



P & I Design Ltd

Process Instrumentation Consultancy & Design

Project Case Study Layer of Protection Analysis

ABSTRACT

This case study provides information involved in conducting a Layer of Protection Analysis (LOPA) relevant to transferring of gasoline products into a storage tank.

LOPA is one technique of risk assessment that can be used in determining if sufficient protection is provided to mitigate against the perceived risk.

The study is normally conducted with a team that have various skills, relevant to the process being considered. The team conducting this LOPA involved managers, operators, engineers and health & safety representatives.

INTRODUCTION

- Following on from the Buncefield Incident, the MIIB and HSE requested all Storage Terminals to carry out risk assessments on their facilities.
- The purpose of the LOPA study was to analyse the specific operations at the terminal and identify if sufficient safe guards were in place.

METHODOLOGY

Normally the requirement for a LOPA study would arise from a HAZOP. In this case it was conducted as part of the requirements arising from the MIIB recommendations.

The LOPA study starts with a numerical Target Frequency, that is the frequency at which the event can be tolerated. All Initiating Events which could lead to the event occurring are considered and an initiating event frequency is assigned to them. Once this is completed, the overall frequency of the event occurring is calculated. The team then considers various other aspects

such as enabling events, conditional modifiers and the various protection devices that are included within the system to prevent the event from occurring.

Once all the aspects have been defined then the mitigated frequency is compared to the Target Frequency. If there is a shortfall then it would be necessary to consider further risk reduction.

In the case of this study, further risk reduction resulted in the installation of a Safety Instrumented System to automatically stop import to the tank on detection of a high level.

As well as being used for safety assessments LOPA can be used as a risk assessment tool for environmental and financial consequence studies.

P & I Design Ltd - LOPA Calculation (Multiple Initiating Events)

Scenario	Initiating Event Frequency (1/y)	Conditional Modifier	Conditional Modifier	Conditional Modifier	Conditional Modifier (Others)	Conditional Modifier (Others)	Protection Layer 1	Protection Layer 2	Protection Layer 3	Protection Layer 4	Protection Layer 5	Top PFD for all PFCs	Frequency of EP + PFCs
Major Release of Gasoline from any large on-site tank leading to space flammable cloud explosion and 2 to 8 on-site fatalities	3.74E-03	Failure to detect and stop event	Required interlocking conditions	Probability of ignition	Probability of personnel in affected area	Probability of fuel injury	AT&S Operator Action	Cross Check: Qualified personnel via pipeline is independent shutdown of tank import	High High Alarm and independent shutdown of tank import			3.19E-04	1.19E-06
Incorrect fillage in receipt tank, still enough fillage to store full import quantity	6.40E-03						1.99E-01	1.99E-03				3.19E-04	1.79E-06
AT&S Failure (Strike on heels level and operator does not pick this up)	3.29E-03						1.09E-01	1.99E-03				1.99E-04	3.94E-07
Final Processed Value	1.19E-02	0.9	0.1	0.7	0.9	1.0	Probability of Unmitigated Consequence per year = 1.0E+00 (1/y) x 0.9 (1/y) x 0.1 (1/y) x 0.7 (1/y) x 0.9 (1/y) x 1.0 (1/y) = 0.063					3.29E-06	

LOPA Summary	
Risk Tolerance Criteria	1.0E-06
Frequency of Consequence mitigated by conditional modifiers but not by protection layers	7.29E-04
Frequency of Mitigated Consequence	3.19E-07
Risk Tolerance Criteria Met	Yes

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