HUMAN RELIABILITY ANALYSIS

The expectations of the Office for Nuclear Regulation (*ONR*) with respect to Human Reliability Analysis (*HRA*) are set out in the ONR Safety Assessment Principles (*SAPs*). In particular SAP EHF.10 must be considered to ensure human errors are adequately represented in the nuclear safety case.

- **EHF.10**: Human Reliability Analysis should identify and analyse all human actions and administrative controls that are necessary for safety.

Of note is Paragraph 465 of the SAPs which states:

"*The analysis should be conducted as part of Design Basis Analysis (DBA), Probabilistic Safety Analysis (PSA) and Severe Accident Analysis (SAA) aspects of the safety case (see Fault analysis, Paragraph 605 ff.). Proportionate analysis should be undertaken to support the claims and arguments made in regard to these actions and administrative controls*."

The HRA should be conducted by a Suitably Qualified and Experienced Person(s) (*SQEP*) or supervised by those who are. It should take consideration of latent errors that may otherwise remain hidden within the human-machine system as described by Kirwan, 'A Guide to Practical Human Reliability Assessment'. Paragraph 466 of the SAPs addresses this and states:

"*The human reliability analysis should include: pre-fault [pre safety-case identified fault] human actions during maintenance, calibration or testing activities where error could result in the non-availability of equipment or systems important to safety; actions that contribute to initiating events; post-fault human actions; and long-term recovery actions in severe accidents*."

Keeping in mind the proportionality of the analysis, according to Paragraph 467 of the SAPs the human error data used for the HRA should:

- Be derived from operational experience data and/or through the application of recognised human reliability assessment techniques. The approach adopted should be justified in terms of its relevance to the task and context.
- Be underpinned by task analysis as described in SAP EHF.5, taking into account the range of factors that might influence the performance of operators.
- Be on a best-estimate basis, properly justified and make due allowance for uncertainties.

The possibility for dependency in human actions should be explored and modelled. Dependency can exist in errors made by single operator and multiple operator task actions. The factors that may create dependency should be considered as part of the Human Error Analysis (*HEA*) and included in the event tree or other method used to show dependency. Paragraph 468 of the SAPs addresses this and the need to be careful of unrealistically low single or combined human error probabilities:

"*Contingent operator actions and dependent human errors committed by single or multiple operators should be modelled explicitly in the human reliability analysis and accounted for quantitatively. The analysis should also account for indirect dependence and avoid unrealistically low single or combined human error probabilities being propagated through the fault analysis*."

In relation to the HRA process, SAP EHF.3 must be considered:

- **EHF.3**: a systematic approach should be taken to identify human actions that can impact safety for all permitted operating modes and all fault and accident conditions identified in the safety case, including severe accidents.

In particular Paragraph 447 of the SAPs highlights the need to identify:

"*… all the safety actions of personnel responsible for monitoring and controlling the facility and of personnel carrying out maintenance, testing and calibration activities. It also includes consideration of the impact on safety arising from engineers, analysts, managers, directors and other personnel who may not interact directly with plant or equipment*."

The main HEA techniques used in the UK are the Human Error Assessment and Reduction Technique (*HEART*) as described in Williams' 'HEART: A Proposed Method for Assessing and Reducing Human Error' and the Technique for Human Error Rate Prediction (*THERP*) as described in Swain and Guttmann's 'Handbook for Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications'. In addition, and for use in the UK, EDF have developed a tailored HEART based technique called Nuclear Action Reliability Assessment (*NARA*) details of which can be found in 'A User Manual for the Nuclear Action Reliability Assessment (NARA) Human Error Quantification Technique'.

Additional Information & Guidance

- ONR, Safety Assessment Principles for Nuclear Facilities, 2014 Edition Revision 1 (January 2020).
- Kirwan, B. (1994), A Guide to Practical Human Reliability Assessment. Basingstoke, Taylor & Francis.
- Williams, J. (1986), HEART – A Proposed Method for Assessing and Reducing Human Error. In 9th Advances in Reliability Technology Symposium, University of Bradford.
- Swain, A.D. & Guttmann, H.E., Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications. 1983, NUREG/CR-1278, USNRC.
- A User Manual for the Nuclear Action Reliability Assessment (NARA) Human Error Quantification Technique. (2011) EDF Energy Nuclear Generation Ltd.