

SPAR Human Reliability Analysis

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SPAR Human Reliability Analysis

- SPAR-H methodology
 - Simple method with worksheets for consistency (worksheets hardwired in the SAPHIRE code)
 - Decomposes probability into diagnosis and action failures
 - Pre-defined base-case Performance Shaping Factors (PSFs) and Human Error Probabilities (HEPs)
 - Base-case diagnosis failure (1E-2) and base-case action failure (1E-3)
 - Diagnosis application limited to complex actions where diagnosis required prior to action
 - Performance shaping factors - available time, stress, experience/training, complexity, ergonomics, procedures, fitness for duty, work processes
 - Dependency assignments based on crew (same or different), timing proximity, location, additional cues

SPAR Human Reliability Analysis

- SPAR model operator action values are a hybrid of the SPAR-H HRA methodology and licensee values
 - Operator actions are initially evaluated using the SPAR-H methodology
 - Values of important/common actions are then compared to the 'licensee values' for these actions
 - 'Licensee values' are the geometric mean of event values found in PRA results
 - Hi/Low spread of specific licensee values approximately 100X
 - Actions with a value difference $\leq 3X$ are retained without further modification
 - Actions with a value difference of $>3X$ are revisited
 - Shaping factors were scrutinized to determine reasonable adjustments to make values more consistent

SPAR Human Reliability Analysis

- SPAR modelers have access to and knowledge of NSSS vendor Emergency Procedures and Severe Accident Guidelines
 - Access to plant specific procedures is very limited
- 60 - 80 operator actions in a typical SPAR model
- Approximately two dozen generic actions with generic values are incorporated in the models
- Very limited credit for operators recovering failed equipment
 - Recoveries of failed diesel generators is the primary exception
 - EPS-XHE-XL-***
- Pre-initiator HEPs
 - Minimal application of miscalibration HEPs
 - However, SPAR failure data includes many pre-initiator failures
 - Failure to restore events after maintenance modeled (-XR-)

SPAR Human Reliability Analysis

- SPAR model Peer Reviews identified two items that should be added to the SPAR HRA application
 - A standardized method to characterize dependencies
 - Dependency impacts are limited
 - Adequacy of dependency analyses in the SPAR is under review
 - An evaluation of dependency is made for specific applications
 - A standardized method to identify HFEs
 - Initial identification of HFEs is based on generic NSSS vendor Emergency Procedures/Severe Accident Guidelines and operations experience of SPAR analysts
 - Identification of important HFEs is completed during the benchmarking process

SPAR Human Reliability Analysis

- Examples of generically loaded SPAR actions

BASIC EVENT	DESCRIPTION	SPAR HEP	LICENSEE VALUE (geomean)	APPLICABILITY
ADS-XHE-XM-MDEPR	OPERATOR FAILS TO INITIATE REACTOR DEPRESSURIZATION	5.0E-04	1.3E-03	BWR
ADS-XHE-XM-ADSINHIB	OPERATOR FAILS TO INHIBIT ADS	1.0E-03	2.5E-03	BWR
CVS-XHE-XM-VENT	OPERATOR FAILS TO VENT CONTAINMENT	1.0E-03	1.2E-03	BWR
OPR-XHE-XM-CTRLTAF	OPERATOR FAILS TO CONTROL LEVEL TO TAF	2.5E-02	2.8E-02	BWR
OPR-XHE-XM-NOOVRFIL	OPERATOR FAILS TO CONTROL RPV LEVEL	1.0E-02	8.2E-03	BWR
PCS-XHE-XM-L1BYP	OPERATOR FAILS TO BYPASS MSIV LEVEL 1 TRIP	2.5E-01	3.4E-01	BWR
RCI-XHE-XM-OPERATE	OPERATOR FAILS TO START/CONTROL RCIC INJECTION	2.0E-03	5.1E-03	BWR
RHR-XHE-XM-SPC	OPERATOR FAILS TO INITIATE SPC COOLING	5.0E-04	2.9E-04	BWR
SLC-XHE-XM-INJ	OPERATOR FAILS TO START/CONTROL SLC	5.0E-03	4.3E-03	BWR
ISL-XHE-XD-DIAG	OPERATOR FAILS TO DIAGNOSE ISLOCA	4.0E-2*	*	BWR/PWR
ISL-XHE-XM-REC	OPERATOR FAILS TO RECOVER (ISOLATE) ISLOCA RUPTURE	4.0E-3*	*	BWR/PWR
CVC-XHE-XM-BORATION	OPERATOR FAILS TO INITIATE EMERGENCY BORATION	2.0E-02	1.2E-02	PWR
HPI-XHE-XM-FAB	OPERATOR FAILS TO INITIATE FEED AND BLEED COOLING	2.0E-02	1.3E-02	PWR
HPI-XHE-XM-RECIRC	OPERATOR FAILS TO START/CONTROL HIGH PRESSURE RECIRC	4.0E-03	7.2E-03	PWR
HPI-XHE-XM-RWSTR	OPERATOR FAILS TO REFILL THE RWST	4.0E-02	2.4E-02	PWR
HPI-XHE-XM-THRTL	OPERATOR FAILS TO CONTROL/TERMINATE SAFETY INJECTION FLOW	2.0E-03	3.2E-03	PWR
LPI-XHE-XM-RECIRC	OPERATOR FAILS TO INITIATE LOW PRESSURE RECIRCULATION	2.0E-02	2.5E-02	PWR
MSS-XHE-XM-SGISO	OPERATOR FAILS TO ISOLATE FAULTED STEAM GENERATOR	2.0E-03	3.1E-03	PWR
OPR-XHE-XM-DEPRCS	OPERATOR FAILS TO DEPRESSURIZE RCS/SECONDARY (SSC)	4.0E-03	3.9E-03	PWR
PPR-XHE-XM-BLK	OPERATOR FAILS TO CLOSE PRESSURIZER BLOCK VALVE	2.0E-03	2.1E-03	PWR
RCS-XHE-XM-RCPTRIP	OPERATOR FAILS TO TRIP RCPs AFTER LOSS OF COOLING	1.0E-03	2.8E-03	PWR
RCS-XHE-XM-SGTR	OPERATOR FAILS TO IDENTIFY SGTR AND IMPLEMENT PROCEDURES	1.0E-03	5.0E-04	PWR
RCS-XHE-XM-ECA312	OPERATOR FAILS TO IMPLEMENT SGTR PROCEDURE ECA 3_1/3_2 (W)	4.0E-03	2.6E-03	PWR
RHR-XHE-XM-RHR	OPERATOR FAILS TO INITIATE RHR/SD COOLING	1.0E-03	4.0E-04	PWR

* Values from white paper and not from SPAR-H. No licensee comparison performed.