



Minimum Human Error Probabilities (HEP) and Minimum Joint HEPs in Event and Condition Analysis

to

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On Development of the Safety Report on HRA for Nuclear Installations

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Risk Assessment Standardization Project (RASP) Handbook

- RASP Handbooks are NRC internal guidance and, publicly available documents
- Documents methods and provides guidance to NRC risk analysts and model developers on performing:
 - Significance Determination Process (SDP)
 - Accident Sequence Precursor (ASP)
 - Event analyses

RASP Handbook (Continued)

- Currently RASP volumes:
 - [Volume 1 – Internal Events \(Revision 2.01\)](#)
 - [Volume 2 – External Events \(Revision 1.01\)](#)
 - [Volume 3 – SPAR Model Review \(Revision 2\)](#)
 - [Volume 4 – Shutdown Events \(Revision 1.0\)](#)

RASP Manual Guidance on Human Reliability Analysis (HRA)

- Found in Volume 1, Section 9
- Minimum HEP for single Human Failure Event (HFE) value
- Determination of dependency
- Minimum Joint HEP values

Minimum HEP for Single HFE Value

- Historically: “Good Practices for Implementing Human Reliability Analysis (HRA),” NUREG-1792 recommends values between $1E-1$ and $1E-4$ for single post-initiator HEP
- Current NRC interpretation takes into consideration EPRI 1021081, “Establishing Minimum Acceptable Values for Probabilities of HFEs: Practical Guidance for PRA,” G. Parry 2010
- Allows values between $1E-5$ and $1E-6$ in following circumstances if all of below criterion are met:
 - Well-practiced and
 - Familiar responses with expansive time to respond and
 - Numerous indications of need for action and
 - Procedural guidance and training that leads to monitoring of plant status to assess efficacy of response, thus allowing opportunity for self-correction and
 - Low workload (i.e., no distractions)

Historical Determination of Dependency

- Two subtasks are assumed to be dependent unless they can be shown to be independent (THERP)
- Typically, existence of dependency was determined using THERP degree of dependency rules

Current NRC's Guidance on Determination of Dependency

- At HFE level (i.e., between task) two task should be considered independent unless it can be shown they are dependent
- Dependence at HFE level occurs when incorrect mental model exists and persists across time
- Therefore, as dependence arises from mindset, key to postulating dependence between HFEs is postulating single mindset that spans HFEs

Factors Allowing for Minimized Dependence

- Time (to allow forgetting and emptying of working memory)
 - Analyst must consider time available to implement recovery actions against time required to determine influence of this factor on dependency. For example, whereas ten minutes may have no impact, one or more shift turnovers may have a significant influence on dependency
- Location (introducing new information, potentially interrupting script)
- Different persons or crew (allows for mindset to develop)
- New cues (stimulate the human to rethink)

Some Compelling Reasons for Dependence (list is not exhaustive)

- No feedback
- Misleading feedback
- Masking of symptoms
- Disbelieving indications
- Incorrect situation assessment or understanding of event in progress
- Situation mimics often-experienced sequence
- Situation triggers well-rehearsed, well-practiced response, and
- Time demand, workload, and task complexity (such that slip, lapse, or mistake is more likely)
- Multiple actions relying on cues or diagnoses

Historical Minimum Joint HEP Values

- ASME PRA Standard through 2003 required establishment of minimum joint HEP
 - This requirement deleted in subsequent revisions
 - PRA standard is currently silent to requirement for joint HEP minimum
- NUREG-1792 recommends minimum joint HEP of 1E-5

NRC's Current Minimum Joint HEP Value Guidance

- Joint HEPs between $1E-5$ and $1E-6$ are permissible with sufficient basis
- Consideration of sufficient basis include:
 - What are differences in indications among HFEs? Do those indications bring in new information?
 - Was there turnover in shift (meaning is time to perform both actions longer than at least one shift's duration)?
 - Were there successes that are indicative of “resetting” of mindsets on operators?
 - How much time is available?
 - What is distribution of workload among operating crew for different HFEs?
- Analyst should not use values below $1E-6$

References

- NUREG -1792, *Good Practices for Implementing Human Reliability Analysis (HRA)*, April 2005
- NUREG/CR-6883, *The SPAR-H Human Reliability Analysis Method*, August 2005
- ASME RA-Sa-2003 *Addenda to ASME RA-S-2002 Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications*, December 2003
- INL/EXT-10-18533, *SPAR-H Step by Step Guidance*, May 2011 (ML112060305)
- *Human Reliability and Safety Analysis Data Handbook*, D.I. Gertman and H.S. Blackman, 1994
- EPRI 1021081, *Establishing Minimum Acceptable Values for Probabilities of Human Failure Events: Practical Guidance for PRA*, G. Parry, 2010
- *SPAR-SD Model Maker's Guideline*, Revision 2.2, April 2011
- EPRI 3002003150, *A Process for HRA Dependency Analysis and Considerations on Use of Minimum Values for Joint Human Error Probabilities*, M. Presley, 2016