is calibrated to give a false reading
OPR906LEMCNA#
2
5.00E-03
Single Person, Operator Check
Tank 906 level sensor failure
LSTTK906FAIA#
2
1.08E-03
Assume discovered during calibration: FR 5E-7/hr
Pump switch fails to open
RLPPUMP-NREG#
1.00E-03
Per Demand, Generic Data
Failure to respond to tank 906 low level alarm
GE_906_ALARM
7.15E-02
Low level alarm in tank 906 fails
ALRTK906NRIG#
6.21E-02
Assumes discovered during Level Sensor Calibration: FR 3E-5/
Operator fails to respond to level alarm in tank 906
OPRTK906CSNA#
2
1.00E-02
Typical Circumstances, Further Loss could shut down process

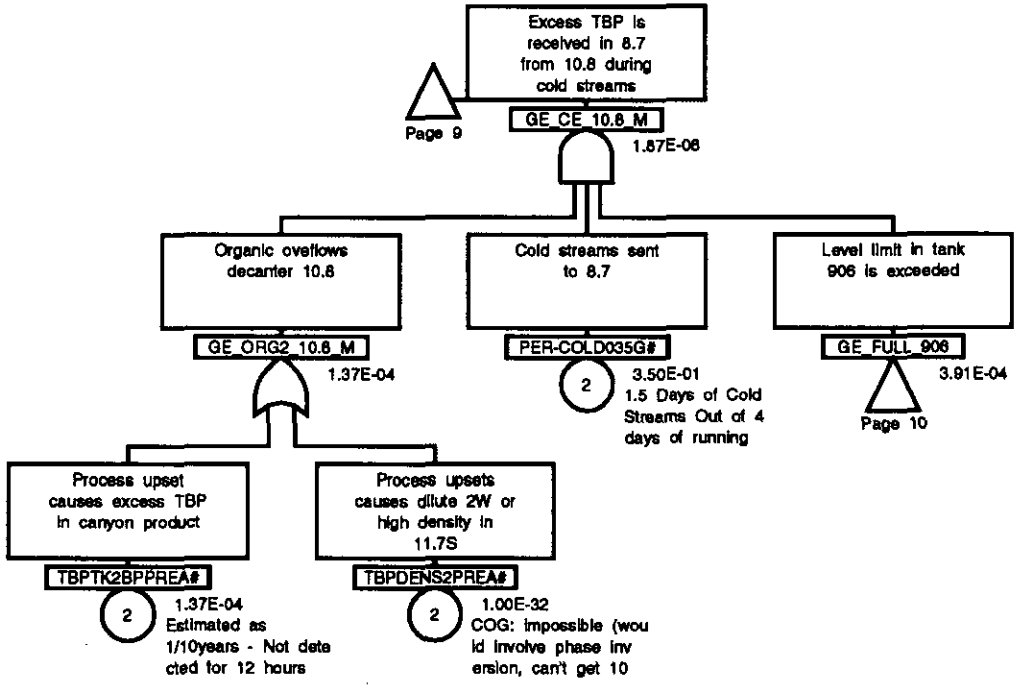


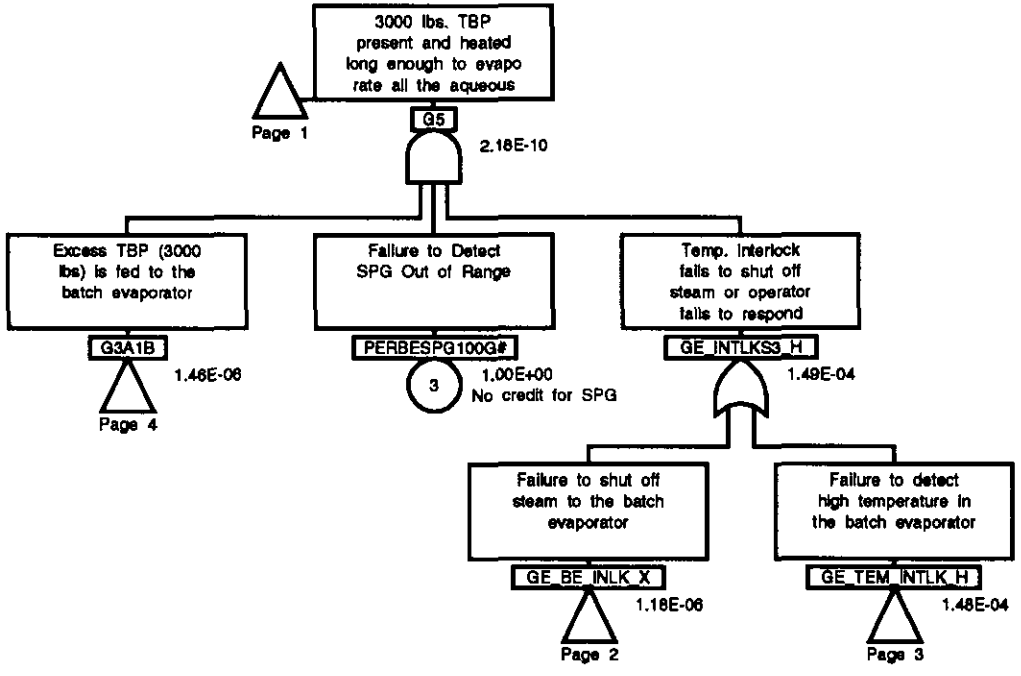
Runaway TBP Rxn in F Batch Evaporators	C:\CAFTA\REDOIL\SCI76B.CAF	3-14-95	Page 7


excess TBP (> 3,000 lbs) accumulates gradually in 8.7
Page 4
GE-ACCUM-G
1.25E-07
operator fails to feed remaining tank contents after 1st interval- clean tank
OPR87EM1ACNA#
5.00E-03 typical circumstances
operator fails to feed remaining tank contents after 3rd interval- clean tank
OPR87EM3ACNA#
5.00E-03 typical circumstances
operator fails to feed remaining tank contents after 2nd interval- clean tank
OPR87EM2ACNA#
5.00E-03 typical circumstances
organic remains in feed tank
PER87ORG100A#
1.00E+00 no credit for feedin g tank contents down to adequate mixing


Excess TBP (10,000 lbs.) is fed from 7.8 to the batch evaporator
Page 1
G3A1A
3.61E-09
TBP Transferred From 7.8 to Batch Evaporator 7.6E
Excess TBP (10,000 lbs) is supplies to the continuous evaporator
Operator fails to assure SPG is within range (10,000 lbs TBP
PER78-76100G#
2
1.00E+00
No credit for sample or spg
G_LOT_TBP
7.23E-08
OPRG7.8-ACHA#
5.00E-02
Knowledge-based diagnosis error- 10 to 30 minutes
Excess TBP is Received in 8.7
30,000 lbs of organic accumulates in 8.7
GE_CE_TO_8.7_M
7.23E-08
PERACCUMINC#
1.00E-32
COG: impossible
Several batches cont aining excess TBP ar e received from 17.5 (30,000 lbs total)
Excess TBP is Received in 8.7 From 11.7
Excess TBP is received in 8.7 from 10.8 during cold streams
TBP17.5-INCG#
1.00E-32
impossible - 3 conse cutive transfers fro m 17.5 during a batc
GE_CE_FR_11.7_M
5.35E-08
GE_CE_10.8_M
1.87E-08
Page 11
Organic overflows decanter
Level limit in tank 906 is exceeded
GE_ORG2_11.7_M
1.37E-04
GE_FULL_906
3.91E-04
Page 10
Process upset causes excess organic in feed
Process upsets causes dilute 2AW or high density in 11.7S
TBPTK--PREA#
2
1.37E-04
Estimated as 1/10years - Not dete cted for 12 hours
TBPDENS1PREA#
2
1.00E-32
COG: impossible (wou ld involve phase inv ersion, can't get 10


Level limit in tank 906 is exceeded
Page 11
Page 9
GE_FULL_906
3.91E-04
Operator over fills tank 906 (Level Procedurally Controlled)
Failure to detect high level in tank 906
OPRLV906ACNA#
5.00E-03
Typical Circumstance s, Level kept low to prevent large loss
GE_HIGH_906
7.71E-02
High level alarm in tank 906 tank fails
Tank 906 level sensor failure
ALRHL906NRIG#
6.21E-02
Assumes discovered d uring Level Sensor C alibration: FR 3E-5/
LSTTK906FAIA#
2
1.08E-03
Assume discovered during calibration: FR 5E-7/hr
Calibration Error - Level Instrument is calibrated to give a false reading
Operator fails to respond to level alarm in tank 906
OPR906LEMCNA#
2
5.00E-03
Single Person, Operator Check
OPRTK906CSNA#
2
1.00E-02
Typical Circumstance s, Further Loss coul d shut down process


Excess TBP is received in 8.7 from 10.8 during cold streams
Page 9
GE_CE_10.8_M
1.87E-06
Organic overflows decanter 10.8
Cold streams sent to 8.7
Level limit in tank 906 is exceeded
GE_ORG2_10.8_M
1.37E-04
PER-COLD035G#
2
3.50E-01
1.5 Days of Cold Streams Out of 4 days of running
GE_FULL_906
3.91E-04
Page 10
Process upset causes excess TBP in canyon product
Process upsets causes dilute 2W or high density in 11.7S
TBPTK2BPPREA#
2
1.37E-04
Estimated as 1/10years - Not dete cted for 12 hours
TBPDENS2PREA#
2
1.00E-32
COG: impossible (wou ld involve phase inv ersion, can't get 10


3000 lbs. TBP present and heated long enough to evapo rate all the aqueous
Page 1
G5
2.18E-10
Excess TBP (3000 lbs) is fed to the batch evaporator
G3A1B
1.46E-06
Page 4
Failure to Detect SPG Out of Range
PERBESPG100G#
3
1.00E+00
No credit for SPG
Temp. Interlock fails to shut off steam or operator fails to respond
GE_INTLKS3_H
1.49E-04
Failure to shut off steam to the batch evaporator
GE_BE_INLK_X
1.18E-06
Page 2
Failure to detect high temperature in the batch evaporator
GE_TEM_INTLK_H
1.48E-04
Page 3

Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone	Gate/Event Name	Page	Zone
ALR-PGT-COMG#	2		GE_FULL_906	10		PERBESPG100G#	1				
ALRHL906NRIG#	10		GE_FULL_906	11		PERBESPG100G#	12				
ALRTK906NRIG#	6		GE_HIGH_906	10		PERBETEM002A#	3				
CAVBESTMFOGG#	1		GE_INTLKS3_H	12		PERFBLININC#	4				
CAVBESTMFOGG#	2		GE_ORG2_10.8_G	7		PERTK175.20A#	4				
EVPBEVAPON-G+	1		GE_ORG2_10.8_M	11		PERTR175002A#	4				
G1	1		GE_ORG2_11.7_G	5		RLPPUMP-NREG#	6				
G2	1		GE_ORG2_11.7_M	9		TBP17.5-INCG#	9				
G3A	1		GE_PMP906_INTLK	6		TBPDENS1PREA#	5				
G3A1A	1		GE_TEM_INTLK_H	1		TBPDENS1PREA#	9				
G3A1A	9		GE_TEM_INTLK_H	3		TBPDENS2PREA#	7				
G3A1B	1		GE_TEM_INTLK_H	12		TBPDENS2PREA#	11				
G3A1B	4		GE_TK906_RECOV	5		TBPTK---PREA#	5				
G3A1B	12		GE_TK906_RECOV	6		TBPTK---PREA#	9				
G4	1		GE_TK906_RECOV	7		TBPTK2BPPREA#	7				
G5	1		G_LIT_TBP	4		TBPTK2BPPREA#	11				
G5	12		G_LOT_TBP	9		TR-17.5-TO-8.7	4				
GE-ACCUM-G	4		LSTTK906FAIA#	6		TSTBETE-FAIG#	3				
GE-ACCUM-G	8		LSTTK906FAIA#	10							
GE_906_ALARM	6		OPR17.5-ACNA#	4							
GE_BE_CC_ALARM	2		OPR87EM1ACNA#	8							
GE_BE_INLK_X	1		OPR87EM2ACNA#	8							
GE_BE_INLK_X	2		OPR87EM3ACNA#	8							
GE_BE_INLK_X	12		OPR906LEMCNA#	6							
GE_BE_INTLKS1_H	1		OPR906LEMCNA#	10							
GE_BE_VALVE_H	1		OPRBBLOCDENA#	2							
GE_CE_10.8_G	4		OPRG7.8-ACHA#	9							
GE_CE_10.8_G	7		OPRGBETEMCNA#	3							
GE_CE_10.8_M	9		OPRLV906ACNA#	10							
GE_CE_10.8_M	11		OPRTK906CSNA#	6							
GE_CE_FR_11.7_G	4		OPRTK906CSNA#	10							
GE_CE_FR_11.7_G	5		PER-COLD035G#	7							
GE_CE_FR_11.7_M	9		PER-COLD035G#	11							
GE_CE_FR_17.5_G	4		PER78-76100G#	4							
GE_CE_TO_8.7_G	4		PER78-76100G#	9							
GE_CE_TO_8.7_M	9		PER87ORG100A#	8							
GE_CW_CAL_TE_G	3		PERACCUMINC#	9							
GE_FULL_906	9		PERBESPG100G#	1							

Cutset Report for 7.6E & 7.7E Evaporators

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	G1					3.83E-07	
1.	ALRHL906NRIG#	High level alarm in tank 906 tank fails	5	6M 3.00E-05H	6.21E-02	2.13E-07	55.5
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPRG7.8-ACHA#	Operator fails to assure SPG is within range (10,000 lbs TBP	1	1N 5.0E-2 N	5.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
2.	ALRHL906NRIG#	High level alarm in tank 906 tank fails	5	6M 3.00E-05H	6.21E-02	7.44E-08	74.9
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPRG7.8-ACHA#	Operator fails to assure SPG is within range (10,000 lbs TBP	1	1N 5.0E-2 N	5.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
3.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	3.42E-08	83.8
	OPRG7.8-ACHA#	Operator fails to assure SPG is within range (10,000 lbs TBP	1	1N 5.0E-2 N	5.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	OPRTK906CSNA#	Operator fails to respond to level alarm in tank 906	1	1N 1.0E-2 N	1.00E-02N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
4.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	1.71E-08	88.3

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRG7.8-ACHA#	Operator fails to assure SPG is within range (10,000 lbs TBP	1	1N 5.0E-2 N	5.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
5.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	1.20E-08	91.4
	OPRG7.8-ACHA#	Operator fails to assure SPG is within range (10,000 lbs TBP	1	1N 5.0E-2 N	5.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	OPRTK906CSNA#	Operator fails to respond to level alarm in tank 906	1	1N 1.0E-2 N	1.00E-02N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
6.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	6.85E-09	93.2
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
7.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	5.99E-09	94.8
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRG7.8-ACHA#	Operator fails to assure SPG is within range (10,000 lbs TBP	1	1N 5.0E-2 N	5.00E-02N		

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
8.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	3.70E-09	95.8
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRG7.8-ACHA#	Operator fails to assure SPG is within range (10,000 lbs TBP	1	1N 5.0E-2 N	5.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
9.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	3.29E-09	96.6
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
	TSTBETE-FAIG#	Batch Evaporator Temperature Sensor Fails	5	4D 1.00E-06 H	4.80E-05		
10.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	2.40E-09	97.2
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
11.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	2.00E-09	97.8
	OPR17.5-ACNA#	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch	1	1N 5.0E-3 N	5.00E-03N		
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
	PERTK175.20A#	Sufficient TBP present in tank 17.5	1	1N 2.00E-03N	2.00E-03N		
	PERTR175002A#	Material Is Being Received From 17.5	1	1N 2.00E-02N	2.00E-02N		
	TR-17.5-TO-8.7	Transfer Excess TBP From 17.5 to 8.7		1.0N	1.00E+00		
12.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	1.48E-09	98.1
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
13.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	1.29E-09	98.5
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRG7.8-ACHA#	Operator fails to assure SPG is within range (10,000 lbs TBP	1	1N 5.0E-2 N	5.00E-02N		
	OPRLV906ACNA#	Operator over fills tank 906 (Level Procedurally Controlled)	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
14.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	1.25E-09	98.8
	OPR87EM1ACNA#	operator fails to feed remaining tank contents after 1st interval- clean tank	1	1N 5.0E-3 N	5.00E-03N		
	OPR87EM2ACNA#	operator fails to feed remaining tank contents after 2nd interval- clean tank	1	1N 5.0E-3 N	5.00E-03N		
	OPR87EM3ACNA#	operator fails to feed remaining tank contents after 3rd interval- clean tank	1	1N 5.0E-3 N	5.00E-03N		
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PER87ORG100A#	organic remains in feed tank	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
15.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	1.15E-09	99.1
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
	TSTBETE-FAIG#	Batch Evaporator Temperature Sensor Fails	5	4D 1.00E-06 H	4.80E-05		
16.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	9.60E-10	99.4
	OPR17.5-ACNA#	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERTK175.20A#	Sufficient TBP present in tank 17.5	1	1N 2.00E-03N	2.00E-03N		
	PERTR175002A#	Material Is Being Received From 17.5	1	1N 2.00E-02N	2.00E-02N		

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	TR-17.5-TO-8.7	Transfer Excess TBP From 17.5 to 8.7		1.0N	1.00E+00		
	TSTBETE-FAIG#	Batch Evaporator Temperature Sensor Fails	5	4D 1.00E-06 H	4.80E-05		
17.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	7.10E-10	99.5
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
	TSTBETE-FAIG#	Batch Evaporator Temperature Sensor Fails	5	4D 1.00E-06 H	4.80E-05		
18.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	6.00E-10	99.7
	OPR87EM1ACNA#	operator fails to feed remaining tank contents after 1st interval- clean tank	1	1N 5.0E-3 N	5.00E-03N		
	OPR87EM2ACNA#	operator fails to feed remaining tank contents after 2nd interval- clean tank	1	1N 5.0E-3 N	5.00E-03N		
	OPR87EM3ACNA#	operator fails to feed remaining tank contents after 3rd interval- clean tank	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PER87ORG100A#	organic remains in feed tank	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TSTBETE-FAIG#	Batch Evaporator Temperature Sensor Fails	5	4D 1.00E-06 H	4.80E-05		
19.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	5.17E-10	99.8
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
20.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	2.48E-10	99.9
	LSTTK906FAIA#	Tank 906 level sensor failure	5	6M 5.00E-07 H	1.08E-03		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
	TSTBETE-FAIG#	Batch Evaporator Temperature Sensor Fails	5	4D 1.00E-06 H	4.80E-05		
21.	ALRTK906NRIG#	Low level alarm in tank 906 fails	5	6M 3.00E-05H	6.21E-02	8.50E-11	99.9
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
	RLPPUMP-NREG#	Pump switch fails to open	1	1N 1.0E-3N	1.00E-03N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
22.	CAVBESTMFOGG#	Pneumatic steam control valve fails open (batch evaporator)	3	24H 3.00E-06 H	7.20E-05	4.93E-11	99.9
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	OPRBBLOCDENA#	Operator fails to respond to alarm(s) (906, temp., pres) (Close valve)	1	1N 1.0E-2 N	1.00E-02N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
23.	ALRTK906NRIG#	Low level alarm in tank 906 fails	5	6M 3.00E-05H	6.21E-02	4.08E-11	99.9
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	RLPPUMP-NREG#	Pump switch fails to open	1	1N 1.0E-3N	1.00E-03N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
	TSTBETE-FAIG#	Batch Evaporator Temperature Sensor Fails	5	4D 1.00E-06 H	4.80E-05		
24.	ALR-PGT-COMG#	Common cause batch evaporator alarm failure (temp, pres.)	5	6M 3.00E-06H	6.45E-03	3.18E-11	100.0
	CAVBESTMFOGG#	Pneumatic steam control valve fails open (batch evaporator)	3	24H 3.00E-06 H	7.20E-05		
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
25.	ALRTK906NRIG#	Low level alarm in tank 906 fails	5	6M 3.00E-05H	6.21E-02	2.98E-11	100.0
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
	RLPPUMP-NREG#	Pump switch fails to open	1	1N 1.0E-3N	1.00E-03N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
26.	CAVBESTMFOGG#	Pneumatic steam control valve fails open (batch evaporator)	3	24H 3.00E-06 H	7.20E-05	1.73E-11	100.0
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq.(/yr)	CUM %
	OPRBBLOCDENA#	Operator fails to respond to alarm(s) (906, temp., pres) (Close valve)	1	1N 1.0E-2 N	1.00E-02N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
27.	CAVBESTMFOGG#	Pneumatic steam control valve fails open (batch evaporator)	3	24H 3.00E-06 H	7.20E-05	1.44E-11	100.0
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPR17.5-ACNA#	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch	1	1N 5.0E-3 N	5.00E-03N		
	OPRBBLOCDENA#	Operator fails to respond to alarm(s) (906, temp., pres) (Close valve)	1	1N 1.0E-2 N	1.00E-02N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERTK175.20A#	Sufficient TBP present in tank 17.5	1	1N 2.00E-03N	2.00E-03N		
	PERTR175002A#	Material Is Being Received From 17.5	1	1N 2.00E-02N	2.00E-02N		
	TR-17.5-TO-8.7	Transfer Excess TBP From 17.5 to 8.7		1.0N	1.00E+00		
28.	ALRTK906NRIG#	Low level alarm in tank 906 fails	5	6M 3.00E-05H	6.21E-02	1.43E-11	100.0
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	RLPPUMP-NREG#	Pump switch fails to open	1	1N 1.0E-3N	1.00E-03N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		
	TSTBETE-FAIG#	Batch Evaporator Temperature Sensor Fails	5	4D 1.00E-06 H	4.80E-05		
29.	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y	1.37E-11	100.0
	OPRGBETEMCNA#	Tank Temperature Sensor is Miscalibrated	1	1N 5.0E-3 N	5.00E-03N		

Cutset Report for 7.6E & 7.7E Evaporators (CONT.)

Set No.	Event Name	Description	C	B.E. Input	Calc. Result	Cutset Freq. (/yr)	CUM %
	OPRTK906CSNA#	Operator fails to respond to level alarm in tank 906	1	1N 1.0E-2 N	1.00E-02N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	PERBETEM002A#	Temperature sensor calibrated just before this batch	1	1N 2.00E-02N	2.00E-02N		
	RLPPUMP-NREG#	Pump switch fails to open	1	1N 1.0E-3N	1.00E-03N		
	TBPTK---PREA#	Process upset causes excess organic in feed	3	12H 0.1Y	1.37E-04		
30.	ALR-PGT-COMG#	Common cause batch evaporator alarm failure (temp, pres.)	5	6M 3.00E-06H	6.45E-03	1.11E-11	100.0
	CAVBESTMFOGG#	Pneumatic steam control valve fails open (batch evaporator)	3	24H 3.00E-06 H	7.20E-05		
	EVPBEVAPON-G+	Batch Evaporator is Used		100Y	1.00E+02Y		
	OPR906LEMCNA#	Calibration Error - Level instrument is calibrated to give a false reading	1	1N 5.0E-3 N	5.00E-03N		
	PER-COLD035G#	Cold streams sent to 8.7	1	1N 3.50E-01N	3.50E-01N		
	PER78-76100G#	TBP Transferred From 7.8 to Batch Evaporator 7.6E	1	1N 1.00E+00N	1.00E+00N		
	PERBESPG100G#	Failure to Detect SPG Out of Range	1	1N 1.00E+00N	1.00E+00N		
	TBPTK2BPPREA#	Process upset causes excess TBP in canyon product	3	12H 0.1Y	1.37E-04		

Basic Event Data for 7.6E & 7.7E Evaporators

Event	C	Input	Calc.	Description	Source
ALR-PGT-COMG#	5	6M 3.00E-06H	6.45E-03	Common cause batch evaporator alarm failure (temp, pres.)	a: calib. every 6 mon., beta factor of .1 for common cause
ALRHL906NRIG#	5	6M 3.00E-05H	6.21E-02	High level alarm in tank 906 tank fails	Assumes discovered during Level Sensor Calibration: FR 3E-5/hr
ALRTK906NRIG#	5	6M 3.00E-05H	6.21E-02	Low level alarm in tank 906 fails	Assumes discovered during Level Sensor Calibration: FR 3E-5/hr
CAVBESTMFOGG#	3	24H 3.00E-06 H	7.20E-05	Pneumatic steam control valve fails open (batch evaporator)	Used Compressed Gas Value, 1 Day Mission Time :FR 3E-6/hr
EVPBEVAPON-G+		100Y	1.00E+02Y	Batch Evaporator is Used	Assumed to Operate 100 Times per Year
LSTTK906FAIA#	5	6M 5.00E-07 H	1.08E-03	Tank 906 level sensor failure	Assume discovered during calibration: FR 5E-7/hr
OPR17.5-ACNA#	1	1N 5.0E-3 N	5.00E-03N	Second consecutive transfer containing TBP from tank 17.5 is fed to same batch	sump receipt tank transfer procedure does not allow a 2nd transfer
OPR87EM1ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents after 1st interval- clean tank	typical circumstances
OPR87EM2ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents after 2nd interval- clean tank	typical circumstances
OPR87EM3ACNA#	1	1N 5.0E-3 N	5.00E-03N	operator fails to feed remaining tank contents after 3rd interval- clean tank	typical circumstances
OPR906LEMCNA#	1	1N 5.0E-3 N	5.00E-03N	Calibration Error - Level instrument is calibrated to give a false reading	Single Person, Operator Check
OPRBBLOCDENA#	1	1N 1.0E-2 N	1.00E-02N	Operator fails to respond to alarm(s) (906, temp., pres) (Close valve)	Several Competing Signals
OPRG7.8-ACHA#	1	1N 5.0E-2 N	5.00E-02N	Operator fails to assure SPG is within range (10,000 lbs TBP	Knowledge-based diagnosis error- 10 to 30 minutes
OPRGBETEMCNA#	1	1N 5.0E-3 N	5.00E-03N	Tank Temperature Sensor is Miscalibrated	Single Person, Operator Check
OPRLV906ACNA#	1	1N 5.0E-3 N	5.00E-03N	Operator over fills tank 906 (Level Procedurally Controlled)	Typical Circumstances, Level kept low to prevent large loss of organic
OPRTK906CSNA#	1	1N 1.0E-2 N	1.00E-02N	Operator fails to respond to level alarm in tank 906	Typical Circumstances, Further Loss could shut down process
PER-COLD035G#	1	1N 3.50E-01N	3.50E-01N	Cold streams sent to 8.7	1.5 Days of Cold Streams Out of 4 days of running
PER78-76100G#	1	1N 1.00E+00N	1.00E+00N	TBP Transferred From 7.8 to Batch Evaporator 7.6E	No credit for sample or spg
PER87ORG100A#	1	1N 1.00E+00N	1.00E+00N	organic remains in feed tank	no credit for feeding tank contents down to adequate mixing point
PERACCUMINC#	1	1N 1.00E-32N	1.00E-32N	30,000 lbs of organic accumulates in 8.7	COG: impossible
PERBESPG100G#	1	1N 1.00E+00N	1.00E+00N	Failure to Detect SPG Out of Range	No credit for SPG
PERBETEM002A#	1	1N 2.00E-02N	2.00E-02N	Temperature sensor calibrated just before this batch	Calibrated every 6 months & 100 batches a year
PERFBLININC#	1	1N 1.00E-32N	1.00E-32N	Excess TBP is Received in 8.7 From 9.7	impossible Event, (no planned B-Line processing)

Basic Event Data for 7.6E & 7.7E Evaporators (CONT.)

Event	C	Input	Calc.	Description	Source
PERTK175.20A#	1	1N 2.00E-03N	2.00E-03N	Sufficient TBP present in tank 17.5	a: 1 in 5 years (1/500 Batches)
PERTR175002A#	1	1N 2.00E-02N	2.00E-02N	Material Is Being Received From 17.5	Pu Recovery, Assume 1 out of 50 batches
RLPPUMP-NREG#	1	1N 1.0E-3N	1.00E-03N	Pump switch fails to open	Per Demand, Generic Data
TBP17.5-INCG#		1.0E-32N	1.00E-32	Several batches containing excess TBP are received from 17.5 (30,000 lbs total)	impossible - 3 consecutive transfers from 17.5 during a batch
TBPDENS1PREA#		1.0E-32N	1.00E-32	Process upsets causes dilute 2AW or high density in 11.7S	COG: impossible (would involve phase inversion, can't get 10,000 lbs organic)
TBPDENS2PREA#		1.0E-32H	8.76E-29Y	Process upsets causes dilute 2W or high density in 11.7S	COG: impossible (would involve phase inversion, can't get 10,000 lbs organic)
TBPTK---PREA#	3	12H 0.1Y	1.37E-04	Process upset causes excess organic in feed	Estimated as 1/10years - Not detected for 12 hours
TBPTK2BPPREA#	3	12H 0.1Y	1.37E-04	Process upset causes excess TBP in canyon product	Estimated as 1/10years - Not detected for 12 hours
TR-17.5-TO-8.7		1.0N	1.00E+00	Transfer Excess TBP From 17.5 to 8.7	Assumed to be present and always transferred
TSTBETE-FAIG#	5	4D 1.00E-06 H	4.80E-05	Batch Evaporator Temperature Sensor Fails	Temp Sensor, Discovered within 4 days: FR1E-6/hr

Type Code Data for 7.6E & 7.7E Evaporators

Type Code	Rate	Description	Source	EF	D
ALR COM	3.00E-06H	Alarm/Annunciator, Fails to alarm (Instr. & Control)	WSRC-TR-93-262, ALR-NR-I		
ALR NRI	3.00E-05H	Alarm/Annunciator, Fails to alarm (Instr. & Control)	WSRC-TR-93-262, ALR-NR-I	10	L
CAV FOG	3.00E-06 H	Valve (Control), Air-Operated, Fails open (Compressed Gas)	WSRC-TR-93-262, CAV-FO-G	10	L
LST FAI	5.00E-07 H	Sensor/Transmitter/, Transducer/Proc. Switch, Level, Failure (Instr. & Control)	WSRC-TR-93-262, LST-FA-I	3	L
OPR ACH	5.0E-2 N	Failure of Administrative Control (High)	WSRC-TR-93-581, Table 4, Item 1, High	5	L
OPR ACN	5.0E-3 N	Failure of Administrative Control (Nominal)	WSRC-TR-93-581, Table 4, Item 1, Nominal	10	L
OPR CSN	1.0E-2 N	Failure to respond to compelling signal (Nominal)	WSRC-TR-93-581, Table 4, Item 2, Nominal	5	L
OPR DEN	1.0E-2 N	Diagnosis error (Nominal)	WSRC-TR-93-581, Table 4, Item 30, Nominal	5	L
OPR MCN	5.0E-3 N	Miscalibration (Nominal)	WSRC-TR-93-581, Table 4, Item 12, Nominal	10	L
PER .20	2.00E-03N	0.2% chance			
PER 002	2.00E-02N	2% chance			
PER 035	3.50E-01N	35% chance			
PER 100	1.00E+00N	100% chance			
PER INC	1.00E-32N	Incredible Event			
RLP NRE	*1.0E-3N*	*Relay fails to open*	*WSRC-TR-93-262m RLP-NRE*		
TBP PRE	0.1Y	Process upset causes excess organic in feed	Never Seen, Estimated as Once in Ten Years		
TST FAI	1.00E-06 H	Sensor/Transmitter/, Transducer/Proc. Switch, Temp., Failure (Instr. & Control)	WSRC-TR-93-262, TST-FA-I	3	L

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