Component Availability Data Sheets

Update 2010

Table of Contents

UPDATE NOTES

This file represents the first 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 2010.

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

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.

Component/Train Unavailability Summaries

1 MSPI Unavailability Data

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

EPS EDG UA (258 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.44E-02	1.44E-02
SD	8.35E-03	7.45E-03
95%	2.84E-02	2.84E-02
Median	1.27E-02	1.31E-02
5%	4.64E-03	4.64E-03
EF	2.24	2.17
α		3.71
β		254.7

HPCS EDG UA (8 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.06E-02	1.06E-02
SD	1.72E-03	1.61E-03
95%	1.33E-02	1.33E-02
Median	1.06E-02	1.05E-02
5%	8.05E-03	8.05E-03
EF	1.26	1.27
α		42.88
β		4021.4

EPS EDGSW UA (6 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.15E-02	1.15E-02
SD	6.39E-03	6.48E-03
95%	2.38E-02	2.38E-02
Median	1.18E-02	1.03E-02
5%	3.23E-03	3.23E-03
EF	2.02	2.32
α		3.12
β		269.2

HPCS EDGSW UA (140 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	4.72E-03	4.79E-03
SD	5.52E-03	4.41E-03
95%	1.35E-02	1.35E-02
Median	3.13E-03	3.52E-03
5%	3.60E-04	3.60E-04
EF	4.33	3.85
α		1.18
β		244.8

AFW EDP UA (5 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	7.45E-03	7.45E-03
SD	1.44E-03	1.25E-03
95%	9.63E-03	9.63E-03
Median	7.29E-03	7.38E-03
5%	5.52E-03	5.52E-03
EF	1.32	1.30
α		35.27
β		4698.1

ESW EDP UA (10 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	3.18E-02	3.18E-02
SD	8.77E-03	8.58E-03
95%	4.71E-02	4.71E-02
Median	3.48E-02	3.10E-02
5%	1.91E-02	1.91E-02
EF	1.35	1.52
α		13.74
β		418.3

AFW HDR UA (85 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	8.54E-03	8.54E-03
SD	9.52E-03	8.54E-03
95%	2.56E-02	2.56E-02
Median	5.14E-03	5.92E-03
5%	4.40E-04	4.40E-04
EF	4.98	4.32
α		1.00
β		116.1

CCW HDR UA (4 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	4.40E-04	6.55E-04
SD	3.40E-04	1.50E-05
95%	6.80E-04	6.80E-04
Median	6.40E-04	6.55E-04
5%	6.31E-04	6.31E-04
EF	1.06	1.04
α		1906.44
β		2908695.7

Table 1-1. (continued).

ESW HDR UA (86 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	7.92E-03	7.92E-03
SD	3.97E-02	7.92E-03
95%	2.37E-02	2.37E-02
Median	2.30E-04	5.49E-03
5%	4.00E-04	4.00E-04
EF	103.04	4.32
α		1.00
β		125.3

HPSI HDR UA (24 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.40E-04	2.48E-04
SD	2.10E-04	2.29E-04
95%	7.00E-04	7.00E-04
Median	4.00E-05	1.82E-04
5%	1.80E-05	1.80E-05
EF	17.50	3.85
α		1.17
β		4740.4

IC HDR UA (6 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	4.52E-03	4.52E-03
SD	2.43E-03	2.23E-03
95%	8.70E-03	8.70E-03
Median	4.15E-03	4.16E-03
5%	1.58E-03	1.58E-03
EF	2.10	2.09
α		4.11
β		905.0

RHR HDR UA (8 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	5.60E-04	5.76E-04
SD	8.20E-04	1.83E-04
95%	9.06E-04	9.06E-04
Median	5.90E-04	5.56E-04
5%	3.11E-04	3.11E-04
EF	1.54	1.63
α		9.90
β		17188.6

RHRSW HDR UA (6 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	9.70E-04	9.66E-04
SD	8.50E-04	9.66E-04
95%	2.90E-03	2.90E-03
Median	8.85E-04	6.70E-04
5%	5.00E-05	5.00E-05
EF	3.27	4.32
α		1.00
β		1033.9

CCW HTX UA (85 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	8.54E-03	8.54E-03
SD	9.52E-03	8.54E-03
95%	2.56E-02	2.56E-02
Median	5.14E-03	5.92E-03
5%	4.40E-04	4.40E-04
EF	4.98	4.32
α		1.00
β		116.1

ESW HTX UA (4 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.54E-02	1.54E-02
SD	1.82E-03	1.82E-03
95%		1.85E-02
Median		1.53E-02
5%		1.25E-02
EF		1.21
α		70.39
β		4503.3

BWR RHR HTX UA (6 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	2.36E-03	2.36E-03
SD	1.41E-03	1.66E-03
95%	5.58E-03	5.58E-03
Median	2.69E-03	1.98E-03
5%	4.19E-04	4.19E-04
EF	2.08	2.82
α		2.00
β		848.3

Table 1-1. (continued).

PWR RHR HTX UA (2 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.20E-04	1.20E-04
SD	7.00E-05	7.00E-05
95%		2.53E-04
Median		1.07E-04
5%		3.21E-05
EF		2.37
α		2.94
β		24482.9

ALL MDP UA (1045 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	6.90E-03	7.00E-03
SD	1.00E-02	6.72E-03
95%	2.04E-02	2.04E-02
Median	4.26E-03	5.00E-03
5%	4.00E-04	4.00E-04
EF	4.79	4.08
α		1.08
β		153.8

AFW MDP UA (124 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	3.63E-03	3.63E-03
SD	2.24E-03	2.26E-03
95%	7.95E-03	7.95E-03
Median	3.26E-03	3.17E-03
5%	8.60E-04	8.60E-04
EF	2.44	2.51
α		2.58
β		710.2

CCW MDP UA (140 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	4.72E-03	4.79E-03
SD	5.52E-03	4.41E-03
95%	1.35E-02	1.35E-02
Median	3.13E-03	3.52E-03
5%	3.60E-04	3.60E-04
EF	4.33	3.85
α		1.18
β		244.8

ESW MDP UA (298 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.32E-02	1.32E-02
SD	1.63E-02	1.32E-02
95%	3.97E-02	3.97E-02
Median	7.96E-03	9.17E-03
5%	7.00E-04	7.00E-04
EF	4.99	4.33
α		1.00
β		74.6

FWS MDP UA (4 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	8.86E-03	8.86E-03
SD	2.76E-03	2.76E-03
95%		1.38E-02
Median		8.58E-03
5%		4.85E-03
EF		1.61
α		10.20
β		1141.6

HPCS MDP UA (8 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	7.05E-03	7.05E-03
SD	2.82E-03	2.72E-03
95%	1.21E-02	1.21E-02
Median	6.71E-03	6.71E-03
5%	3.24E-03	3.24E-03
EF	1.80	1.80
α		6.70
β		943.8

HPI MDP UA (199 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	3.45E-03	3.45E-03
SD	2.15E-03	2.20E-03
95%	7.68E-03	7.68E-03
Median	3.31E-03	2.99E-03
5%	7.70E-04	7.70E-04
EF	2.32	2.57
α		2.45
β		708.0

Table 1-1. (continued).

MDP-RHR (221 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	5.27E-03	5.37E-03
SD	2.92E-03	2.97E-03
95%	1.10E-02	1.10E-02
Median	4.90E-03	4.83E-03
5%	1.58E-03	1.58E-03
EF	2.24	2.27
α		3.27
β		607.0

MDP-RHR-BWR (80 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	5.74E-03	5.74E-03
SD	2.28E-03	2.30E-03
95%	9.97E-03	9.97E-03
Median	5.76E-03	5.43E-03
5%	2.55E-03	2.55E-03
EF	1.73	1.83
α		6.23
β		1078.6

MDP-RHR-PWR (141 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	5.01E-03	5.15E-03
SD	3.19E-03	3.18E-03
95%	1.13E-02	1.13E-02
Median	4.43E-03	4.52E-03
5%	1.24E-03	1.24E-03
EF	2.54	2.49
α		2.62
β		506.4

MDP-RHRSW (51 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	3.64E-03	3.85E-03
SD	2.07E-03	2.00E-03
95%	7.62E-03	7.62E-03
Median	3.33E-03	3.51E-03
5%	1.25E-03	1.25E-03
EF	2.29	2.17
α		3.72
β		961.0

TDP-AFW (66 Trains, 2002 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	5.33E-03	5.33E-03
SD	3.06E-03	3.83E-03
95%	1.28E-02	1.28E-02
Median	4.94E-03	4.44E-03
5%	9.00E-04	9.00E-04
EF	2.59	2.88
α		1.93
β		360.5

TDP-HCI (24 Trains, 2003 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.15E-02	1.15E-02
SD	3.12E-03	3.33E-03
95%	1.74E-02	1.74E-02
Median	1.23E-02	1.11E-02
5%	6.60E-03	6.60E-03
EF	1.42	1.56
α		11.88
β		1024.5

TDP-RCI (30 Trains, 2004 - 2010)		
Statistic	Train Data	Beta Distribution
Mean	1.02E-02	1.02E-02
SD	4.82E-03	4.28E-03
95%	1.81E-02	1.81E-02
Median	8.12E-03	9.57E-03
5%	4.29E-03	4.29E-03
EF	2.23	1.89
α		5.65
β		550.1

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. Comparison of IPE and ROP SSU UA estimates.

System Train	IPE UA (1980s) (61 Plants)	MSPI UA (2002 - 2004) (103 Plants)	IPE/MSPI	ROP SSU UA (1998 - 2002) (103 Plants)	IPE/ROP
EDG	0.0270	0.0134	2.01	0.0090	3.00
HPCI TDP	0.0310	0.0130	2.38	0.0112	2.77
HPSI MDP	0.0094	0.0041	2.28	0.0050	1.88
HPCS MDP	0.0140	0.0131	1.07	0.0068	2.06
RCIC TDP	0.0280	0.0107	2.62	0.0129	2.17
AFWS MDP	0.0100	0.0040	2.53	0.0050	2.00
AFWS TDP	0.0240	0.0054	4.41	0.0050	4.80
AFWS DDP	0.0030	0.0097	0.31	0.0050	0.60
RHR BWR	0.0100	0.0076	1.31	0.0073	1.37
RHR PWR	0.0089	0.0052	1.72	0.0052	1.71
		Average	2.06	Average	2.24

Acronyms - AFWS (auxiliary feedwater system), BWR (boiling water reactor), DDP (diesel-driven pump), EDG (emergency diesel generator), HPCI (high-pressure coolant injection), HPSI (high-pressure safety injection), IPE (Individual Plant Examination), MDP (motor-driven pump), MSPI (mitigating systems performance index), PWR (pressurized water reactor), RCIC (reactor core isolation cooling), RHR (residual heat removal), ROP (Reactor Oversight Process), SSU (Safety System Unavailability), TDP (turbine-driven pump), UA (unavailability)

Table 2-2. IPE UA estimates.

Train Unavailability Event	Description	Data Source	Data	Recommended Probability Distribution				
			IPE (Ref. B-3)	Distribution (note a)	Mean	α	β	Error Factor
AHU-TM	Air Handling Unit Test or Maintenance	IPEs	Table C-1, CFC-FAN-TM	Beta (IPEs, SCNID)	2.48E-03	0.50	2.01E+02	8.4
BAC-TM	Bus (ac) Test or Maintenance	IPEs	Table C-1, ACP-BAC-TM	Beta (IPEs, SCNID)	2.15E-04	0.50	2.33E+03	8.4
BCH-TM	Battery Charger Test or Maintenance	IPEs	Table C-1, CDP-BCH-TM	Beta (IPEs, SCNID)	2.20E-03	0.50	2.27E+02	8.4
CHL-TM	Chiller Test or Maintenance	IPEs	Table C-1, EHV-FAN-TM-TRN	Beta (IPEs/2, SCNID)	1.98E-02	0.50	2.48E+01	8.2
CTF-TM	Cooling Tower Fan Test or Maintenance	IPEs	Table C-1, OLW-FAN-TM	Beta (IPEs, SCNID)	1.86E-03	0.50	2.68E+02	8.4
CTG-TM	Combustion Turbine Generator Test or Maintenance	IPEs	Table C-1, GTG-TM	Beta (IPEs/2, SCNID)	5.00E-02	0.50	9.50E+00	7.7
EOV-TM	Explosive-Operated Valve Test or Maintenance	IPEs	Table C-1, SLC-EPV-TM	Beta (IPEs, SCNID)	5.52E-04	0.50	9.05E+02	8.4
FAN-TM	Fan Test or Maintenance	IPEs	Table C-1, EHV-FAN-TM	Beta (IPEs, SCNID)	2.00E-03	0.50	2.50E+02	8.4
HTX-TM	Heat Exchanger Test or Maintenance	IPEs	Table C-1, RHR-HTX-TM	Beta (IPEs, SCNID)	2.74E-03	0.50	1.82E+02	8.4
MDC-TM	Motor-Driven Compressor Test or Maintenance	IPEs	Table C-1, IAS-MDC-TM	Beta (IPEs/2, SCNID)	1.30E-02	0.50	3.80E+01	8.3
PDP-TM	Positive Displacement Pump Test or Maintenance	IPEs	Table C-1, CVC-PDP-TM	Beta (IPEs, SCNID)	3.19E-03	0.50	1.56E+02	8.4

Acronyms - AHU (air-handling unit), BAC (bus ac), BCH (battery charger), CHL (chiller), CNID (constrained noninformative distribution), CTF (cooling tower fan), CTG (combustion turbine generator), EOV (explosive-operated valve), FAN (fan), HTX (heat exchanger), IPE (Individual Plant Examination), LL (lower limit), MDC (motor-driven compressor), PDP (positive displacement pump), SCNID (simplified constrained noninformative distribution), TM (test or maintenance)

Note a - The format for the distributions is the following: distribution type (source for mean, source for α factor). If the source for the mean indicates IPE/2, these are cases in which the IPE value was divided by two to reflect more current performance.

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.