

Component Unavailability Data Sheets

Update 2015

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UPDATE NOTES

This file represents the second update to the original set of component availability data sheets, which was completed in February 2007. The original set of component availability data sheets were extracted from NUREG/CR-6928 [Reference 4] and generally contained data from the date range of 2002 to 2004. This file generally represents availability results using a date range of 2002 to 2015.

No significant differences from the current estimates to the estimates in NUREG/CR-6928 were noted.

The curve fitting of the MSPI availability data was changed to a Normal distribution, based on recommendations from statisticians.

The date of each availability update sheet is in the footer of the availability data sheet. Some of the availability data sheets have not been updated since the original NUREG/CR-6928 since the particular piece of data is not maintained and have February 2007 in the footer.

Table 1. Comparison with previous availability estimates.

Rule	Description	2010 Data		2015 Data		Difference	Comments
		Distribution	Mean	Distribution	mean		
HDR-RHRSW	RHRSW Header Total Unavailability	Exponential	9.66E-04	Normal	1.20E-03	24%	
MDP-RHRSW	Motor Driven Pump Test And Maintenance, RHR Service Water	Gamma	3.85E-03	Normal	4.55E-03	18%	
HCS-SW	Service Water for the High Pressure Core Spray Generator	Gamma	4.79E-03	Normal	5.54E-03	16%	
HDR-ESW	ESW Header Total Unavailability	Exponential	7.92E-03	Normal	8.95E-03	13%	
EDG-HCS	HPCS Diesel Generator Test And Maintenance	Gamma	1.06E-02	Normal	1.17E-02	11%	
HDR-RHR	RHR Header Total Unavailability	Gamma	5.76E-04	Normal	6.36E-04	11%	
HTX-RHR-BWR	Heat Exchanger And Pump Train Test Or Maintenance (RHR-BWR)	Gamma	2.36E-03	Normal	2.55E-03	8%	
MDP-HCS	Motor Driven Pump Test And Maintenance, Clean System	Gamma	7.05E-03	Normal	7.35E-03	4%	
MDP-RHR-BWR	Motor Driven Pump Test And Maintenance, Clean System	Gamma	5.74E-03	Normal	5.95E-03	4%	
EDG-EPS	Diesel Generator Test And Maintenance	Gamma	1.44E-02	Normal	1.48E-02	3%	
TDP-RCI	Turbine Driven Pump Test Or Maintenance (HPCI-RCI)	Gamma	1.02E-02	Normal	1.04E-02	2%	
TDP-HCI	Turbine Driven Pump Test Or Maintenance (HPCI-RCI)	Gamma	1.15E-02	Normal	1.17E-02	2%	
TDP-AFW	Turbine Driven Pump Test Or Maintenance (AFW)	Gamma	5.33E-03	Normal	5.24E-03	-2%	
MDP-RHR	Motor Driven Pump Test And Maintenance, Clean System	Gamma	5.37E-03	Normal	5.18E-03	-3%	
MDP-HPI	Motor Driven Pump Test And Maintenance, Clean System	Gamma	3.45E-03	Normal	3.32E-03	-4%	
MDP-RHR-PWR	Motor Driven Pump Test And Maintenance, Clean System	Gamma	5.15E-03	Normal	4.81E-03	-7%	
MDP-CCW	Motor Driven Pump Test And Maintenance, Clean System	Gamma	4.79E-03	Normal	4.46E-03	-7%	
MDP-AFW	Motor Driven Pump Test And Maintenance, Clean System	Gamma	3.63E-03	Normal	3.34E-03	-8%	

Rule	Description	2010 Data		2015 Data		Difference	Comments
		Distribution	Mean	Distribution	mean		
EDP-ESW	Engine Driven Pump Test And Maintenance	Gamma	3.18E-02	Normal	2.89E-02	-9%	
HDR-HPI	HPI Header Total Unavailability	Gamma	2.48E-04	Normal	2.21E-04	-11%	
MDP-ALL	Motor Driven Pump Test And Maintenance, Clean System	Gamma	7.00E-03	Normal	6.21E-03	-11%	
HDR-ISO	ISO Header Total Unavailability	Gamma	4.52E-03	Normal	4.01E-03	-11%	
EDP-AFW	Engine Driven Pump Test And Maintenance	Gamma	7.45E-03	Normal	6.44E-03	-14%	
HTX-CCW	Heat Exchanger Test Or Maintenance (CCW)	Exponential	8.54E-03	Normal	7.31E-03	-14%	
EDG-SW	Service Water for the Emergency Diesel Generator	Gamma	1.15E-02	Normal	9.17E-03	-20%	
MDP-ESW	Motor Driven Pump Test And Maintenance, Clean System	Exponential	1.32E-02	Normal	9.66E-03	-27%	
HDR-CCW	CCW Header Total Unavailability	Gamma	6.55E-04	Normal	3.17E-04	-52%	
HDR-AFW	AFW Header Total Unavailability	Exponential	8.54E-03	Normal	5.61E-04	-93%	
HTX-ESW	Heat Exchanger Test Or Maintenance (ESW)	None		Normal	1.50E-02		
HTX-RHR-PWR	Heat Exchanger And Pump Train Test Or Maintenance (RHR-BWR)	None		Normal	2.42E-04		
MDP-FWS	Feed Water System Motor-Driven Pumps Total Unavailability	None		Normal	9.44E-03		

Component/Train Unavailability Summaries

1 MSPI Unavailability Data

Table 1-1. MSPI UA data and fitted distributions.

EDG-EPS (100 Plants, 2002--2015)			EDG-HCS (8 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	1.48E-02	1.48E-02	Mean	1.17E-02	1.17E-02
SD	6.33E-03	6.30E-03	SD	2.49E-03	2.50E-03
95%	2.52E-02	2.52E-02	95%	1.57E-02	1.58E-02
Median	1.48E-02	1.48E-02	Median	1.17E-02	1.17E-02
5%	4.36E-03	4.44E-03	5%	7.56E-03	7.59E-03
EF	1.70	1.70	EF	1.34	1.35
μ	--	1.48E-02	μ	--	1.17E-02
σ	--	6.30E-03	σ	--	2.50E-03
EDG-SW (4 Plants, 2002--2015)			HCS-SW (7 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	9.17E-03	9.17E-03	Mean	5.54E-03	5.54E-03
SD	7.02E-03	7.00E-03	SD	1.31E-03	1.30E-03
95%	2.07E-02	2.07E-02	95%	7.69E-03	7.64E-03
Median	9.17E-03	9.20E-03	Median	5.54E-03	5.50E-03
5%	-2.38E-03	-2.31E-03	5%	3.39E-03	3.36E-03
EF	2.26	2.25	EF	1.39	1.39
μ	--	9.20E-03	μ	--	5.50E-03
σ	--	7.00E-03	σ	--	1.30E-03
EDP-AFW (5 Plants, 2002--2015)			EDP-ESW (4 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	6.44E-03	6.44E-03	Mean	2.89E-02	2.89E-02
SD	1.43E-03	1.40E-03	SD	5.07E-03	5.10E-03
95%	8.79E-03	8.70E-03	95%	3.73E-02	3.73E-02
Median	6.44E-03	6.40E-03	Median	2.89E-02	2.89E-02
5%	4.09E-03	4.10E-03	5%	2.06E-02	2.05E-02
EF	1.36	1.36	EF	1.29	1.29
μ	--	6.40E-03	μ	--	2.89E-02
σ	--	1.40E-03	σ	--	5.10E-03
HDR-AFW (7 Plants, 2002--2015)			HDR-CCW (14 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	5.61E-04	5.61E-04	Mean	3.17E-04	3.17E-04
SD	6.71E-04	7.00E-04	SD	6.93E-04	7.00E-04
95%	1.67E-03	1.75E-03	95%	1.46E-03	1.45E-03
Median	5.61E-04	6.00E-04	Median	3.17E-04	3.00E-04
5%	-5.43E-04	-5.51E-04	5%	-8.22E-04	-8.51E-04
EF	2.98	2.92	EF	4.61	4.83
μ	--	6.00E-04	μ	--	3.00E-04
σ	--	7.00E-04	σ	--	7.00E-04

Table 1-1. (continued).

HDR-ESW (26 Plants, 2002--2015)			HDR-HPI (8 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	8.95E-03	8.95E-03	Mean	2.21E-04	2.21E-04
SD	2.40E-02	2.40E-02	SD	1.83E-04	2.00E-04
95%	4.85E-02	4.85E-02	95%	5.22E-04	5.29E-04
Median	8.95E-03	9.00E-03	Median	2.21E-04	2.00E-04
5%	-3.06E-02	-3.05E-02	5%	-8.03E-05	-1.29E-04
EF	5.42	5.39	EF	2.36	2.65
μ	--	9.00E-03	μ	--	2.00E-04
σ	--	2.40E-02	σ	--	2.00E-04
HDR-ISO (4 Plants, 2002--2015)			HDR-RHR (8 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	4.01E-03	4.01E-03	Mean	6.36E-04	6.36E-04
SD	1.79E-03	1.80E-03	SD	1.24E-03	1.20E-03
95%	6.95E-03	6.96E-03	95%	2.68E-03	2.57E-03
Median	4.01E-03	4.00E-03	Median	6.36E-04	6.00E-04
5%	1.06E-03	1.04E-03	5%	-1.41E-03	-1.37E-03
EF	1.73	1.74	EF	4.21	4.28
μ	--	4.00E-03	μ	--	6.00E-04
σ	--	1.80E-03	σ	--	1.20E-03
HDR-RHRSW (5 Plants, 2002--2015)			HTX-CCW (34 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	1.20E-03	1.20E-03	Mean	7.31E-03	7.31E-03
SD	1.02E-03	1.00E-03	SD	8.22E-03	8.20E-03
95%	2.87E-03	2.84E-03	95%	2.08E-02	2.08E-02
Median	1.20E-03	1.20E-03	Median	7.31E-03	7.30E-03
5%	-4.65E-04	-4.45E-04	5%	-6.20E-03	-6.19E-03
EF	2.39	2.37	EF	2.85	2.85
μ	--	1.20E-03	μ	--	7.30E-03
σ	--	1.00E-03	σ	--	8.20E-03
HTX-ESW (13 Plants, 2002--2015)			HTX-RHR-BWR (3 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	1.50E-02	1.50E-02	Mean	2.55E-03	2.55E-03
SD	6.84E-03	6.80E-03	SD	1.82E-03	1.80E-03
95%	2.63E-02	2.62E-02	95%	5.55E-03	5.56E-03
Median	1.50E-02	1.50E-02	Median	2.55E-03	2.60E-03
5%	3.78E-03	3.81E-03	5%	-4.45E-04	-3.61E-04
EF	1.75	1.75	EF	2.18	2.14
μ	--	1.50E-02	μ	--	2.60E-03
σ	--	6.80E-03	σ	--	1.80E-03

Table 1-1. (continued).

HTX-RHR-PWR (14 Plants, 2002--2015)			MDP-ALL (103 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	2.42E-04	2.42E-04	Mean	6.21E-03	6.21E-03
SD	4.37E-04	4.00E-04	SD	4.54E-03	4.50E-03
95%	9.61E-04	8.58E-04	95%	1.37E-02	1.36E-02
Median	2.42E-04	2.00E-04	Median	6.21E-03	6.20E-03
5%	-4.76E-04	-4.58E-04	5%	-1.26E-03	-1.20E-03
EF	3.97	4.29	EF	2.21	2.19
μ	--	2.00E-04	μ	--	6.20E-03
σ	--	4.00E-04	σ	--	4.50E-03
MDP-AFW (66 Plants, 2002--2015)			MDP-CCW (51 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	3.34E-03	3.34E-03	Mean	4.46E-03	4.46E-03
SD	1.91E-03	1.90E-03	SD	3.89E-03	3.90E-03
95%	6.49E-03	6.43E-03	95%	1.09E-02	1.09E-02
Median	3.34E-03	3.30E-03	Median	4.46E-03	4.50E-03
5%	1.92E-04	1.75E-04	5%	-1.94E-03	-1.91E-03
EF	1.94	1.95	EF	2.44	2.42
μ	--	3.30E-03	μ	--	4.50E-03
σ	--	1.90E-03	σ	--	3.90E-03
MDP-ESW (99 Plants, 2002--2015)			MDP-FWS (14 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	9.66E-03	9.66E-03	Mean	9.44E-03	9.44E-03
SD	1.17E-02	1.17E-02	SD	5.52E-03	5.50E-03
95%	2.90E-02	2.89E-02	95%	1.85E-02	1.84E-02
Median	9.66E-03	9.70E-03	Median	9.44E-03	9.40E-03
5%	-9.65E-03	-9.54E-03	5%	3.61E-04	3.53E-04
EF	3.00	2.98	EF	1.96	1.96
μ	--	9.70E-03	μ	--	9.40E-03
σ	--	1.17E-02	σ	--	5.50E-03
MDP-HCS (8 Plants, 2002--2015)			MDP-HPI (69 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	7.35E-03	7.35E-03	Mean	3.32E-03	3.32E-03
SD	2.31E-03	2.30E-03	SD	1.98E-03	2.00E-03
95%	1.11E-02	1.11E-02	95%	6.58E-03	6.59E-03
Median	7.35E-03	7.30E-03	Median	3.32E-03	3.30E-03
5%	3.55E-03	3.52E-03	5%	6.11E-05	1.03E-05
EF	1.51	1.52	EF	1.98	2.00
μ	--	7.30E-03	μ	--	3.30E-03
σ	--	2.30E-03	σ	--	2.00E-03

Table 1-1. (continued).

MDP-RHR (103 Plants, 2002--2015)			MDP-RHR-BWR (34 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	5.18E-03	5.18E-03	Mean	5.95E-03	5.95E-03
SD	2.45E-03	2.40E-03	SD	1.97E-03	2.00E-03
95%	9.21E-03	9.15E-03	95%	9.19E-03	9.29E-03
Median	5.18E-03	5.20E-03	Median	5.95E-03	6.00E-03
5%	1.16E-03	1.25E-03	5%	2.71E-03	2.71E-03
EF	1.78	1.76	EF	1.54	1.55
μ	--	5.20E-03	μ	--	6.00E-03
σ	--	2.40E-03	σ	--	2.00E-03
MDP-RHR-PWR (69 Plants, 2002--2015)			MDP-RHRSW (22 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	4.81E-03	4.81E-03	Mean	4.55E-03	4.55E-03
SD	2.58E-03	2.60E-03	SD	2.13E-03	2.10E-03
95%	9.05E-03	9.08E-03	95%	8.05E-03	7.95E-03
Median	4.81E-03	4.80E-03	Median	4.55E-03	4.50E-03
5%	5.63E-04	5.23E-04	5%	1.05E-03	1.05E-03
EF	1.88	1.89	EF	1.77	1.77
μ	--	4.80E-03	μ	--	4.50E-03
σ	--	2.60E-03	σ	--	2.10E-03
TDP-AFW (63 Plants, 2002--2015)			TDP-HCI (24 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	5.24E-03	5.24E-03	Mean	1.17E-02	1.17E-02
SD	2.98E-03	3.00E-03	SD	2.69E-03	2.70E-03
95%	1.01E-02	1.01E-02	95%	1.61E-02	1.61E-02
Median	5.24E-03	5.20E-03	Median	1.17E-02	1.17E-02
5%	3.33E-04	2.65E-04	5%	7.25E-03	7.26E-03
EF	1.93	1.94	EF	1.38	1.38
μ	--	5.20E-03	μ	--	1.17E-02
σ	--	3.00E-03	σ	--	2.70E-03
TDP-RCI (30 Plants, 2002--2015)			TDP-ALL (95 Plants, 2002--2015)		
Statistic	Plant Data	Normal Distribution	Statistic	Plant Data	Normal Distribution
Mean	1.04E-02	1.04E-02	Mean	7.25E-03	7.25E-03
SD	4.57E-03	4.60E-03	SD	4.24E-03	4.20E-03
95%	1.79E-02	1.80E-02	95%	1.42E-02	1.41E-02
Median	1.04E-02	1.04E-02	Median	7.25E-03	7.20E-03
5%	2.88E-03	2.83E-03	5%	2.72E-04	2.92E-04
EF	1.72	1.73	EF	1.96	1.96
μ	--	1.04E-02	μ	--	7.20E-03
σ	--	4.60E-03	σ	--	4.20E-03

Acronyms - AFW (auxiliary feedwater), BWR (boiling water reactor), CCW (component cooling water), EDG (emergency diesel generator), EDGSW (EDG service water), EDP (engine driven pump), EPS (emergency power system), ESW (emergency service water), FWS (feedwater system), HDR (header), HPCI (high pressure coolant injection), HPCS (high pressure core spray), HPSI (high pressure safety injection), HTX (heat exchanger), IC (isolation condenser), MDP (motor driven pump), PWR (pressurized water reactor), RCIC (reactor core isolation cooling), RHR (residual heat removal), RHRSW (RHR service water), TDP (turbine driven pump), UA (unavailability)

2 Other Unavailability Estimates

Table 2-1. Other Source UA estimates.

Train Unavailability Event	Description	Data		Recommended Probability Distribution				
		Source	Reference	Distribution	Mean	α	β	Error Factor
ACX-TM	Air Handling/Heating Fan Test Or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	2.50E-03	0.50	199.5	8.4
BAC-TM	AC Bus In Test Or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	2.00E-04	0.50	2499.5	8.4
BAT-TM	Battery Test or Maintenance	IPEs	Letter: Generic Test and Maintenance Unavailability Values, JCN W6467 - MBS-02- 99	Lognormal	2.72E-03	52.90	--	8.4
BCH-TM	Battery Charger Test & Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	2.00E-03	0.50	249.5	8.4
BDC-TM	DC Bus Test & Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	2.00E-04	0.50	2499.5	8.4
CCP-TM-RPS	RPS Channel-A IN T&M	IPEs	RPS Study NUREGs; NUREG/CR-5500, Vol 2,3,10, and 11	Beta	5.00E-03	0.24	47.8	30.2
CHL-TM	Chiller Unit In Test Or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	2.00E-02	0.50	24.5	8.2
CRB-TM	Circuit Breaker Test Or Maintenance	IPEs	Letter: Generic Test and Maintenance Unavailability Values, JCN W6467 - MBS-02- 99	Lognormal	5.00E-01	0.50	--	2.0
CTF-TM	Cooling Tower Fan Test Or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	2.00E-03	0.50	249.5	8.4
CTG-TM	Gas Turbine Generator Test & Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	5.00E-02	0.50	9.5	7.7
DDC-TM	Diesel Driven Compressor Fails Due To T&M	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	1.20E-02	0.50	41.2	8.3
EDC-TM	Engine-Driven Compressor Test or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	1.20E-02	0.50	41.2	8.3
EPV-TM	Explosive-Operated (SQUIBB) Valve Test or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	6.00E-04	0.50	832.8	8.4
FAN-TM	HVAC Fan In Test Or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	2.00E-03	0.50	249.5	8.4

Train Unavailability Event	Description	Data		Recommended Probability Distribution				
		Source	Reference	Distribution	Mean	α	β	Error Factor
HTX-TM	Heat Exchanger In Test Or Maintenance	IPEs	SPAR (IPEs)	Beta	2.50E-03	0.30	119.7	18.7
MDC-TM	Motor-Driven Compressor Test or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	1.20E-02	0.50	41.2	8.3
PDP-TM	Positive Displacement Pump Test Or Maintenance	IPEs	NUREG/CR-6928 Appendix B, Section B.4	Beta	3.00E-03	0.50	166.2	8.4
TFM-TM	Startup Transformer Test or Maintenance	IPEs	Letter: Generic Test and Maintenance Unavailability Values, JCN W6467 - MBS-02-99	Lognormal	1.75E-03	90.50	--	8.4

3 References

1. U.S. Nuclear Regulatory Commission, "Mitigating Systems Performance Index (MSPI)," <http://nrc.gov/NRR/OVERSIGHT/ASSESS/mspi.html>.
2. U.S. Nuclear Regulatory Commission, "Reactor Oversight Process (ROP)," <http://nrc.gov/NRR/OVERSIGHT/ASSESS/index.html>.
3. M.S. DeHaan et al., "Generic Test and Maintenance Unavailabilities Based on Data from the IPEs," September 1999, attached to letter from M.B. Sattison, Idaho National Laboratory, to E.G. Rodrick, U.S. Nuclear Regulatory Commission, MBS-02-99, September 20, 1999.
4. S.A. Eide et al., *Industry-Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, NUREG/CR-6928, January 2007.