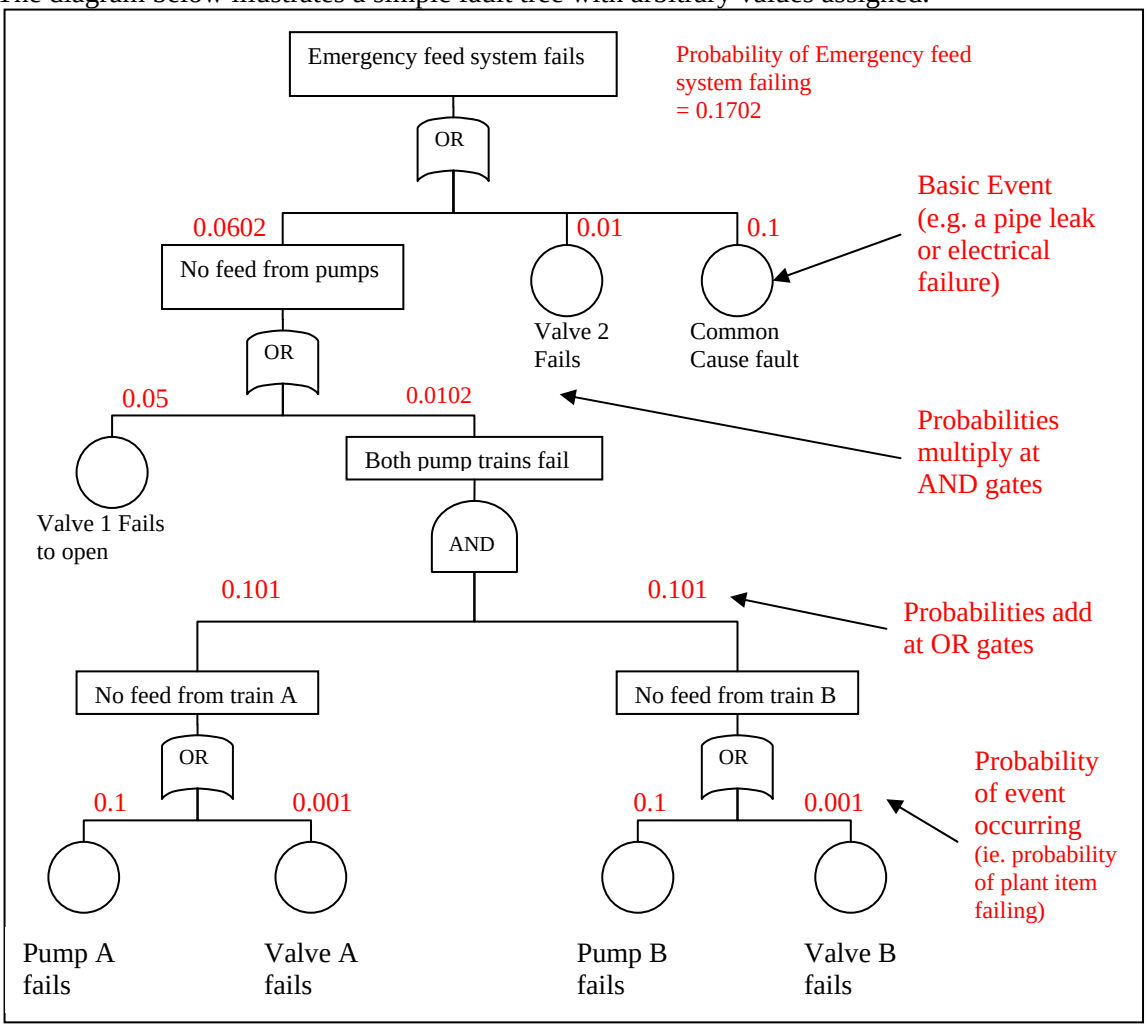
Use of Boolean Logic and Probabilistic Analysis in work

During my YINI placement I have been working in the Safety Case Team for Hinkley Point B and Hunterston B nuclear power stations at British Energy – part of EDF Energy, the owner and operator of eight nuclear power stations in the UK.

When designing and operating a nuclear power station, safety is a top priority. Modern power stations operate with the help of Probabilistic Safety Analysis (PSA). This enables the frequency of radiological releases to be calculated, and helps the Company keep the frequency of these events as low as reasonably practicable (ALARP), with a target of less than a 1 in a million chance of a significant release per year.

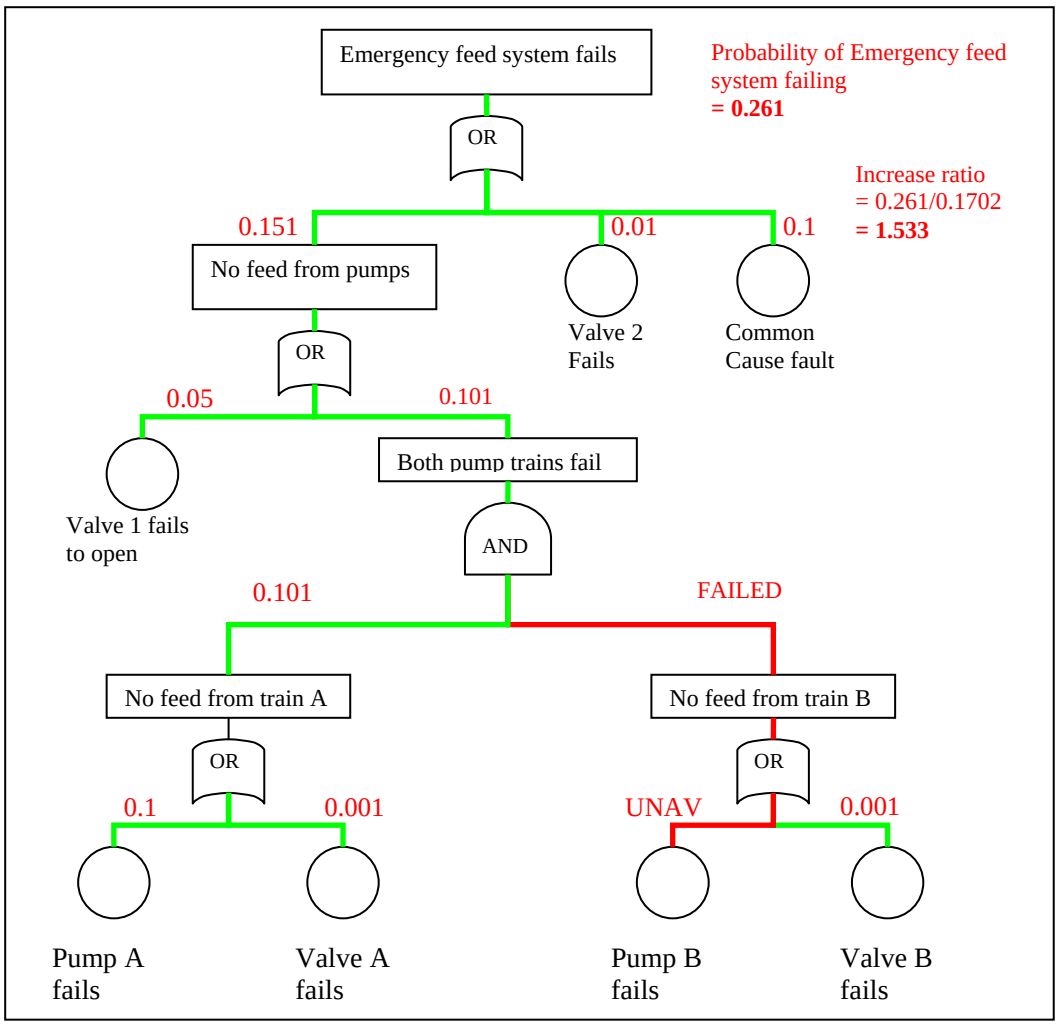
The frequency of radiological releases is calculated using a PSA model on a computer.
This program enables us to create fault trees using Boolean Logic. Once completed, a model will have hundreds of fault trees and event trees, and the probability of every conceivable hazard and its consequence can be calculated in minutes.

The diagram below illustrates a simple fault tree with arbitrary values assigned.



(Note that real probability values are much lower)

This is a simple example of one fault tree. This fault tree would then connect to other fault trees and event trees in the model relating to different parts of the plant. Fault trees are particularly useful when planning maintenance. Suppose Pump B had to be taken offline for maintenance. One could use the PSA model to work out the probability of the emergency feed system failing if pump B is unavailable - see diagram below.



Making pump B unavailable does not fail the whole system because pump A is still functioning normally. However, the probability of the system failing has increased by a factor of 1.533 as only one pump is now available to feed the system. Therefore the operators would wish to carry out the maintenance of pump B as quickly as possible in order to keep the probability of the system failing ALARP.

By repeating this process on the full PSA model, it is possible to test the contribution each plant item has in reducing the frequency of events.

The graph shows the % increase in events caused by unavailability of combinations of plant items.

As shown in the graph, the frequency of events increases by over 2000% if plant items in case number 21 are made unavailable. Therefore the operating rules would forbid the operators from entering this condition as the frequency of events is no longer ALARP.