

Figure 1.3a Cold Catastrophic Failure of Road Tanker Tree F3

Tanker impact during maneuvering into

compound (per visit)

1.50E-04

number of filling

operations per year

365

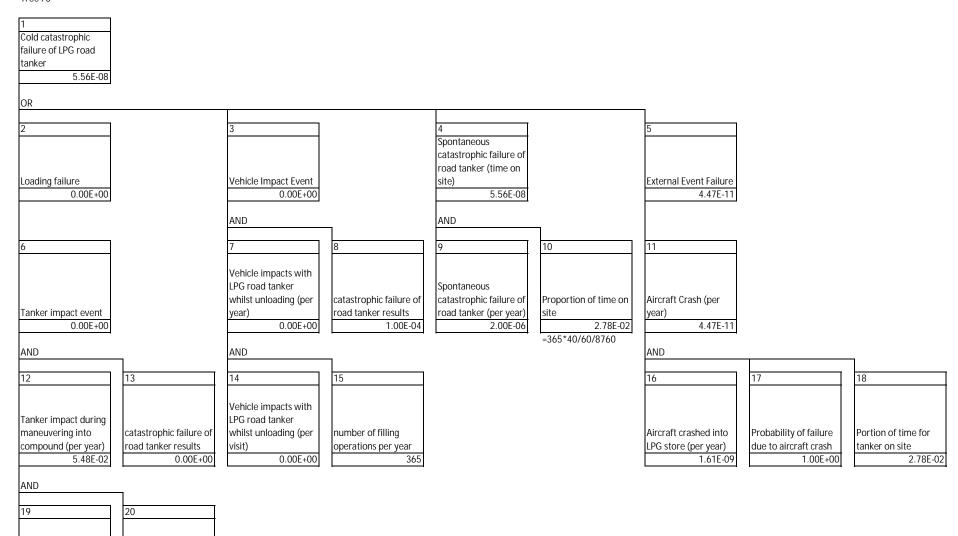


Figure 1.4a Cold Partial Failure of Road Tanker Tree F4

Tanker impact during maneuvering into

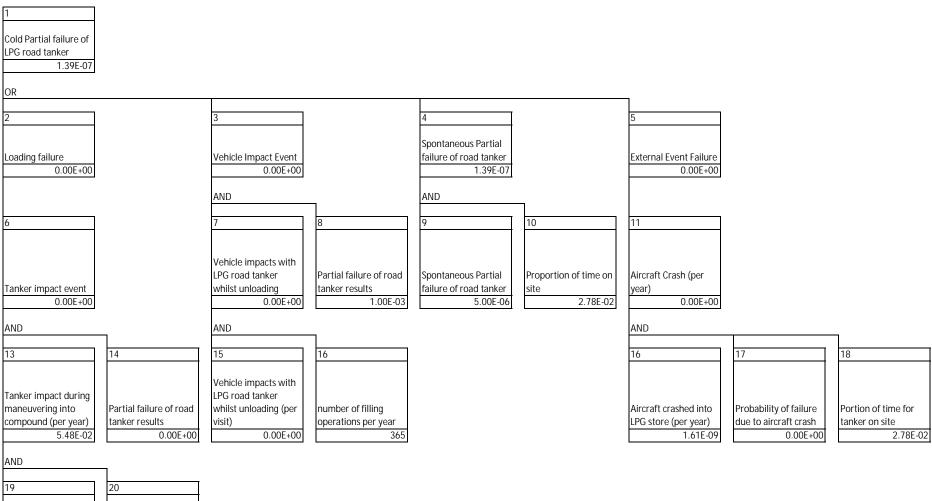
compound (per visit)

1.50E-04

Number of filling

operations per year

365



Tree F5.1 Guillotine Failure of Vessel Filling Line 1.85E-07 OR External Event Loading Failure Spontaneous failure Failure 5.48E-11 8.33E-08 1.02E-07 AND AND Probability operator Failure due to Pipework overfills storage Spontaneous Failure Aircraft Crash (per earthquake (per Over-pressurisation Guillotine Failure of Number of Filling Proportion of time in results vessel pipework operations per year Rate (/m/yr) Length of line (m) operation/visit year) year) 1.50E-11 2.00E-02 5.00E-01 1.61E-09 1.00E-07 365 1.00E-06 3.00E+00 2.78E-02 AND AND AND 13 14 15 13 14 15 16 Earthquake of Modified Mercali failure of tank truck Intnesity (MMI) VIII pump overpressure Failure of relief valve Operator fails to Aircraft crashed into Probability of failure Probabilty of failure LPG store (per year)

1.61E-09 due to earthquake 1.00E-02 protection system 1.00E-04 rectify problem due to aircraft crash on storage tank (per year)

1.00E+00

1.00E-05

Figure 1.5a

Guillotine Failure of LiquidFilling Line to Vessel (fed from Tanker)

1.00E-04

1.50E-03

Figure 1.5b Guillotine Failure of LiquidFilling Line to Vessel (fed from Vessel) Tree F5.2 Guillotine Failure of Vessel Filling Line 1.85E-07 OR External Event Loading Failure Spontaneous failure Failure 5.48E-11 8.33E-08 1.02E-07 AND AND OR Probability operator Failure due to Pipework overfills storage Spontaneous Failure Over-pressurisation Guillotine Failure of Number of Filling Proportion of time in Aircraft Crash (per earthquake (per results vessel pipework operations per year Rate (/m/yr) Length of line (m) operation/visit year) year) 1.50E-11 2.00E-02 5.00E-01 1.61E-09 1.00E-07 365 1.00E-06 3.00E+00 2.78E-02 AND AND AND 14 15 16 17 18 19 20 Earthquake of Modified Mercali failure of tank truck Intnesity (MMI) VIII

Aircraft crashed into

LPG store (per year)

1.61E-09

Probability of failure

due to aircraft crash

1.00E+00

(per year)

1.00E-05

Probabilty of failure

due to earthquake 1.00E-02

pump overpressure

protection system 1.00E-04

Failure of relief valve

1.00E-04

on storage tank

Operator fails to

rectify problem

1.50E-03

Tree F6 Guillotine Failure of Liquid Supply Line to Vaporiser 2.01E-05 OR Loading Failure External Event Failure Spontaneous failure 2.00E-05 1.02E-07 5.48E-11 AND AND OR 10 Overfill/ over-Failure due to pressurisation results number of filling Spontaneous Failure Aircraft Crash (per earthquake (per in Partial failure operations per year Rate (/m/yr) Length of line (m) year) year) 365 1.00E-06 2.00E+01 1.61E-09 1.50E-13 1.00E-07 AND AND AND 11 12 13 14 15 16 17 Earthquake of Probabilty operator Modified Mercali overfills storage Aircraft crashed into Probability of failure Intnesity (MMI) VIII Probabilty of failure Over-pressurisation Guillotine Failure of LPG store (per year) results pipework due to aircraft crash (per year) due to earthquake vessel 1.50E-11 2.00E-02 5.00E-01 1.61E-09 1.00E+00 1.00E-05 1.00E-02 AND 18 20 19 Failure of tank truck pump overpressure Failure of relief valve Operator fails to rectify problem protection system on storage tank

Figure 1.6a

1.00E-04

1.00E-04

1.50E-03

Guillotine Failure of Liquid Supply Line to Vaporiser

Figure 1.7a Guillotine Failure of LiquidFilling Line to Flexible Hose Tree F7 Guillotine Failure of Liquid Filling Line to Flexible Hose 2.55E-07 AND Guillotine Failure of Liquid Filling Line to Number of Flexible Hose operations per year 7.00E-10 365 External Event Loading Failure Spontaneous failure Failure 2.32E-11 2.20E-10 4.57E-10 AND 10 Failure of Driver error leads to Guillotine failure of Failure due to overpressure overpressurisation of pipework due to Aircraft Crash (per earthquake (per protection overpressure year) 5.00E-01 3.68E-13 2.28E-11 2.20E-08 2.00E-02 AND AND AND AND 13 14 15 16 14 15 16 17 Earthquake of . Modified Mercali Failure of tank truck Proportion of time Driver Fails to Rectify for tank on site per overpressure Spontaneous Failure Aircraft crashed into Probability of failure Intnesity (MMI) VIII Probabilty of failure Problem Rate (/m/yr) visit LPG store (per year) due to aircraft crash (per year) due to earthquake protection system Length of line (m) 1.00E-04 1.00E+00 2.20E-04 1.00E-06 2.00E+00 2.28E-04 1.61E-09 1.00E-05 1.00E-02 Proportion of time Proportion of time for tank on site per for tank on site per visit 2.28E-04 2.28E-04

Tree F9.1 Guillotine failure of flexible hose 1.02E-04 OR External Event Loading Failure Spontaneous failure Failure 3.65E-05 6.57E-05 2.82E-09 AND AND 10 Failure due to Number of Filling Spontaneous failure No. of operation per Aircraft Crash (per earthquake (per Loading Failure Operatinos per year per operation year year) year) 2.78E-09 1.00E-07 365 1.80E-07 365 4.47E-11 AND AND 10 11 14 15 16 17 Earthquake of Modified Mercali Intnesity (MMI) VIII Aircraft crashed into Probability of failure Probabilty of failure LPG store (per year)

1.61E-09 Disconnection error Tanker driveway due to aircraft crash due to earthquake Misconnection error (per year) 4.50E-08 3.00E-09 5.20E-08 1.00E+00 1.00E-05 1.00E-02 AND AND AND 16 14 18 11 Hose disconnected Tanker driveway Flexible hose Operator fails to during loading Operator fails to during loading guillotine failure Breakaway coupling Proportion of time Proportion of time Incorrect connection operation rectify problem for tanker on site of flexible hoses rectify problem operation results does not work for tanker on site

1.00E+00

1.30E-02

2.78E-02

2.78E-02

4.00E-06

1.50E-03

Figure 1.9a

3.00E-05

Guillotine Failure of Flexible Hose (Fed from Tanker)

2.00E-06

1.50E-03

Figure 1.9b Guillotine Failure of Flexible Hose (Fed from Vessel) Tree F9.2 Guillotine failure of flexible hose 1.02E-04 OR External Event Loading Failure Spontaneous failure Failure 3.65E-05 6.57E-05 2.82E-09 AND AND 10 Failure due to Number of Filling Spontaneous failure No. of operation per Aircraft Crash (per earthquake (per Loading Failure Operatinos per year per operation year year) year) 2.78E-09 1.00E-07 365 1.80E-07 365 4.47E-11 AND AND 10 11 14 15 16 17 Earthquake of Modified Mercali Intnesity (MMI) VIII Aircraft crashed into Probability of failure Probabilty of failure LPG store (per year)

1.61E-09 Disconnection error Tanker driveway due to aircraft crash due to earthquake Misconnection error (per year) 4.50E-08 3.00E-09 5.20E-08 1.00E+00 1.00E-05 1.00E-02 AND AND AND 16 14 18 11 Hose disconnected Tanker driveway Flexible hose

guillotine failure

1.00E+00

results

Breakaway coupling

1.30E-02

does not work

Proportion of time

2.78E-02

for tanker on site

Proportion of time

2.78E-02

for tanker on site

Operator fails to

rectify problem

1.50E-03

Incorrect connection

3.00E-05

of flexible hoses

during loading

2.00E-06

operation

Operator fails to

rectify problem

1.50E-03

during loading

4.00E-06

operation

Figure 1.11a Tree F11.a Failure to Isolate 1.30E-01 AND Operator fails to close manual valve Emergency Isolate Excess flow valve System fails fails to operate (EFV) (MV) Failure of NRVs 1.00E+00 1.30E-01 1.00E+00 1.00E+00 OR OR OR 10 Operator fails to Operator present Failure of system activate system but fails to close Non-Common Mode Common Mode Operator not (ACT) (EIS) failure of NRVs manual valve failure of NRVs present at site 0.00E+00 1.00E+00 1.00E+00 0.00E+00 9.72E-01 2.97E-02 AND AND AND 14 15 16 17 Non-return valve Non-return valve Fraction of time Failure of double fails to operate fails to operate check filer valve operator present at Probability fail to (NRV) (DCV) (NRV) time close manual valve

1.00E+00

Beta factor

5.94E-02

5.00E-01

0.00E+00

Failure to Isolate (Line to Vaporiser)

1.00E+00

1.00E+00

Figure 1.11b Failure to Isolate (Liquid filling line to flexible hose) Tree F11.b Failure to Isolate 7.55E-03 AND Operator fails to Emergency Isolate close manual valve Excess flow valve System fails 1.51E-02 fails to operate (EFV) Failure of NRVs (MV) 1.00E+00 1.00E+00 5.00E-01 OR OR OR 10 Operator fails to Operator present but activate system Failure of system Non-Common Mode fails to close manual Common Mode Operator not present (ACT) (EIS) failure of NRVs failure of NRVs at site valve 1.00E-04 5.00E-01 1.50E-02 1.00E+00 0.00E+00 0.00E+00 AND AND 15 Failure of double Non-return valve Non-return valve fails to operate check filer valve fails to operate (NRV) (NRV) (DCV) Beta factor 1.00E+00 1.00E+00 1.00E+00 0.00E+00

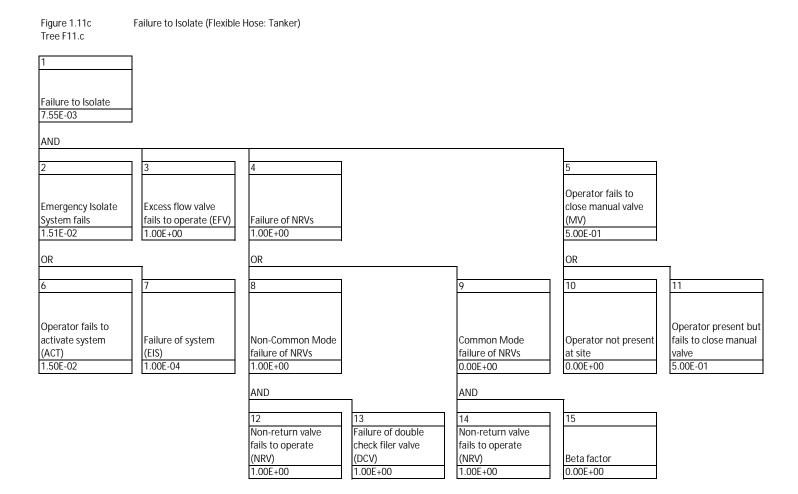
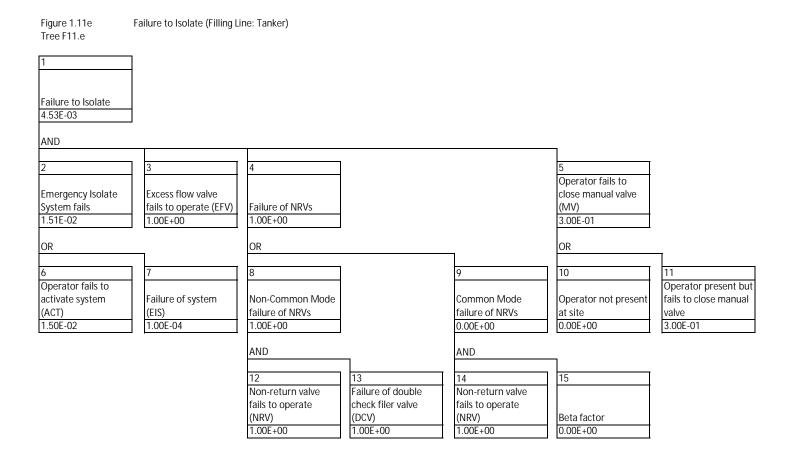


Figure 1.11d Failure to Isolate (Flexible Hose: Vessel) Tree F11.d Failure to Isolate 1.30E-03 AND Operator fails to Emergency Isolate Excess flow valve fails close manual valve System fails to operate (EFV) (MV) Failure of NRVs 1.00E+00 2.60E-03 1.00E+00 5.00E-01 OR OR OR 10 Operator present but Failure of system fails to close manual Operator fails to Non-Common Mode Common Mode Operator not present activate system (ACT) (EIS) failure of NRVs failure of NRVs at site valve 0.00E+00 1.00E+00 2.60E-03 0.00E+00 5.00E-01 0.00E+00 AND AND 12 14 15 Failure of double Non-return valve fails check filer valve Non-return valve fails to operate (NRV) (DCV) to operate (NRV) Beta factor 1.00E+00 1.00E+00 2.60E-03 0.00E+00



Tree F11.f Failure to Isolate 1.27E-02 AND Operator fails to close manual valve Emergency Isolate Excess flow valve fails System fails to operate (EFV) (MV) Failure of NRVs 1.00E+00 1.00E+00 1.30E-02 9.78E-01 OR OR OR 10 Operator present but Failure of system fails to close manual Operator fails to Non-Common Mode Common Mode Operator not present activate system (ACT) (EIS) failure of NRVs failure of NRVs at site valve 0.00E+00 1.00E+00 1.30E-02 0.00E+00 9.72E-01 6.02E-03 AND AND AND 12 13 15 17 14 16 Failure of double Fraction of time check filer valve Operator present at Probability fail to Non-return valve fails Non-return valve fails (DCV) to operate (NRV) site close manual valve to operate (NRV) Beta factor 1.30E-02 1.00E+00 1.00E+00 0.00E+00 2.78E-02 0.5

Figure 1.11f

Failure to Isolate (Filling Line: Vessel)

Tree F12a Fire protection/fighting system fails to prevent BLEVE 2.58E-02 AND Protection fire Water Spray System coating fails to Fails to prevent prevent BLEVE Fire Services fail to BLEVE (COAT) prevent BLEVE 5.15E-01 5.00E-01 1.00E-01 OR OR Water spray system Fire Services arrive operates but but ineffective Water Spray System ineffective against against fire attack Fire Services arrive fire attack (FSFIRE) fails to operate late (LATE) 3.00E-02 4.85E-01 5.00E-01 0.00E+00 OR AND 10 11 12 Water spray systems Water spray system Water spray system initiated but fails Water spray system ineffective against operates (WSO) fire attack (WSFIRE) not initiated (WSF) 1.50E-02 1.50E-02 9.70E-01 5.00E-01 AND 13 14 Operator does not Water spray system initiate Water spray fails to initiate system (OP) automaically (AUTO) 1.00E+00 1.50E-02

Fire Protection/Fighting Systems Fail to Prevent BLEVE (jet Fire, Road Tanker)

Figure 1.12a