Assessment of Human Errors

An assessment was performed for the DOE Savannah River Site to quantify human errors, "Savannah River Site Human Error Data Base Development for Nonreactor Nuclear Facilities," Westinghouse Savannah River Co., WSRC-TR-93-581, February 28. 1994. This data base includes models and quantification for 35 representative human errors.

Results of the DOE survey indicated that two main human reliability analysis (HRA) models are typically used to quantify human error:

THERP - Technique for Human Error Rate Prediction (Ref.: *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications*, A.D. Swain and H.E. Guttmann, NUREG/CR-1278, August 1983.

ASEP - *Accident Sequence Evaluation Program Human Reliability Analysis Procedure*, Martin Marietta Energy Systems, Inc., ES/CSET-16, May 1993.

In addition, several other human reliability models have been used:

HCR - *Human Cognitive Model for PRA Analysis (draft)*, NUS Corporation, NUS-4531, December 1984.

INTENT - "INTENT: A method for estimating human error probabilities for discision-based errors," *Reliability Engineering and System Safety*, 35, 1992, pp. 127-138.

Actual national or regional data for transportation accidents and expert judgment elicitations (based on T.A. Wheeler, et al., *Analysis of Core Damage Frequency from Internal Events: Expert Judgment Elicitation*, NUREG/CR-4450, Vol. 2, 1989) have also been used to quantify human errors.

Guidelines for selecting error factors (EFs), the 95th percentile divided by the 50th percentile, based on a assumed lognormal distribution are summarized in a Table 1.

Table 1 - Guidelines for selection of EFs

Human error mean failure probability (P)	Suggested error factor (EF)
$0.0 < P < 0.01$	10
$0.01 \leq P < 0.1$	5
$0.1 \leq P \leq 0.3$	3
$0.3 < P \leq 0.5$	2

B/30

$0.5 < P \leq 1.0$	1

The human error events listed in Table 2 may be considered to be applicable to this risk-informed evaluation. (Recommended cross-reference scheme examples are: 1N, 3H or 10L.)

Table 2 - Recommended human error probabilities and rates

Human error event	Type	Failure probability or rate		Notes
		Mean	EF	
1. Failure of administrative control (Failure to follow a policy or procedure)	Nominal	0.01	5	Typical circumstances
	High	0.1	3	Unusual circumstances
	Low	0.001	10	Routine, repetitive
2. Failure to respond to compelling signal	Nominal	0.01	5	Several competing signals
	High	0.1	3	Many competing signals
	Low	0.003	10	Few competing signals
3. Failure to verify inside control room (Commission and omission)	Nominal	0.01	5	Good layout, procedures
	High	0.05	5	Poor layout, procedures
	Low	0.003	10	Excellent layout, procedures
4. Failure to verify outside control room (Commission and omission)	Nominal	0.03	5	Good layout, procedures
	High	0.1	3	Poor layout, procedures
	Low	0.01	5	Excellent layout, procedures
5. Error in selecting control inside control room (Commission and omission)	Nominal	0.01	5	Good layout, procedures
	High	0.03	5	Poor layout, procedures
	Low	0.001	10	Excellent layout, procedures
6. Error in selecting control or valve outside control room (Commission and omission)	Nominal	0.01	5	Good layout, procedures
	High	0.05	5	Poor layout, procedures
	Low	0.003	10	Excellent layout, procedures

Human error event	Type	Failure probability or rate		Notes
		Mean	EF	
7. Communication error	Nominal	0.05	5	Moderate information
	High	0.5	2	Complex information
	Low	0.001	10	Simple information
8. Failure to restore following test	Nominal	0.01	5	Single-person, operator check
	High	0.03	5	Single-person, no check
	Low	0.005	10	Two-person team, operator check
9. Failure to restore following maintenance	Nominal	0.01	5	Single-person, operator check
	High	0.1	3	Single-person, no check
	Low	0.005	10	Two-person team, operator check
10. Random actuation or shutdown of system	Nominal	$1x10^{-5}$/hr	10	Some activities could affect system
	High	$1x10^{-4}$ /hr	10	Many activities could affect system
	Low	$1x10^{-6}$ /hr	10	Almost no activities affect system
11. Diagnosis error, Knowledge-based	Nominal	0.01	5	30 to 120 minutes
	High	0.1	3	10 to 30 minutes
	Low	0.001	10	> 120 minutes
12. Failure of visual inspection to observe abnormal characteristics	Nominal	0.1	3	Procedure, easy to observe
	High	0.5	2	Difficult to observe
	Low	0.01	5	Procedure, very easy to observe
13. Incorrect reading or recording of data	Nominal	0.01	5	Good display
	High	0.5	2	Poor display
	Low	0.003	10	Excellent display
14. Miscalibration	Nominal	0.01	5	Single-person, operator check
	High	0.05	5	Single-person, no check
	Low	0.005	10	Two-person team, operator check

Human error event	Type	Failure probability or rate		Notes
		Mean	EF	
15. Failure to verify parameter with calculation	Nominal	0.03	5	Procedure usually used
	High	0.1	3	No verification
	Low	0.005	10	Procedure mostly used
16. Failure of manual fire detection	Nominal	0.1	3	Area occupied 80% of time
	High	0.5	2	Area unoccupied
	Low	0.05	5	Area occupied 100% of time
17. Failure of manual fire suppression by occupant	Nominal	0.1	3	Typical fire extinguisher
	High	0.5	2	Poor fire extinguisher
	Low	0.05	5	Excellent fire extinguisher
18. Failure of manual fir suppression by non-occupant	Nominal	0.5	2	10 minute response time
	High	1.0	1	> 10 minute response time
	Low	0.1	3	< 10 minute response time
19. Failure of long-term accident recovery	Nominal	0.003	10	24 to 48 hours to recover
	High	0.1	3	< 24 hours to recover
	Low	$3x10^{-5}$	10	3 to 7 days to recover
20. TBD	Nominal			
	High			
	Low			
21. TBD	Nominal			
	High			
	Low			
22. TBD	Nominal			
	High			

Human error event	Type	Failure probability or rate		Notes
		Mean	EF	
	Low			
23. TBD	Nominal			
	High			
	Low			