



Summary of SPAR Component Unreliability Data and Results

2010 Paramater Estimation Update

Group	Component Failure Mode	Description	Data Source	Data			Industry-average Failure Probability or Rate Distribution (note a)						Comments (see Appendix A for details)	Effective Date	
				Failures	Demands or Hours	d or h	Components	Distribution (note b)	Analysis Type	Mean	$\alpha$	$\beta$			Error Factor
Pumps	EDP AFW FTR>1H	Engine-Driven Pump (EDP) Standby Fail to Run greater than 1 hour	EPIX	0	231	h	5	Gamma	JNID/IL	2.16E-03	0.500	2.311E+02	3.8		Feb-2012
	EDP AFW FTR≤1H	Engine-Driven Pump (EDP) Standby Fail to Run less than or equal to 1 hour	EPIX	4	584	h	5	Gamma	JNID/IL	7.70E-03	4.500	5.800E+02	1.9		Feb-2012
	EDP AFW FTS	Engine-Driven Pump (EDP) Fail to Start	EPIX	6	1132	d	5	Beta	EB/PL/KS	4.88E-03	0.633	1.291E+02	3.5		Feb-2012
	EDP ELS	Engine-Driven Pump (EDP) External Leak Small	EPIX	7	6267335	h	55	Gamma	JNID/IL	1.20E-06	7.500	6.267E+06	1.7		Feb-2012
	EDP ELL	Diesel-Driven Pump External Leak Large	EPIX		114473	h		Gamma (ELS*0.07, LL)		8.40E-08	0.300	3.571E+06	18.8	> 50 gpm. Small leak times 0.07.	Feb-2007
	EDP FTR>1H	Engine-Driven Pump (EDP) Standby Fail to Run greater than 1 hour	EPIX	9	4182	h	36	Gamma	JNID/IL	2.27E-03	9.500	4.182E+03	1.6	No data. FTR≤1H times 0.06	Feb-2012
	EDP FTR≤1H	Engine-Driven Pump (EDP) Standby Fail to Run less than or equal to 1 hour	EPIX	8	7698	h	36	Gamma	EB/PL/KS	1.26E-03	0.554	4.411E+02	3.7		Feb-2012
	EDP FTS	Engine-Driven Pump (EDP) Fail to Start	EPIX	44	13647	d	41	Beta	EB/PL/KS	5.09E-03	0.732	1.429E+02	3.3		Feb-2012
	MDP ELS	Motor-Driven Pump (MDP) External Leak Small	EPIX	93	258455367	h	2271	Gamma	EB/PL/KS	3.42E-07	0.731	2.136E+06	3.4		Feb-2012
	MDP ELL	Motor-Driven Pump External Leak Large	EPIX			h		Gamma (ELS*0.07, LL)		2.40E-08	0.300	1.252E+07	18.8	> 50 gpm. Small leak times 0.07.	Feb-2007
	MDP FTR	Motor-Driven Pump (MDP) Fail to Run	EPIX	149	45853637	h	704	Gamma	EB/PL/KS	3.53E-06	2.292	6.496E+05	2.3		Feb-2012
	MDP FTS	Motor-Driven Pump (MDP) Fail to Start	EPIX	150	114473	d	706	Beta	EB/PL/KS	1.36E-03	3.282	2.406E+03	2.0		Feb-2012
	MDP SBY FTR>1H	Motor-Driven Pump (MDP) Standby Fail to Run greater than 1 hour	EPIX	110	14219837	h	1341	Gamma	EB/PL/KS	1.04E-05	0.781	7.501E+04	3.3		Feb-2012
	MDP SBY FTR≤1H	Motor-Driven Pump (MDP) Standby Fail to Run less than or equal to 1 hour	EPIX	38	326023	h	1341	Gamma	EB/PL/KS	1.23E-04	1.820	1.479E+04	2.4		Feb-2012
	MDP SBY FTS	Motor-Driven Pump (MDP) Fail to Start	EPIX	315	363935	d	1341	Beta	EB/PL/KS	9.47E-04	1.948	2.054E+03	2.4		Feb-2012
	PDP ELS	Positive Displacement Pump (PDP) External Leak Small	EPIX	14	19599696	h	172	Gamma	JNID/IL	7.40E-07	14.500	1.960E+07	1.5		Feb-2012
	PDP ELL	Positive Displacement Pump External Leak Large	EPIX			h		Gamma (ELS*0.07, LL)		5.18E-08	0.300	5.792E+06	18.8	> 50 gpm. Small leak times 0.07.	Feb-2007
	PDP FTR	Positive Displacement Pump (PDP) Fail to Run	EPIX	48	2216149	h	59	Gamma	EB/PL/KS	2.30E-05	1.152	5.006E+04	2.9		Feb-2012
	PDP FTS	Positive Displacement Pump (PDP) Fail to Start	EPIX	62	25438	d	62	Beta	EB/PL/KS	3.15E-03	1.020	3.229E+02	3.0		Feb-2012
	PDP SBY FTR>1H	Positive Displacement Pump (PDP) Standby Fail to Run greater than 1 hour	EPIX	2	1175	h	74	Gamma	JNID/IL	2.13E-03	2.500	1.175E+03	2.2	No data. FTR≤1H times 0.06	Feb-2012
	PDP SBY FTR≤1H	Positive Displacement Pump (PDP) Standby Fail to Run less than or equal to 1 hour	EPIX	2	3527	h	74	Gamma	JNID/IL	7.09E-04	2.500	3.525E+03	2.2		Feb-2012
	PDP SBY FTS	Positive Displacement Pump (PDP) Fail to Start	EPIX	62	25438	d	62	Beta	JNID/IL	1.79E-03	14.500	8.066E+03	1.5		Feb-2012
	PMP FTR	Pump Volute Fail to Run	EPIX	9	74199	h	180	Gamma (EB/PL/KS, EB/PL/KS)		1.35E-04	1.389	1.029E+04	3.5		Feb-2007
	PMP FTS	Pump Volute Fail to Start	EPIX	4	16776	d	180	Beta (Jeffreys, SCNID)		2.68E-04	0.500	1.864E+03	8.4		Feb-2007
	TDP ELS	Turbine-Driven Pump (TDP) External Leak Small	EPIX	14	20036597	h	178	Gamma	JNID/IL	7.24E-07	14.500	2.004E+07	1.5		Feb-2012
	TDP ELL	Turbine-Driven Pump External Leak Large	EPIX			h		Gamma (ELS*0.07, LL)		5.07E-08	0.300	5.919E+06	18.8	> 50 gpm. Small leak times 0.07.	Feb-2007
	TDP FTR	Turbine-Driven Pump (TDP) Fail to Run	EPIX	39	4276404	h	42	Gamma	EB/PL/KS	9.34E-06	1.792	1.919E+05	2.5		Feb-2012
	TDP FTS	Turbine-Driven Pump (TDP) Fail to Start	EPIX	8	957	d	42	Beta	EB/PL/KS	8.93E-03	0.877	9.728E+01	3.1		Feb-2012
	TDP SBY FTR>1H	Turbine-Driven Pump (TDP) Standby Fail to Run greater than 1 hour	EPIX	12	8028	h	133	Gamma	JNID/IL	1.56E-03	12.500	8.028E+03	1.5		Feb-2012
	TDP SBY FTR≤1H	Turbine-Driven Pump (TDP) Standby Fail to Run less than or equal to 1 hour	EPIX	54	13062	h	133	Gamma	EB/PL/KS	4.43E-03	0.962	2.164E+02	3.0		Feb-2012
TDP SBY FTS	Turbine-Driven Pump (TDP) Fail to Start	EPIX	117	19760	d	133	Beta	EB/PL/KS	6.49E-03	0.942	1.441E+02	3.0		Feb-2012	
Generators	CTG FTLR	Combustion Turbine Generator (CTG) Fail to Load/Run	EPIX	2	156296	d	3	Beta	JNID/IL	1.60E-05	2.500	1.563E+05	2.2		Feb-2012
	CTG FTR	Combustion Turbine Generator (CTG) Fail to Run	EPIX	3	473	h	3	Gamma	JNID/IL	7.40E-03	3.500	4.732E+02	2.0	1998 - 3Q2004 data used. Data limited so EDG FTR used	Feb-2012
	CTG FTS	Combustion Turbine Generator (CTG) Fail to Start	EPIX	10	672	d	3	Beta	JNID/IL	1.56E-02	10.500	6.629E+02	1.6		Feb-2012
	EDG FTLR	Emergency Diesel Generator (EDG) Fail to Load/Run	EPIX	182	49383	d	224	Beta	EB/PL/KS	3.78E-03	2.774	7.311E+02	2.1		Feb-2012
	EDG FTR	Emergency Diesel Generator (EDG) Fail to Run	EPIX	113	106820	h	224	Gamma	EB/PL/KS	1.10E-03	4.487	4.093E+03	1.9		Feb-2012
	EDG FTS	Emergency Diesel Generator (EDG) Fail to Start	EPIX	161	56695	d	224	Beta	EB/PL/KS	2.89E-03	8.111	2.798E+03	1.6		Feb-2012
	EDG-SBO FTLR	EDG-Station Blackout Fail to Load/Run	EPIX	4	444	d	4	Beta		1.01E-02	4.500	4.402E+02	2.0		
	EDG-SBO FTR	EDG-Station Blackout Fail to Run	EPIX	1	1155	h	4	Gamma		1.30E-03	1.500	1.155E+03	3.3		
	EDG-SBO FTS	EDG-Station Blackout Fail to Start	EPIX	14	372	d	4	Beta		4.32E-02	1.094	2.423E+01	4.0		
	HTG FTLR	Hydro Turbine Generator (HTG) Fail to Load/Run	EPIX	6	3087	d	2	Beta	JNID/IL	2.10E-03	6.500	3.081E+03	1.7		Feb-2012
	HTG FTR>1H	Hydro Turbine Generator (HTG) Fail to Run	EPIX	1	7449	h	2	Gamma	JNID/IL	2.01E-04	1.500	7.449E+03	2.6		Feb-2012
	HTG FTS	Hydro Turbine Generator (HTG) Fail to Start	EPIX	7	5141	d	2	Beta	JNID/IL	1.46E-03	7.500	5.135E+03	1.7		Feb-2012



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				Failures	Demands or Hours	d or h	Distribution (note b)	Analysis Type	Mean	$\alpha$	$\beta$			Error Factor
Reactor Protection	BIS FTOP	Bistable Fail to Operate	RPS SSS	55	102094	d	Beta (Jeffreys, SCNID)		5.44E-04	0.500	919.2747748	8.4		Feb-2007
	MSW FTO/C	Manual Switch Fail to Open or Close	RPS SSS	2	19789	d	Beta (Jeffreys, SCNID)		1.26E-04	0.500	3.958E+03	8.4		Feb-2007
	PLDT FTOP	Process Logic (Delta Temperature) Fail to Operate	RPS SSS	24.3	4887	h	Beta (Jeffreys, SCNID)		5.07E-03	0.500	9.803E+01	8.4		Feb-2007
	PLF FTOP	Process Logic (Flow) Fail to Operate	RPS SSS	No data		h	Beta (PLL, SCNID)		6.26E-04	0.500	7.988E+02	8.4	No data, so PLL FTOP used	Feb-2007
	PLL FTOP	Process Logic (Level) Fail to Operate	RPS SSS	3.3	6075	h	Beta (Jeffreys, SCNID)		6.26E-04	0.500	7.988E+02	8.4		Feb-2007
	PLP FTOP	Process Logic (Pressure) Fail to Operate	RPS SSS	5.6	38115	h	Beta (Jeffreys, SCNID)		1.60E-04	0.500	3.124E+03	8.4		Feb-2007
	RLY FTOP	Relay Fail to Operate	RPS SSS	23.7	974417	h	Beta (Jeffreys, SCNID)		2.48E-05	0.500	2.013E+04	8.4		Feb-2007
	RTB (BME) FTO/C	RPS Breaker (Mechanical) Fail to Open or Close	RPS SSS	1.0	97359	d	Beta (Jeffreys, SCNID)		1.54E-05	0.500	3.245E+04	8.4		Feb-2007
	RTB (BSN) FTOP	RPS Breaker (Shunt Trip) Fail to Operate	RPS SSS	14.0	44104	h	Beta (Jeffreys, SCNID)		3.29E-04	0.500	1.520E+03	8.4		Feb-2007
	RTB (BUV) FTOP	RPS Breaker (Undervoltage Trip) Fail to Operate	RPS SSS	23.1	57199	h	Beta (Jeffreys, SCNID)		4.13E-04	0.500	1.211E+03	8.4		Feb-2007
	RTB FTO/C	RPS Breaker (Combined) Fail to Open or Close	RPS SSS			d	Beta (Jeffreys, SCNID)		1.55E-05	0.500	3.217E+04	8.4	RTB combined failure probability is BME + BSN*BUV	Feb-2007
	STF FTOP	Sensor/Transmitter (Flow) Fail to Operate	RPS SSS			h	Beta (STL, SCNID)		8.15E-04	0.500	6.132E+02	8.4	Level sensor/transmitter results used. Both the beta distribution and the gamma	Feb-2007
	STL FTOP	Sensor/Transmitter (Level) Fail to Operate	RPS SSS	5.0	6750	d	Beta (Jeffreys, SCNID)		8.15E-04	0.500	6.132E+02	8.4	Both the beta distribution and the gamma distribution must be used (added). For the	Feb-2007
	STP FTOP	Sensor/Transmitter (Pressure) Fail to Operate	RPS SSS	2.3	23960	d	Beta (Jeffreys, SCNID)		1.17E-04	0.500	4.278E+03	8.4	Both the beta distribution and the gamma distribution must be used (added). For the	Feb-2007
STT FTOP	Sensor/Transmitter (Temperature) Fail to Operate	RPS SSS	35.2	43430451	h	Gamma (Jeffreys, SCNID)		8.22E-07	0.500	6.083E+05	8.4	Both the beta distribution and the gamma distribution must be used (added). For the	Feb-2007	
Control Rods	CRD FTOP	Control Rod Drive Fail to Operate	EPIX	13	136286592	h	Gamma	JNID/IL	9.91E-08	13.500	1.363E+08	1.5		Feb-2012
	CRD SOP	Control Rod Drive (CRD) Spurious Operation	EPIX	26	136286592	h	Gamma	JNID/IL	1.94E-07	26.500	1.363E+08	1.3		Feb-2012
	HCU FTI	Hydraulic Control Unit (HCU) Fail to Insert	EPIX	2	269552	d	Beta	JNID/IL	9.27E-06	2.500	2.696E+05	2.2		Feb-2012
	HCU FTOP	Hydraulic Control Unit (HCU) Fail to Operate	EPIX	22	747292641	h	Gamma	EB/PL/KS	3.28E-08	0.633	1.931E+07	3.5		Feb-2012
	HCU SOP	Hydraulic Control Unit (HCU) Spurious Operation	EPIX	14	747292641	h	Gamma	JNID/IL	1.94E-08	14.500	7.473E+08	1.5		Feb-2012
	ROD FTOP	Control Rod (ROD) Fail to Operate	EPIX	28	95605727	h	Gamma	JNID/IL	2.98E-07	28.500	9.561E+07	1.3		Feb-2012
	ROD SOP	Control Rod (ROD) Spurious Operation	EPIX	18	95605727	h	Gamma	JNID/IL	1.94E-07	18.500	9.561E+07	1.4		Feb-2012
	AHU FTR	Air Handling Unit (AHU) Fail to Run	EPIX	52	12998080	h	Gamma	EB/PL/KS	5.61E-06	0.774	1.379E+05	3.3		Feb-2012
	AHU FTS	Air Handling Unit (AHU) Fail to Start	EPIX	44	12566	d	Beta	EB/PL/KS	3.86E-03	0.461	1.189E+02	3.9		Feb-2012
	AHU SBY FTR>1H	Air Handling Unit (Standby) Fail to Run After First Hour of Operation	EPIX	0	131445	h	Gamma		3.80E-06	0.500	1.314E+05	8.4		Feb-2012
	AHU SBY FTR<=1H	Air Handling Unit (Standby) Fail to Run During First Hour of Operation	EPIX	4	6965	h	Gamma		2.28E-03	0.300	1.316E+02	18.8		Feb-2012
	AHU SBY FTS	Air Handling Unit (Standby) Fail to Start	EPIX	10	22251	d	Beta		8.29E-04	0.360	4.339E+02	13.5		Feb-2012
	AOD FTO/C	Air Damper (DMP) Fail to Open/Close	EPIX	10	28725	d	Beta	JNID/IL	3.66E-04	10.500	2.872E+04	1.6		Feb-2012
	AOD SOP	Air Damper (DMP) Spurious Operation	EPIX	1	20625312	h	Gamma	JNID/IL	7.27E-08	1.500	2.063E+07	2.6		Feb-2012
CHL FTR	Chiller (CHL) Fail to Run	EPIX	180	5913615	h	Gamma	JNID/IL	3.05E-05	180.500	5.914E+06	1.1		Feb-2012	
CHL FTS	Chiller (CHL) Fail to Start	EPIX	84	19071	d	Beta	EB/PL/KS	1.30E-02	0.581	4.408E+01	3.6		Feb-2012	
FAN FTR	Fan (FAN) Fail to Run	EPIX	59	12619800	h	Gamma	EB/PL/KS	5.88E-06	0.530	9.019E+04	3.8		Feb-2012	
FAN FTS	Fan (FAN) Fail to Start	EPIX	42	59920	d	Beta	JNID/IL	7.09E-04	42.500	5.988E+04	1.3		Feb-2012	
FAN SBY FTR>1H	Fan (FAN) Standby Fail to Run greater than 1 hour	EPIX	4	99174	h	Gamma	JNID/IL	4.54E-05	4.500	9.917E+04	1.9		Feb-2012	
FAN SBY FTR<=1H	Fan (FAN) Standby Fail to Run less than or equal to 1 hour	EPIX	33	31278	h	Gamma	JNID/IL	1.07E-03	33.500	3.125E+04	1.3		Feb-2012	
FAN SBY FTS	Fan (FAN) Fail to Start	EPIX	34	40959	d	Beta	JNID/IL	8.42E-04	34.500	4.093E+04	1.3		Feb-2012	
HOD FTO/C	Air Damper (DMP) Fail to Open/Close	EPIX	20	35320	d	Beta	JNID/IL	5.80E-04	20.500	3.530E+04	1.4		Feb-2012	
HOD ILS	Air Damper (DMP) Internal Leak Small	EPIX	0	13902144	h	Gamma	JNID/IL	3.60E-08	0.500	1.390E+07	3.8		Feb-2012	
HOD SOP	Air Damper (DMP) Spurious Operation	EPIX	8	13902144	h	Gamma	JNID/IL	6.11E-07	8.500	1.390E+07	1.6		Feb-2012	
MOD FTO/C	Air Damper (DMP) Fail to Open/Close	EPIX	7	28537	d	Beta	EB/PL/KS	2.33E-04	1.546	6.634E+03	2.6		Feb-2012	
MOD ILS	Air Damper (DMP) Internal Leak Small	EPIX	1	10825440	h	Gamma	JNID/IL	1.39E-07	1.500	1.083E+07	2.6		Feb-2012	
MOD SOP	Air Damper (DMP) Spurious Operation	EPIX	0	10825440	h	Gamma	JNID/IL	4.62E-08	0.500	1.083E+07	3.8		Feb-2012	

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Miscellaneous Equipment	ACC ELS	Accumulator (ACC) External Leak Small	EPIX	8	76505917	h	675	Gamma	JNID/IL	1.11E-07	8.500	7.651E+07	1.6		Feb-2012
	ACC ELL	Air Accumulator External Leak Large	EPIX			h		Gamma (ELS*0.07, LL)		7.77E-09	0.300	3.861E+07	18.8	Small leak times 0.07	Feb-2007
	ADU FTOP	Air Dryer Unit Fail to Operate	WSRC			h		Gamma (WSRC, LL)		5.00E-06	0.300	6.000E+04	18.8		Feb-2007
	CTF FTR	Cooling Tower Fan (CTF) Fail to Run	EPIX	2	1086740	h	20	Gamma	JNID/IL	2.30E-06	2.500	1.087E+06	2.2		Feb-2012
	CTF FTS	Cooling Tower Fan (CTF) Fail to Start	EPIX	1	1941	d	20	Beta	JNID/IL	7.73E-04	1.500	1.940E+03	2.6		Feb-2012
	CTF SBY FTR>1H	Cooling Tower Fan (CTF) Standby Fail to Run greater than 1 hour	EPIX	9	334665	h	46	Gamma	JNID/IL	2.84E-05	9.500	3.347E+05	1.6		Feb-2012
	CTF SBY FTR≤1H	Cooling Tower Fan (CTF) Standby Fail to Run less than or equal to 1 hour	EPIX	9	334665	h	46	Gamma	JNID/IL	2.84E-05	9.500	3.347E+05	1.6		Feb-2012
	CTF SBY FTS	Cooling Tower Fan (CTF) Fail to Start	EPIX	18	23885	d	46	Beta	EB/PL/KS	3.54E-03	0.578	1.625E+02	3.6		Feb-2012
	EDC FTR	Engine-driven Air Compressor (EDC) Fail to Run	EPIX	15	5687	h	5	Gamma	EB/PL/KS	3.78E-03	0.633	1.676E+02	3.5		Feb-2012
	EDC FTS	Engine-driven Air Compressor (EDC) Fail to Start	EPIX	2	1019	d	5	Beta	JNID/IL	2.45E-03	2.500	1.017E+03	2.2		Feb-2012
	HTX CCW/RHR LOHT	Heat Exchanger (HTX) Loss of Heat Transfer	EPIX	16	31564654	h	277	Gamma	JNID/IL	5.23E-07	16.500	3.156E+07	1.4	Data limited to CCW and RHR systems	Feb-2012
	HTX SHELL ELS	Heat Exchanger (HTX) External Leak Small	EPIX	60	222547790	h	1953	Gamma	EB/PL/KS	3.34E-07	0.616	1.842E+06	3.6		Feb-2012
	HTX SHELL ELL	Heat Exchanger Shell External Leak Large	EPIX			h		Gamma (ELS*0.07, LL)		2.34E-08	0.300	1.282E+07	18.8	> 50 gpm. Small leak times 0.07.	Feb-2007
	HTX TUBE ELL	Heat Exchanger (HTX) Loss of Heat Transfer	EPIX	82	222547790	h	1953	Gamma	EB/PL/KS	4.57E-07	0.534	1.170E+06	3.8	> 50 gpm. Small leak times 0.15.	Feb-2012
	HTX TUBE ELS	Heat Exchanger (HTX) Internal Leak Small	EPIX	78	222547790	h	1953	Gamma	EB/PL/KS	3.79E-07	0.430	1.133E+06	4.1		Feb-2012
	MDC FTR	Air Compressor (CMP) Fail to Run	EPIX	389	5540316	h	128	Gamma	EB/PL/KS	8.50E-05	2.003	2.357E+04	2.4		Feb-2012
	MDC FTS	Air Compressor (CMP) Fail to Start	EPIX	152	24466	d	128	Beta	EB/PL/KS	1.71E-02	0.586	3.372E+01	3.6		Feb-2012
	MDC SBY FTR>1H		EPIX	17.9	10999	h	28	Gamma (EB/PL/KS, EB/PL/KS)		2.62E-03	1.696	6.473E+02	3.1		Feb-2007
	MDC SBY FTR≤1H		EPIX	3	939	h	5	Gamma (EB/PL/KS, LL)		3.14E-03	0.300	9.554E+01	18.6		Feb-2007
	MDC SBY FTS		EPIX	15	2150	d	33	Beta (EB/PL/KS, EB/PL/KS)		7.13E-03	0.476	6.628E+01	8.9		Feb-2007
	ORF PG	Orifice Plug	WSRC			h		Gamma(WSRC, LL)		1.00E-06	0.300	3.000E+05	18.8		Feb-2007
	PIPE OTHER ELS	Piping Non-Service Water System External Leak Small	EPIX	3.5	1583000000	h		Gamma (Jeffreys, SCNID)		2.53E-10	0.500	1.979E+09	8.4	1 to 50 gpm. 1997 - 2004 data. Leakage rate is per hour per foot.	Feb-2007
	PIPE OTHER ELL	Piping Non-Service Water System External Leak Large	EPIX			h-ft		Gamma (ELS*0.1, LL)		2.53E-11	0.300	1.187E+10	18.8	> 50 gpm. Small leak times 0.1. Leakage rate is per hour per foot.	Feb-2007
PIPE SWS ELS	Piping Service Water System External Leak Small	EPIX	8.5	1306000000	h		Gamma (Jeffreys, SCNID)		6.89E-10	0.500	7.256E+08	8.4	1 to 50 gpm. 1997 - 2004 data. Leakage rate is per hour per foot.	Feb-2007	
PIPE SWS ELL	Piping Service Water System External Leak Large	EPIX			h-ft		Gamma (ELS*0.2, LL)		1.38E-10	0.300	2.177E+09	18.8	> 50 gpm. Small leak times 0.2. Leakage rate is per hour per foot.	Feb-2007	
TNK PRES ELS	Tank (TNK) External Leak Small	EPIX	6	19941600	h	175	Gamma	JNID/IL	3.26E-07	6.500	1.994E+07	1.7		Feb-2012	
TNK PRES ELL	Tank Unpressurized External Leak Large	EPIX			h		Gamma (ELS*0.07, LL)		2.28E-08	0.300	1.315E+07	18.8	> 50 gpm. Small leak times 0.07.	Feb-2007	
TNK UNPR ELS	Tank (TNK) External Leak Small	EPIX	6	24955440	h	219	Gamma	JNID/IL	2.60E-07	6.500	2.496E+07	1.7		Feb-2012	
TNK UNPR ELL	Tank Unpressurized External Leak Large	EPIX			h		Gamma (ELS*0.07, LL)		1.82E-08	0.300	1.648E+07	18.8	> 50 gpm. Small leak times 0.07.	Feb-2007	

Acronyms - BWR (boiling water reactor), EB/PL/KS (empirical Bayes/plant level/Kass Steffey), EPIX (Equipment Performance and Information Exchange), JNID/IL (Jeffreys noninformative distribution/industry level), LL (lower limit), PLL (process logic level), PWR (pressurized water reactor), SCNID

Note a - The Jeffreys mean is obtained from a Bayesian update of the Jeffreys noninformative prior. For demand-related events, the mean is  $(n + 0.5)/(D + 1)$ , where n is the number of failures and D is the number of demands. For time-related failures, the mean is  $(n + 0.5)/T$ , where T is the number of

Note b - The error factor is from an empirical Bayes analysis at the plant level, with Kass-Steffey adjustment. The error factor is the 95th percentile divided by the median.

Note b - The format for the distributions is the following: distribution type (source for mean, source for  $\alpha$  factor)