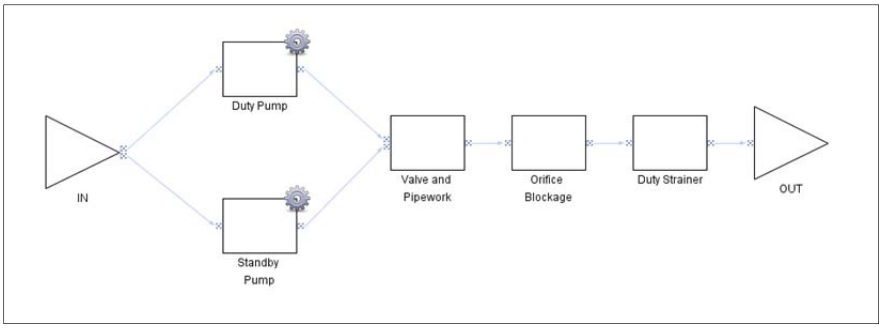
Reliability Analysis

What is it?

Reliability analysis encompasses a range of activities to better understand when and how components or systems may fail or lose functionality. Potential failure modes are identified to estimate the reliability of particular system functions which can be used to build up an estimate of the reliability of the whole system. There is a large range of risk and reliability tools and techniques which can be used, either to support the design, or operational decision making. Component relationships/failure modes are usually expressed using logic diagrams, such as Reliability Block Diagrams (RBDs) or Fault Tree Analysis (FTA).



A RBD uses a functional diagram to help visualise the reliability relationships between the components of a system. The model may then be analysed to provide estimates of expected system reliability, availability and throughput. Each element of the system is represented by a block that is interconnected with the other blocks of the system to represent the logical structure required for mission success. A complete system model may contain various combinations of series and parallel structures. Voting arrangements, such as 2 out of 3, can also be represented.

Fault tree diagrams are logical models that display the state of a system (top event) in terms of the states of its components (basic events). Like RBDs, fault tree diagrams are a graphical design technique; however, unlike RBDs they are used to represent mission failure, rather than success.

Industries in which FTA/RBDs are commonly used include nuclear power, aerospace, communication systems, chemical and other industrial processes.

Why is it important?

FTA and RBDs provide important information about the relative strengths and weaknesses of a system and can identify the importance of components or sub-systems, with respect to the reliability of the system (as per, BS 5760-2 and BS 5760-7). They are also useful tools to present graphically how a system can fail in an easily understandable way. In addition, they can be used for:

- Identification of the causes or combinations of causes leading to the top event.
- Determination of whether a particular system reliability measure meets a stated requirement.
- Determination of the factor(s) which most seriously affects the reliability of a particular system which provides an indication of the changes required to improve that measure.
- Identification of common dependencies or common cause failures.

What we do

CRA has extensive experience in reliability modelling, encompassing the following areas of expertise:

- Examination of the effect of changes to plant configuration on system reliability.
- Review of component reliability data that is used to populate reliability models. In particular, reviewing and updating component reliability data based upon operational experience.
- Perform Human Error (HE) quantification to represent human interactions. CRA uses the most up to date Human Reliability Analysis (HRA) techniques in Nuclear (NARA) and Rail (RARA) as well as using more generic methods such as HEART and THERP for other industries.
- Common Cause Failure (CCF) modelling, including the use of alpha factor, beta factor and Unified Partial Method (UPM) techniques.
- Assessments of maintenance schedules through modelling changes to component test intervals and advising on optimisation of maintenance schedules.

Our work

CRA have developed and maintained the Probabilistic Safety Analysis (PSA) models for the UK AGR fleet, making us the leading provider of reliability assessments for existing UK nuclear power plants. Most of the systems on nuclear power plants are in fact conventional in nature. Our understanding of these systems and how they are modelled means that CRA are well placed to develop similar models for other designs and industries. Example projects include:

- **Steam Supply:** Conducting a reliability study of a redesigned auxiliary steam system. The existing FTA model was reviewed against the as-built plant configuration and updates made as required. In addition, sensitivity studies were performed to help inform various options for operational configuration – in particular taking redundant trains of a system out of service following a seismic event.
- **Electrical Distribution & Supply:** Conducting a reliability assessment for nuclear submarine refuelling. This involved extensive modelling of electrical supplies and included allowance for common cause failure and human error quantification.
- **Water Coolant Supply:** Modelling the pressure vessel cooling system for UK nuclear power stations. This involved using the output from an FMEA workshop to develop functional block diagrams and fault trees to model cooling circuits, pumps and operator actions.
- **Operator Reliability:** Conducted an assessment of rail control system reliability and operator reliability during a study into improving track worker safety.
- **Hazard Modelling:** Maintained and improved many of the Train Hazardous Event fault trees at the heart of the UK Rail Safety Risk Model.