
FAULT TREE ANALYSIS

Clint Guymon, PhD PE

Brigham Young University

1st Jan, 2025

created in  Curvenote

Keywords Spiritual Safety, Process Safety, Chemical Engineering, Risk Assessment

Learning Outcomes

- Construct a Fault Tree Analysis (FTA) using deductive logic to map lower-level failures to a top-level hazardous event.
- Use Boolean logic gates (AND, OR) to combine contributing factors like equipment failure and human error.
- Identify steps to determine the combination of failures required to cause a system failure.

Reading

- Foundations of Spiritual and Physical Safety: with Chemical Processes; Chapter 5, Sections 2.2
- Fault Tree Analysis: [Fault tree analysis](#)

Fault tree analysis (FTA) is a top-down, deductive failure analysis in which an undesired state of a system is analyzed using boolean logic to combine a series of lower-level events. This analysis method is used to understand how systems can fail, to identify the best ways to reduce risk, and to estimate event rates of a safety accident or a particular system level (functional) failure.

1 1st Example of Fault Tree Analysis (FTA)

1.1 Procedure

Commutte to work or school avoiding injury from a traffic accident or other hazards.

2 2nd Example of Fault Tree Analysis (FTA)

2.1 Procedure

A batch reactor is used to complete a reaction needed for the benefit of others. The reactor process has the following processing steps:

1. The reactor is filled with the raw material, a somewhat toxic material.
2. The reactor is heated to the desired temperature (100 F).
3. The reactor is pressurized to the desired pressure (20 psig).
4. Reactant B is slowly added to the reactor. An exothermic reaction occurs and the jacket must begin to cool the reactor to maintain the desired temperature.
5. The reaction proceeds at a given reaction rate at that temperature and pressure until all of the reactant B has been added.
6. The reactor is cooled to room temperature and the product is removed.

2.2 Some Hazards

- Product C has a low boiling point and is toxic. If the reactor is not cooled properly, the product will vaporize and escape from the reactor.
- If stirring is not maintained, the reaction will not proceed at the desired rate and the reactor will overheat.
- Reactor is used for multiple products

Figure 3: Image of the batch reactor credit to: <https://www.essentialchemicalindustry.org/processes/chemical-reactors.html>

3 Combination of FTA and FMEA:

An accident investigation prior to the accident

Example start on an FTA: (lower left is 'Blades fall off')

Example start of the FMEA/ Hazards Analysis

Action Items

1. Draw a Fault Tree Diagram for the production of polyethylene. Most safety concerns are around the plug flow reactor with a highly exothermic reaction occurring. A compressor is used to pressurize the ethylene feed to near 1500 bar. A cooling jacket surrounds the plug flow reactor where the temperature is controlled to near 70C. A separator is then used to collect the polyethylene solids and the unreacted ethylene is recycled.
2. Identify a "Top Level Event" for a commute to school and deduce at least three sub-events that could lead to that outcome.
3. Comment on the both the success and failure portions of the Fault tree for spiritual scenarios Figure V.10([Guymon, 2025](#)) page (95). What covenants have you made or could you make with God to help you succeed and draw closer to God?

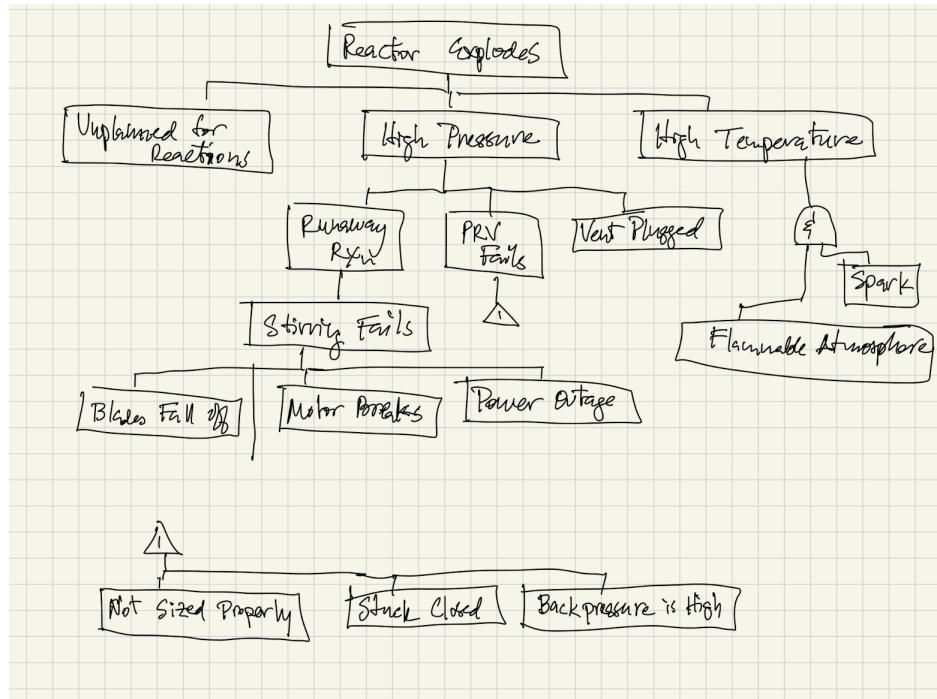


Figure 4: Example Fault Tree Analysis



Job Hazards Analysis (JHA)

Title:	Document No.:	Page:
Operator/ Test Individual:	Rev:	Date:

BYU CH EN Job Hazards Analysis						
Task Description	Hazard Type	Hazard Description	Consequence	Safeguards	Rank	Recommendations
Reactor Operation - Stirring	Electrical Failure	Controller Fails from Power Outage	Stirring ceases resulting in a runaway reaction, high pressure, and potential violent reactor explosion	Battery Powered alarm present to indicate power failure Backup power generator present	2D	
Reactor Operation - Stirring	Component Failure	Motor Fails	Stirring ceases resulting in a runaway reaction, high pressure, and potential violent reactor explosion	Alarm present on motor indicating presence of stirring Emergency venting of reactor contents possible	2D	

Figure 5: FMEA Example

References

C. Guymon. *Foundations of Spiritual and Physical Safety: with Chemical Processes*. 2025.